2019

BRITISH MASTITIS CONFERENCE

Organised by

The Dairy Group

British Cattle Veterinary Association

The University of Nottingham
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QMMS

Topics:

- Mycoplasma
- Milking time assessments
- Research updates
- Dairying in unfavourable conditions
- Environmental management of dairy cows
- Mastitis case study

Wednesday 6th November 2019

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GENERAL INFORMATION

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CHAIRMAN'S INTRODUCTION

Welcome to the 2019 British Mastitis Conference.

The Organising Committee has worked hard since last year's conference to bring together a group of speakers, both international and home grown, that we believe will prove thought provoking and stimulating presentations. We have strived to balance the latest research with practical presentations and clear take home messages.

Our first paper looks at Mycoplasma and whether it is an important vector of mastitis in the UK. This is followed by a paper on the importance of milking time assessments in establishing optimum milking performance and hygienic milk production.

Building on the previous success, endorsed by delegates, we have selected four posters from the Knowledge Transfer section for oral presentation. The four papers are followed by an opportunity for delegates to debate with the presenters.

After lunch, we will turn our attention to dairying and mastitis control under difficult environmental conditions, followed by a paper on the environmental management of dairy cows. The conference will be closed by the now, regular and well received slot, on a practical mastitis control case study presented by a dairy producer and his veterinary surgeon.

This year sees another excellent but varied selection of high-quality poster submissions – all targeting improvement in udder health. I urge you all to make time to review the posters and speak with the authors. Each year the presenters put a great deal of effort into providing the abstracts and preparing and presenting their posters.

We endeavour to find you the best speakers with the most relevant (and latest) information. This is only achievable thanks to all our generous sponsors. This year our sponsors are: Vetoquinol (Platinum), Boerhinger Ingelheim (Gold), Hipra (Gold), MSD Animal Health (Gold), milkrite | InterPuls (Silver), Zoetis (Silver) and Ambic (Bronze).

As always, the event could not happen without able administration, provided by Karen Hobbs and Anne Sealey at *The* Dairy Group.

Finally, thank you for attending and supporting the conference. I trust you will have an enjoyable and worthwhile day and we hope to see you at our 32nd BMC in 2020.

Ian Ohnstad, British Mastitis Conference Chairperson
The Dairy Group

TIMETABLE of EVENTS

09:00	**ARRIVE / REGISTRATION / COFFEE and POSTER DISPLAY**	
09:45	**CHAIRMAN'S INTRODUCTION**	**Ian Ohnstad** *The* Dairy Group, UK
	Session One	**Brian Pocknee** DHC, Spain
09:55	Mycoplasma: is it an important mastitis vector?	**Colin Mason** SRUC, UK
10:25	The importance of milking time tests.	**Ian Ohnstad** *The* Dairy Group, UK
10.55	Questions and Discussion	
11:10	**COFFEE and POSTERS**	
	Research updates (also presented as posters)	**Elizabeth Berry** BCVA, UK
11:40	Fast MALDI MS profiling for the analysis of cow milk to investigate clinical and pre-clinical mastitis.	**Cristian Piras** University of Reading, UK
12.00	Do herd mastitis patterns change over time? Study on heifer mastitis - prevalence, risk factors, aetiology and antibiogram in Jammu, North India	**Neelesh Sharma** Sher-e-Kashmir University of Jammu, India
12:20	QuarterPRO - an industry initiative to promote and improve udder health.	**Derek Armstrong** AHDB, UK
12:40	Comparison of two point-of-care tests to support treatment decisions in non-severe bovine clinical mastitis.	**Francisco Malcata** University of Glasgow, UK
13:00	**LUNCH and POSTERS**	
14:10	**WELCOME BACK AND VOTING ON POSTERS**	
	Session Three	**Brian Pocknee** DHC, UK
14.15	Dairying and mastitis control in arduous environmental conditions.	**Sofie Piepers** MEXCELLENCE BVBA, Belgium
14.45	Environmental management of dairy cows.	**Jamie Robertson** Livestock Management Systems Ltd, UK
15.15	Implementation of the AHDB Dairy Mastitis Control Plan to reduce dry period infection rate and improve somatic cell count.	**James Breen** University of Nottingham, UK **Austin Russell** Church Farm, Cirencester, UK
15.45	Questions and Discussion	
16:00	**POSTER AWARD and CLOSE**	
16:05	**TEA and DEPART**	

Titles of Papers and Presenters

Scientific programme

Session One

Research Update Session (also presented as posters)

Session Three

Titles of Posters and Authors

Poster abstracts – presented at the Technology Transfer Session
(presenting author underlined):

Poster abstracts – also as an oral presentation in the Research Updates session

(presenting author underlined)

FURTHER INFORMATION

Organised by *The* Dairy Group, BCVA, QMMS and University of Nottingham

The Dairy Group

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Conference Secretariat: Karen Hobbs & Anne Sealey
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AMBIC

NMC

A global organization for mastitis control and milk quality

National Mastitis Council is a professional organization that promotes research and provides information to the dairy industry to help reduce mastitis and enhance milk quality. For more than 50 years, NMC has distinguished itself internationally as a leader in meeting those objectives.

What does NMC do?

- Provides a forum for the global exchange of information on mastitis and milk quality
- Publishes educational materials, including books and brochures
- Establishes guidelines for mastitis control and milking management practices
- Monitors technological and regulatory developments relating to udder health, milk quality and milk safety
- Conducts meetings and workshops, providing educational opportunities for all segments of the dairy industry
- Funds the NMC Scholars program

Who are the members of NMC?

NMC membership is comprised of people from more than 40 countries, representing a wide range of dairy professionals who share an interest in milk quality and mastitis control. These people include veterinarians, milk quality consultants, dairy producers, university researchers and extension specialists, milk procurement field staff, equipment and supply representatives, regulatory officials and students.

What can NMC do for you?

The continued pressure to ensure milk safety and improve milk quality, as well as the need to increase production efficiency, requires greater team effort among producers, veterinarians and other dairy professionals. Each team member plays a key role in developing successful mastitis control programs. NMC can serve as your resource for information related to udder health, milking management, milk quality and milk safety.

Why join NMC?

- To receive the latest technical and applied information on udder health, milking management and milk quality
- To provide leadership on milk quality issues within the industry
- To participate and learn about mastitis and milk quality developments at NMC meetings
- To establish valuable industry contacts
- To support education and research efforts that help raise awareness and understanding of milk quality issues

NMC membership benefits

- NMC annual meeting and regional meeting proceedings, which contain all of the papers and posters presented at the meetings
- The NMC electronic newsletter addresses the latest information on udder health, milking management and milk quality
- Access to the "members-only" section of the NMC website, which includes the NMC Proceedings Library, NMC newsletter archives and NMC membership directory
- Opportunities to network with other dairy professionals concerned with milk quality, udder health and mastitis prevention, control and treatment

Working together

Since 1961, NMC has coordinated research and educational efforts to help control the losses associated with mastitis. By bringing together all segments of the industry, a strong and successful organization has been created to enhance the quality of milk and dairy products. NMC welcomes your active participation and support. Please visit the NMC website for additional information and resources.

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2019

PAPERS

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MYCOPLASMA BOVIS: IS IT AN IMPORTANT MASTITIS VECTOR?

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MYCOPLASMA BOVIS, THE ORGANISM

Mycoplasma bovis was first recognised as a bovine pathogen in 1961 (Hale et al 1962) and in the UK in the 1970s (Davies and Broughton 1976) and is one of 13 Mycoplasma species known to infect cattle. The significance of mixed Mycoplasma infections in cattle populations will vary depending on scenario with some Mycoplasma species such as *Mycoplasma bovis* and *Mycoplasma dispar* considered more pathogenic than for example *Mycoplasma bovirhinis.* (Nicholas and Ayling 2003). *Mycoplasma bovis* is considered to be the most important mycoplasma mastitis pathogen, although *M. alkalescens, M. bovigenitalium, M. californicum* and *M. canadense* also considered significant (Fox et al 2005). This paper will focus primarily on *Mycoplasma bovis.*

Mycoplasma bovis is known to cause a complex of disease syndromes including mastitis, pneumonia, arthritis, keratoconjunctivitis and otitis media.

Mycoplasma species have no cell wall and instead have a cell membrane with variable surface lipoproteins. These are used for organism attachment and elicit variable immune responses from the host. The organism can also produce and survive in biofilms and it is this plus variable evasion of the host's immune response which permits the organism to persist and cause disease. (Maunsell et al 2011).

THERAPEUTICS AND TREATMENT OPTIONS

Some of the organism's characteristics have a direct effect on antibiotic treatment choices. As the organism has no cell wall B lactam antibiotics are ineffective. The organism does not synthesise folic acid and therefore Sulphonamides are ineffective. *Mycoplasma bovis* tends to be susceptible to antibiotics that interfere with protein or DNA synthesis such as the Tetracyclines, macrolides, lincosamides, florfenicol and fluoroquinolones (Taylor-Robinson et al 1997). The selection of antibiotics to treat Mycoplasma bovis associated disease presents obvious challenges to veterinary practitioners for responsible prescribing: Fluoroquinolones and increasingly macrolides are considered to be High Priority Critically Important Antibiotics (HPCIAs).

Readily available and cheap antibiotic sensitivity testing techniques such as disk diffusion are not appropriate for Mycoplasma species. Therefore, currently assessment of antibiotic sensitivity patterns for *Mycoplasma bovis* isolates cannot easily be carried out in diagnostic labs or veterinary practices. Minimum Inhibitory Concentration (MIC) testing is available for *Mycoplasma bovis* and although more expensive is justifiable in practice to ensure appropriate and responsible antibiotic selections.

A study comparing MIC values for 45 *Mycoplasma bovis* isolates identified between 2004 and 2009 showed increases in MIC values for chloramphenicol, oxytetracycline and the fluoroquinolones suggesting developing resistance (Ayling et al 2014).

DIAGNOSTICS

Given some of the challenges with treatment and management of *Mycoplasma bovis* mastitis, making an accurate diagnosis is important.

Pathogen detection can be achieved by molecular methods, PCR or diffuse gradient gel electrophoresis, (DGGE). DGGE gives an advantage of being able to detect DNA from all potential Mycoplasma species. Mycoplasma culture methods are also available and an isolate is required if assessing antibiotic sensitivity or autogenous vaccine production is being considered. The pathogen detection method has to be considered based on a combination of test cost and reasons for testing and can be applied to milk samples, plus other sample types (lung, swabs, joint fluid etc.). One of the challenges to culture methods is bacterial overgrowth and sampling using Mycoplasma transport media is suggested to reduce these risks.

Serological testing can be of use as part of herd health surveillance and health planning. Seroconversion occurs after 4 weeks. Although this does not prove a direct association with a disease outbreak, it does confirm exposure and if the clinical picture on farm is consistent then this permits future health planning decisions.

DISEASE TRANSMISSION

Transmission of *Mycoplasma bovis* between milking cows might occur either via direct udder and teat contact through the milking machine. Fomite spread is thought to be a significant means of transmission and therefore milkers' hands or tools are another potential risk factor for spread in addition (Fox 2012).

Nasal transmission is another means of spread. Usually after colonisation of mucosal surfaces of the upper respiratory tract there is a period of haematogenous spread which can permit the organism to spread throughout the body, particularly to the lungs, joints and mammary gland. This may bring about more significant herd outbreaks of disease with multiple disease presentations. (Maunsell et al 2012).

Large and expanding herds are a risk factor for Mycoplasma bovis mastitis (Nicholas et al 2016).

MASTITIS CLINICAL PRESENTATIONS

As would be expected *Mycoplasma bovis* can cause clinical and subclinical mastitis in lactating and dry cows. In clinical cases there are some reports of a rice like sediment in the milk, but such clinical signs and variable and should not be considered pathognomonic (Radaelli et al 2011). Clinical cases can show milk changes with or without clinically obvious udder changes. Our experience of mastitis cases in the UK has been with sporadic cases occurring. However, there have been some notable exceptions with outbreaks of disease being seen in conjunction with arthritis and pneumonia and such incidents involving larger numbers of cattle (Houlihan et al 2007).

One common clinical sign is that *Mycoplasma bovis* mastitis cases do not respond well to treatment (Wilson et al 2007).

It has often been considered that *Mycoplasma bovis* can be present asymptomatically in milk and it is through this route that infection can spread initially to calves. One recent study (Tinomen et al 2017) has shown that some *Mycoplasma bovis* PCR positive cattle within an infected herd did not have mastitis. They did however have a reduced daily milk yield, increased somatic cell counts and lower milk fat and urea levels compared to matched *Mycoplasma bovis* negative milk samples within the same herd. This does raise the intriguing question that sub-clinical infections do occur and that there might be a yield effect on cattle that in itself is a justification for control.

CRITICAL CONTROL POINTS FOR DISEASE PREVENTION

Evidence based information relating to *Mycoplasma bovis* transmission risk factors in the UK is lacking, however the information available does permit practical control measures to be implemented on farm.

Biosecurity:

Biosecurity offers significant challenges and potential opportunities for disease control. The current situation is that the *Mycoplasma bovis* status of individual animals purchased and herds of origin are not known. There is also an obvious risk of bringing in naive animals into an endemically infected herd. For the future assessing herd level disease status and maximising animal immunity provide a potential way forward in reducing the disease effects of *Mycoplasma bovis*. Bulk milk PCR and serology testing of the herd of origin offer potential options for assessing herd status. Group calving pens have recently been identified as potential risk factors for *Mycoplasma bovis* transmission which can be addressed (Gile et al 2018).

Teat disinfection:

In experimental models *Mycoplasma bovis* is susceptible to commercial test disinfectants containing 1% Hydrogen peroxide, 1% chlorine dioxide and 0.5%-1% Iodofor solutions (Boddie et al 2002). However these findings may not translate to field conditions in all cases. Other pathways of transmission may also occur such as the nasal route, therefore segregation of affected cows within the shed and also airspace if possible is an important control measure.

CRITICAL CONTROL POINTS FOR PREVENTING DISEASE SPREAD

Given that fomite spread is a significant risk factor the milking process is deemed to be a significant risk.
The following points for limiting spread are important therefore (Nicholas et al 2016):

Purchased cows and heifers should be quarantined in a different shed and airspace and milked last.

Purchased cows and heifers should only be admitted to the main herd once their milk has tested *Mycoplasma bovis* negative.

It is important that large dairy herds and those that are expanding through cattle purchase have a regular bulk milk surveillance programme for *Mycoplasma bovis* to allow early identification of new infections into the herd.

Isolate cows with confirmed Mycoplasma mastitis in a different shed and airspace and milk last.

Milking order should be low risk uninfected cows and heifers, intermediate risk cows (high somatic cell count but unconfirmed Mycoplasma cases) and then confirmed cases.

Milking hygiene should be improved to limit fomite spread with single use towels, gloves and post milking teat disinfection essential to minimise spread. Wash cycles for the milking plant should be reviewed and improved as necessary.

While spontaneous cure might occur, usually this is not the case and confirmed infected cows with unresponsive mastitis or chronic high somatic cell count whose welfare is compromised should be culled (Byrne et al 1998).

Although culling is part of a *Mycoplasma bovis* mastitis control strategy, large scale culling of infected cattle was not associated with a raised clearance time in herds in one study. An equal number of herds cleared the infection without large scale culling within a month of diagnosis, compared to those that did not (Punyapornwithaya et al 2012).

It must always be considered that *Mycoplasma bovis* may be detected in milk either as a sub-clinical or asymptomatic infection as well as a cause of mastitis in an infected herd. Therefore, each cow needs to be assessed on her individual merits, somatic cell count and individual infection state.

In addition, it is important to remember that even though *Mycoplasma bovis* has been diagnosed in a herd, this will not be the only cause of mastitis to be present.

It is essential that any waste milk from infected cows is not fed to calves.

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NOTES

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THE IMPORTANCE OF MILKING TIME TESTS

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SUMMARY

International Standards exist which clearly set out the procedures and methods that should be used to test a milking machine (ISO 6690:2007) and outlines the basic operating parameters which should be achieved (ISO 5707:2007). However these standards describe tests which are generally carried out with the milking system operating but not actually milking any animals.

It has become increasingly apparent that evaluating a milking system without taking account of the animals being milked or the operator that is using the machine is likely to lead to an in-complete evaluation and of more concern, may lead to a system being described as satisfactory when in fact this is far from the case. International Dairy Federation Bulletin 396/2005 provides excellent background reading on the subject (1).

The purpose of this paper, is not to describe a prescriptive set of physical tests that must be carried out to fully evaluate a milking system, but rather to highlight a number of key points that will allow anybody with a working knowledge of cow behaviour and a basic understanding of the mechanics of machine milking to assess the suitability of the milking system.

INTRODUCTION

I have attempted to separate the observations into three broad areas. Mechanical observations, operator observations and cow observations. Inevitably there is some overlap.

1. Mechanical observations

- **Vacuum levels**

The use of a simple vacuum gauge of known accuracy is critical. System vacuum will be set primarily based on whether the milkline or recorder jars are below or above the cow standings. Low level milk lines will generally operate at lower regulator vacuum levels. Irrespective of the position of the milkline, the system vacuum should be set to achieve an average clawpiece vacuum of 32.0 – 42.0 kPa at peak milk flow.

Lower milking vacuum can extend machine on time (2), increase liner slip and may decrease milk yields (3). Higher milking vacuum can lead to teat congestion and incomplete milking (4).

The farm gauge should be cross checked with a test vacuum gauge and it is always worth checking that the needle on the farm gauge falls to 0.0 kPa when the milking system is switched off.

➢ Vacuum stability

The stability of the vacuum system is as important as the actual level. During normal operation, the vacuum level in the receiver vessel should not fluctuate by more than +/- 2.0 kPa. Additionally, the vacuum in the milkline should not vary by more than 2.0 kPa from the vacuum level at the receiver for more than 95% of a normal milking. Failure to control the vacuum could indicate inadequate effective vacuum reserve or poor control of the vacuum by the regulator or a variable frequency drive (VFD).

An example of satisfactory vacuum stability can be seen in Figure 1.

Figure 1 – Satisfactory system vacuum stability

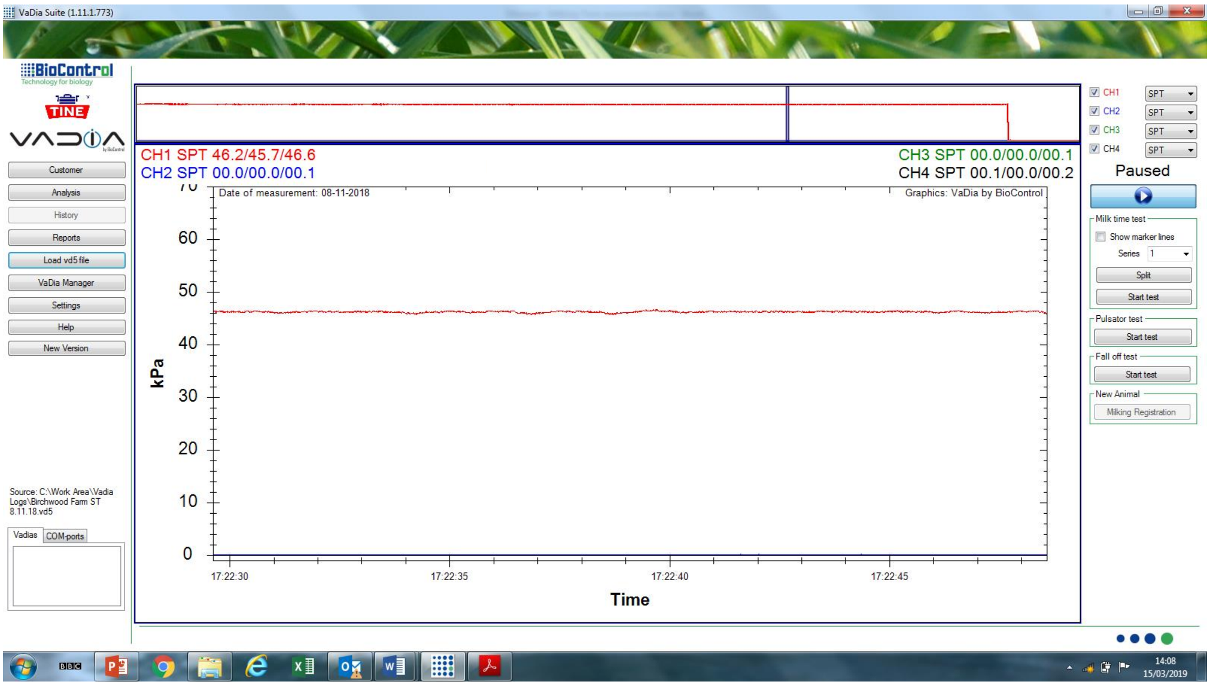
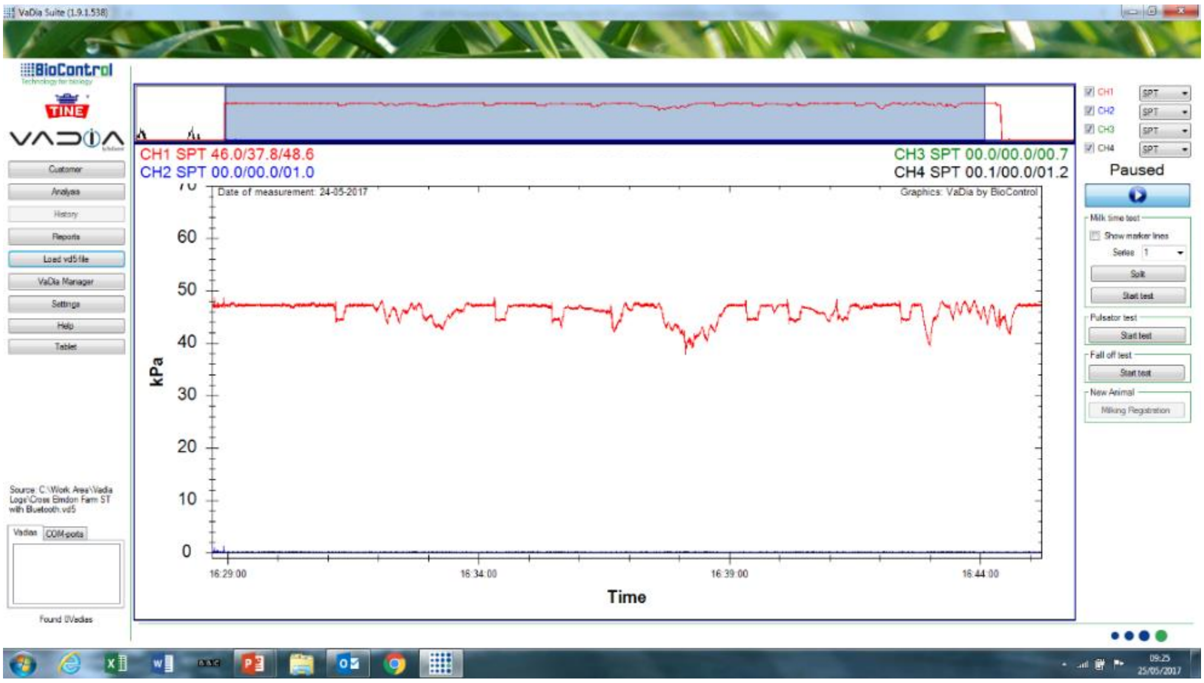


Figure 2 illustrates poor vacuum stability.

Figure 2 – Un-satisfactory vacuum stability

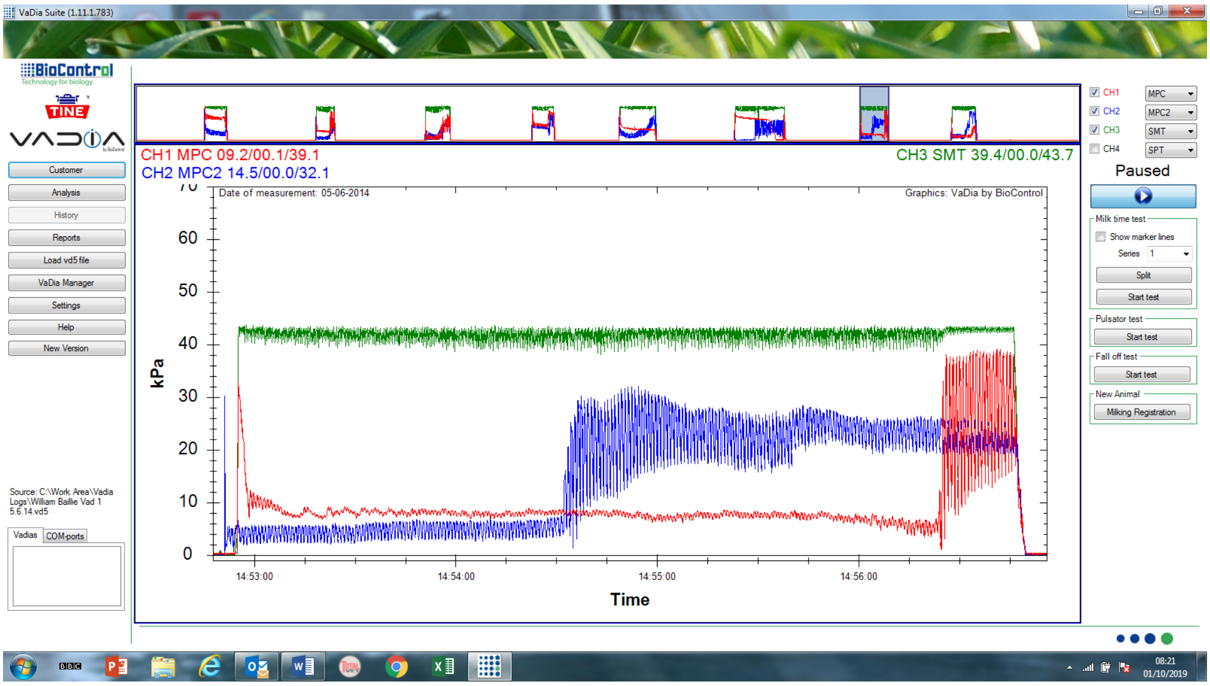


➢ **Vacuum in the liner mouthpiece chamber**

The average mouthpiece chamber (MPC) vacuum should be at least 10kPa less than the average claw vacuum during peak milk flow (5). This vacuum difference should be sufficient to ensure the liner closes around the teat end during the collapse phase of the pulsation cycle. Teat barrel congestion and palpable mouthpiece rings appear to be reduced when the MPC vacuum is less than 20 kPa.

There is a marked change in MPC vacuum at the commencement of over-milking (Figure 3) and larger bore liners have a tendency to generate higher MPC vacuum. The presence of palpable mouthpiece rings on more than 20% of teats warrants further investigation as there is an association between circulatory impairment and new infection rates (6).

Figure 3 – Increase in MPC vacuum during over milking



➢ Operation of the vacuum regulator

A simple test of the regulators response is to listen to the air admission with a conventional regulator or the speed of the vacuum pump if the system is fitted with a VFD. If units are opened and air admitted, the vacuum level will drop. When the vacuum level drops by around 3.0 kPa, the regulator should stop admitting air. If the VFD is operating correctly, reducing the vacuum by admitting air should result in an increase in operating RPM.

➢ Fall off test

A milking machine should have sufficient vacuum reserve to supply the normal operating requirements of the milking machine plus un-intended air admissions that may occur when clusters are attached or fall off. With the milking machine operating and all teat cups plugged, opening a single unit should lead to a drop in vacuum of <2.0 kPa. This confirms the system has sufficient effective vacuum reserve. One unit should be opened for every 32 milking points.

➢ Pulsation

There should be regular, intermittent air admission into the pulsators. Listen closely to each pulsator for uniformity between pulsators. It is worth looking inside the liner to ensure that it is mounted correctly and is not twisted and there are no obvious cracks or splits.

Inserting a thumb into each teat cup will confirm whether the liner is moving through a full range of movement. Identification of any shortfalls requires a call to the local service support to rectify the problem.

- **Liner slippage**

If a liner is appropriately sized to match the average teat dimensions, the regulator vacuum level is appropriate and the milking unit is well positioned, the incidence of liner slippage should be minimal.

If more than 5% of cows exhibit liner slippage, further investigation is required (7). It is important to establish whether the problem is herd wide and not a small % of animals with poor udder confirmation.

2. Operator observations

- **Attachment of the milking units**

Milking units should be applied with a minimum of air admission in a smooth, efficient manner. Once the milking unit is attached, the ACR cord should be fully extended, the long milk and pulse tube adjusted and adjustments made to ensure the milking unit is hanging squarely below the udder with even weight distribution on all four teats.

- **Removal of the milking unit**

Where no ACRs are fitted, units should be manually removed at the completion of visible milk flow. It is important that the vacuum supply is restricted (pinch clip or kink the long milk tube) for around 2 seconds before the milking unit is removed. This allows time of the vacuum to dissipate through the cluster air bleed.

Blocked air bleeds will lead to slower milking, liner slippage and teats being bathed in milk during peak milk flow. Blocked air bleeds can be identified by flooded clawpieces and milk splash when clusters are removed.

Over-milking must always be avoided. There have been many studies examining ACR removal flow rates (8) and it has been demonstrated that when cows are milked twice a day, units should be removed promptly when the flow rate drops to between 0.3 – 0.5 kg/min. When herds are milked three times a day, the end point can be raised to nearer 0.6 – 0.8 kg/min.

If the unit is removed at the appropriate time, the majority of quarters will have little or no milk present. There may be a problem with ACR settings or unit positioning of > 20% of quarters when hand stripped yield more than 100ml milk.

Observation of cluster removal should show the clawpiece vacuum decay to the point the cluster starts to fall from the cow coincide with the operation of the ACR cord.

- **Cleanliness of the operator**

A clean, dry milking environment is essential for the production of hig- quality milk. This extends to the milking staff and gloves and clean waterproof overalls should be worn at all times. These overalls should be washed at the end of each milking.

Examination of areas in frequent contact with hands, such as milking keypads, can often highlight problems with basic hygiene.

- **Demeanour of the operator**

Dairy cows respond positively to a quiet, calm and consistent milking environment. Research has shown that the release of adrenaline within 30 minutes of the start of milking can interfere with milk let-down and prolong milkings (9).

Calm cows do not generally defecate and if more than 5% of cows defecate when being milked, further examination is required. Cows should enter and leave the milking facility in a calm manner.

- **Consistency of milking routine**

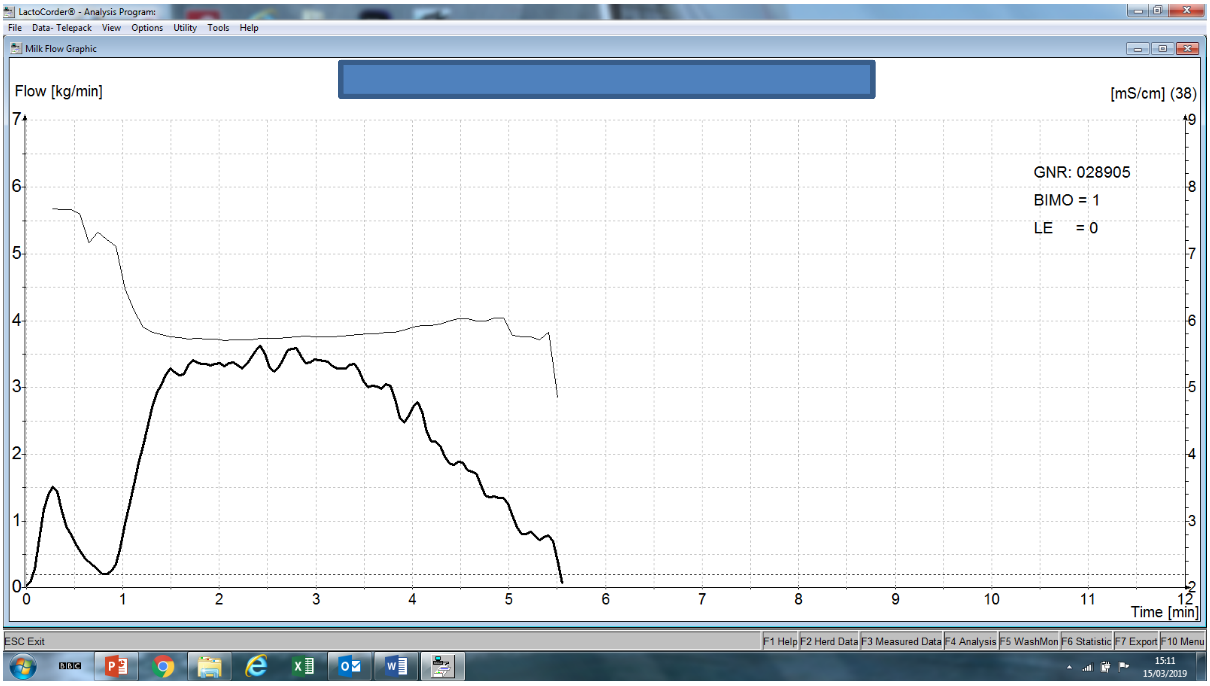
A consistent, well designed milking routine ensures that all cows receive the same preparation intensity and duration. They should have a standard time lag from first contact to attachment of the milking units and teats should be clean and dry prior to attachment.

It can often be informative to wipe teats post preparation with a moist white towel to assess how thoroughly teats are prepared.

- **Milk Let down**

If cows are well stimulated and then left between 60 – 90 seconds before attaching the milking unit, the majority of cows should be sufficiently stimulated. This will reduce the incidence of two stage or bi-modal milking (Figure 3).

Figure 3



A calm, well stimulated cow should produce around 50% of her production with 2.0 minutes of unit attachment. When the routine is well designed and consistently implemented, less than 10% of cows should exhibit bimodality.

➢ Teat disinfection

Teats should be disinfected as soon as practical after cluster removal to help control contagious mastitis infections and to assist in conditioning the teat skin surface. It is important to ensure total teat coverage.

Using a light and mirror allows disinfectant coverage to be assessed around the teat. Alternatively, wrapping a paper towel around the teat and examining how comprehensive the coverage can be valuable.

Whether teats are dipped or sprayed, the objective must be to cover all teat ends and the majority of the teat barrel. This requires more time and effort when spraying. Studies have demonstrated that on average only 50.0% of a teat barrel receives disinfectant when sprayed compared with 95.0% when dipped (10).

3. Cow Observations

➢ Cow behaviour

As previously stated, an effective milking requires calm quiet cows. Failure to achieve this has significant implications for milking efficiency and milk quality.

➢ Teat Condition

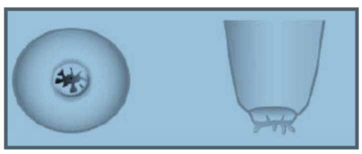
Routine assessment of teat condition should be a corner stone of any milking time assessment. As well as being used for investigations and problem solving, routine scoring should form part of every milk quality programme.

Attention should be paid to teat end hyperkeratosis, teat oedema and congestion, teat colour and the presence of palpable teat base rings. The National Mastitis Council (nmconline.org) has recently update the Teat Condition Portfolio (This resource highlights various different teat conditions, helps with identification and provides suggestions to resolve the conditions)

A minimum of 80 cows should be scored (or 20% of the herd) and this should take account of parity and stage of lactation.

Hyperkeratosis can be scored following the guidelines of the Teat Club International (11) as described in Table 5.

Table 5. A scoring system for teat end hyperkeratosis (from Mein et al 2001)

Score	Description	Illustration
N	**No ring** The teat end is smooth with a small, even orifice. This is a typical status for many teats soon after the start of lactation.	
S	**Smooth or Slightly rough ring** A raised ring encircles the orifice. The surface of the ring is smooth or it may feel slightly rough, but no fronds of old keratin are evident.	
R	**Rough ring** A raised, roughened ring with isolated fronds or mounds of old keratin extending 1-3 mm from the orifice.	
V	**Very rough ring** A raised ring with rough fronds or mounds of old keratin extending 4 mm or more from the orifice. The rim of the ring is rough and cracked, often giving the teat end a 'flowered' appearance.	

Less than 20% of teat scored should have rough or very rough teat ends and < 10% should be very rough.

- **Cow cleanliness**

Cow cleanliness drives milking efficiency and milk quality. There are many scoring systems available to allow cow cleanliness to be assessed. When cows are regularly scored, changes in management, environment and housing can be clearly identified.

CONCLUSIONS

The assessment of a milking does not need to involve complicated, expensive monitoring equipment. In reality, detailed observations can highlight the strengths and weaknesses of the overall milking process.

Any comprehensive assessment needs to take account of the complex interaction between the milking machine, the operator and the cow. Failure to understand the relationship may lead to inappropriate conclusions being drawn and incorrect recommendations.

It is not sufficient to consider the operation of the milking system based on physical tests without the interaction of the milker and the cows.

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FAST MALDI MS PROFILING FOR THE ANALYSIS OF COW MILK TO INVESTIGATE CLINICAL AND PRE-CLINICAL MASTITIS

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SUMMARY

A longitudinal well-characterized sample collection from a controlled research environment provides the basis for analysing health conditions/pathologies in relation to time. At the University of Reading (UoR) we have recently concluded such sample collection, using the dairy cow herd of our research farm at the Centre for Dairy Research (CEDAR). The biorepository counts around 12,000 milk samples from 450 individual cows sampled weekly for 24 weeks. This provided 80 pre-clinical mastitis samples, 80 clinical mastitis samples, a consistent number of high somatic cell count (hSCC) samples and a large number of controls. A representative amount of these samples has been analysed through fast liquid AP-MALDI MS demonstrating the possibility to detect pre-clinical mastitis.

INTRODUCTION

The study of different pathologies in the field of cow husbandry can be very difficult, particularly if it is necessary to target the pre-clinical phase. Pre-clinical mastitis has been investigated using animal models obtained with experimental bacterial infection [1, 2]. Although these efforts represent a good start for the comprehension of the physiology and the timing of the infection, they represent lab-based research and are less connected to the daily farm routine where animals can be exposed to several different pathogens and produce different indirect (secondary) biomarkers.
Here we propose liquid AP-MALDI MS for the profiling of milk aliquots from the daily milking process for the early detection of mastitis, providing proof-of-principle data using a representative set of controls, hSCC, pre-clinical mastitis and clinical mastitis samples.

MATERIALS & METHODS

Milk sampling for the 12,000-sample strong biobank was carried out from July 2018 to December 2018 on a weekly basis allowing the storage of individual milk samples from 450 to 500 cows. Every cow was monthly analysed for somatic cell count (SCC), milk volume, protein content and fat content. For mass spectrometry analysis, milk aliquots were precipitated with trichloroacetic acid and re-suspended in water/acetonitrile/isopropanol. The analyte extract solution was spotted on a stainless-steel MALDI target plate with alpha-cyano-4-hydroxycinnamic acid (CHCA) mixed with ethylene glycol as the liquid MALDI matrix. Automated acquisition was achieved with a Waters Synapt G2-Si and an in-house developed AP-MALDI ion source. Data analysis was undertaken with AMX (Waters) software.

RESULTS

Clinical bovine mastitis was detected with an accuracy of 98.52% (100% specificity).
Ion signatures typical of pre-clinical mastitis were detected up to 6 days before the clinical event with both principal component analysis (PCA) and LDA. The classification was mainly driven by the differential detection of multiply charged peptides/proteins.

DISCUSSION

The purpose of this new biobank of 12,000 milk sample from a well-characterized research herd is to provide the possibility to study the evolution of diseases and health conditions over time in an easily collected and biologically informative specimen.
The dataset obtained through liquid AP-MALDI MS highlights the presence of different ion signatures indicative for clinical mastitis and usable for the detection of pre-clinical mastitis.

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DO HERD MASTITIS PATTERNS CHANGE OVER TIME? STUDY ON HEIFER MASTITIS - PREVALENCE, RISK FACTORS, AETIOLOGY AND ANTIBIOGRAM IN JAMMU, NORTH INDIA

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The present study was envisaged with the objective to study the clinic-epidemiological investigations on heifer mastitis in Jammu, North India. This was a first study in India on heifers mastitis. Animal wise overall prevalence of mastitis in cow heifers was found to be 90.80% by cultural examination, and out of them 30.00% animals produced clinical signs. Quarter wise prevalence of mastitis in cow heifers was found to be 75.51% by cultural examination and 26.77% of the quarters produced clinical signs with the highest prevalence in the hind quarters. A significant result was obtained with respect to risk factors associated with mastitis. The *Staphylococcus spp.* majorly the Coagulase Negative Staphylococci (CNS) was found to be the chief etiological agent in cow heifer mastitis followed by *S. aureus* and other environmental microorganisms. Cultural sensitivity test revealed that Gram positive organisms were highly sensitive towards Amoxyclav (amoxicillin-clavulanic acid), Ciprofloxacin, while gram negative organisms were highly sensitive towards Ciprofloxacin.

Heifer mastitis is a disease that potentially threatens production and udder health in the first and subsequent lactation leading to economic losses for dairy farms [1]. Several potential heifer mastitis risk factors have been identified including- increased age at first calving, milk leakage. Other factors included are calving in early summer, increased herd SCC, the presence of organisms on the skin etc. [2]. Coagulase-negative staphylococci (CNS) are the most common bacteria responsible for the development of heifer mastitis [3] and subclinical mastitis (SCM) in dairy cow [4].

A total of 250 dairy cow heifers were screened for the study to ascertain the prevalence of mastitis, associated risk factors, etiology and antibiogram in study area. Lacteal secretion samples were taken from the heifers 5 to 10 days before parturition following aseptic conditions and prevalence was evaluated on the basis of cultural results. A standard questionnaire was prepared to record all related data to understand the impact of associated risk factors on the occurrence of mastitis in heifer. Susceptibility of individual bacterial isolates to antibiotics was determined by disc diffusion method using commercially available antibiotic discs (Hi-Media Lab. Mumbai, India).

The overall prevalence of heifer mastitis was found to be 90.80% by cultural examination, but only 30.00% of the animals produced clinical signs. On the combination basis, the prevalence of heifer mastitis on cultural examination and on the basis of clinical signs produced was found to be highest in the hind quarter that is 80.68% and 27.03%, respectively than in forequarter that is 70.15% and 26.50% respectively.

In addition to this epidemiological data pertaining to various risk factors associated with cow heifer mastitis was collected in and around Jammu, and descriptive and bivariate chi square analysis was done and significant results were obtained both in organized and unorganized management system with respect to these risk factors like season of calving, milk leakage at calving, prepartum IMI, poor udder hygiene, sanitation, beddings, floor type, contact of heifers with older cows, etc.

On culture, out of the 915 lacteal secretion samples, 1049 isolates were obtained amongst which *Staphylococcus spp.* majorly the Coagulase Negative Staphylococci were found to be the chief etiological agents with the prevalence of 16.40% followed by *S. aureus* (14.30%), *Strep. agalactiae* (11.82%), *E. coli* (11.15%) etc.

On cultural sensitivity test it was observed that most of the Gram positive isolates were highly sensitive to Amoxyclav and Ciprofloxacin. The Gram-negative isolates that are *E. coli, Salmonella* and *Klebsiella,* were highly sensitive to Ciprofloxacin followed by Enrofloxacin and Ceftriaxone/ Tazobactum.

Present study concluded that there is a serious concern of heifers mastitis in dairy production in India, which was unheeded by the researchers. It is strongly recommended that control of mastitis at heifer level may be key point of success in the control of mastitis.

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QUARTERPRO - AN INDUSTRY INITIATIVE TO PROMOTE AND IMPROVE UDDER HEALTH

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SUMMARY

QuarterPRO is an industry initiative which aims to help farmers achieve continuous improvement in mastitis control and udder health on farm leading to more saleable milk, better milk quality, better cow welfare and less antibiotic use.

How does QuarterPRO work?

Mastitis is a common health problem on most dairy farms. QuarterPRO encourages the farm team to sit down with the farm vet and/or advisors once a quarter to review what has been happening with mastitis on the farm.

The first step is to make better use of the farm's clinical mastitis and somatic cell count data. Vets, advisers and plan deliverers will be encouraged to use the Mastitis Pattern Analysis Tool to PREDICT the most important udder health issues on farm in the next quarter. The Tool will help identify the main patterns of mastitis in the previous quarter. It can show whether most cows are picking up infection during the dry period or during lactation. The pattern can also show whether more infections are being picked up from the environment or if the majority of spread is from cow-to-cow. Using this information, it is possible to PREDICT the main pattern of mastitis which is likely to be seen in the next quarter.

The farm team and advisers can then look at ways to try and prevent new cases of mastitis in the next quarter. The group can use AHDB QuarterPRO resources specific to the pattern of mastitis on their farm to see what might be causing the problem and what could be done to reduce the possibility of mastitis in the next quarter. Together the farm team agrees how to REACT and decides what changes to make and who will be directly responsible for making sure the decisions are put into action. Implementing a full Mastitis Control Plan may be considered and is recommended.

Over the next quarter the farm team works together to make the changes needed to OPTIMISE udder health on the farm. It is a good idea to check regularly how well the agreed changes are being implemented.

At the end of the first QuarterPRO meeting a date is put in the diary to get together again in 3 months to REVIEW mastitis and how well any changes were made and whether they were effective. Over time the aim is continuous improvement in mastitis control and udder health on farm, leading to more saleable milk, better milk quality, better cow welfare and less antibiotic use.

Red Tractor has from 1 October 2019 strengthened in the Dairy Standards the requirements for the Livestock Health Plan. The Plan must now set out policies and details for different scenarios/diseases which must be recorded. As with QuarterPRO each plan is farm specific and the detail will reflect the actions to be taken on that farm. The plan must be made in conjunction with a vet, who is to sign the final version to say it is a reflection of the farming practices on that farm. The Mastitis Control Plan and AHDB Dairy Mastitis Pattern Analysis Tool have been listed as examples to consider.

Implementing QuarterPRO on dairy farms would be an excellent way of meeting the requirements of the Red Tractor Dairy Standards as well as of improving mastitis control and cow welfare and productivity. It should also help the industry achieve its targets of sustainable improvements in cattle health, as a basis for reducing the need to use antimicrobials and reducing the risk of antimicrobial resistance.

Broad industry engagement with QuarterPRO will be needed to make it a success and AHDB and the DMCP team are happy to help support initiatives to drive uptake.

NOTES

COMPARISON OF TWO POINT-OF-CARE TESTS TO SUPPORT TREATMENT DECISIONS IN NON-SEVERE BOVINE CLINICAL MASTITIS

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This study aimed to evaluate and compare the performance of two point-of-care (POC) tests, intended to support treatment decisions in cases of non-severe clinical mastitis (CM), against a reference test consisting of bacteriological culture and matrix-assisted laser desorption/ionization time-of-flight mass spectrometry (MALDI-ToF MS).

Milk samples from CM cases were collected aseptically by trained staff from seven dairy farms in Scotland. Samples were frozen on farm (-20 °C) and cultured within 4 weeks from sampling. Milk samples were processed simultaneously using standard laboratory methods[1] and the two POC tests. A slide-test (VétoSlide, Vetoquinol) which consists of a double-sided plastic slide: the red side is selective for Gram-positive (GP) bacteria and the green side is selective for Gram-negative (GN) bacteria with ability to differentiate *Escherichia coli* (growth of red colonies) from other GN species (growth of white colonies). A plate-based test commercially available (VétoRapid, Vetoquinol)[2], a triplate with three selective media: one for GN, one for staphylococci and one for streptococci and enterococci. Concurrently, the same milk sample was inoculated onto both Sheep Blood Agar 5% and MacConkey agar number 3 plates (E & O Laboratories Limited, Bonnybridge, Scotland). POC test kits and plates were incubated at 37°C in aerobic conditions and were examined after 24 and 48 hours. POC tests and plates with no visible colonies were considered negative for mastitis-associated pathogens. Plates that contained three or more morphotypes were considered contaminated[3] and excluded from the analysis. Isolates from standard bacteriology were preserved with 15% glycerol (vol/vol) in cryovials at -80°C and submitted to an external laboratory (Vétoquinol SA, Lure, France) for species identification by MALDI-ToF MS. These results, reference test, were taken as definitive to classify true-positive, true-negative, false-positive and false negative.

From 156 milk samples from CM, contaminated samples (n = 23) and samples with non-identifiable isolates (n = 3) based in the reference test were excluded from the analysis. The accuracy of GP detection in samples from non-severe CM was 80.7% for the slide test and 74.3% for the plate test, placing the slide test in the same range as other commercially available POC tests, e.g. Petrifilm (80.2%)[4] and MastDecide (58.6-85.3%)[3]. The slide-test had positive predictive value (PPV) and negative predictive value (NPV) of 80% and 82%, respectively. The plate-test had PPV and NPV of 70% and 82%, respectively.

These results demonstrate that both POCT tests can be useful tools to support treatment decisions and implement a targeted or selective treatment in non-severe CM as a means to reduce antimicrobial use and avoid blanket treatment.

ACKNOWLEDGEMENTS

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DAIRYING AND MASTITIS CONTROL IN ARDUOUS ENVIRONMENTAL CONDITIONS

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SUMMARY

Mastitis is the result of micro-organisms, typically bacteria, entering the bovine mammary gland via the teat canal, establishing an intramammary infection (IMI) and resulting in an inflammatory reaction. Multiple players have a role in the development and outcome of mastitis. Bacteria, farmer (management) and host are all involved. When the balance tilts in favour of the pathogen, mastitis occurs. In countries including the Middle East and Israel that struggle with often extremely hot weather conditions, the latter risk is even more often right around the corner as the cows are especially in summertime constantly exposed to heat stress. An effective cooling system, high quality forages and an optimal standard mastitis prevention and control program are the key success factors for obtaining and maintaining a good udder health throughout the year. This paper focusses on the negative impact of heat stress and on how mastitis is controlled (or not controlled) in those countries that have to deal with often arduous environmental conditions.

INTRODUCTION

Mastitis is the result of micro-organisms, typically bacteria, entering the bovine mammary gland via the teat canal, establishing an intramammary infection (IMI) and resulting in an inflammatory reaction. The disease can present in a clinical and subclinical form. *Clinical mastitis* is characterized by abnormal milk and swelling or pain in the udder and may be accompanied by systemic signs such as elevated rectal temperature, lethargy and anorexia. *Subclinical mastitis* is the form in which there is no detectable change in the udder and there are no observable abnormalities in the milk. Still, milk production decreases, bacteria are present in the secretion and composition is altered. In this case, tests have to be used to detect the presence of IMI either directly (culturing of the causative bacterium) or indirectly (by showing inflammatory responses including an elevated somatic cell count). In either form, mastitis in dairy cows is a costly disease due to depression of milk yield, milk withdrawal, extra treatment and labour costs, and early culling. It should be prevented rather than cured.

Multiple players have a role in the development and outcome of mastitis (1). Bacteria, farmer (management) and host are all involved. A certain cow (of a certain age, breed, at a certain lactation stage, with a certain immune competence), managed by a particular farmer (deciding on a specific nutrition, implementing certain milking procedures) within a specified environment (characterised by a certain type of housing, hygiene etc.) in a specific region or country is exposed to a diversity of mastitis pathogens (contagious or opportunistic in nature and with different virulence features) able to cause disease. When the balance tilts in favour of the pathogen, mastitis occurs. In countries including the Middle East and Israel that struggle with often extremely hot weather conditions, the latter risk is even more often right around the corner as the cows are especially in summertime constantly exposed to heat stress.

Given all that, the severity of the inflammatory reaction is determined by 3 factors:

- **Type of mastitis agent**. *Escherichia coli* often causes hyperacute clinical udder inflammation with strongly pronounced clinical signs, while less harmful mastitis agents such as the non-*aureus* staphylococci and *Corynebacterium bovis* tend to cause subclinical mastitis or in rare cases very mild clinical mastitis.

- The number of bacteria the cow is exposed to or the so-called the **infection pressure**. The more bacteria that penetrate into the udder, the more pronounced the inflammatory reaction will be and the more likely it is that clinical signs will appear.

- **The immunity of the cow**. In cows with reduced resistance, the migration of immune cells from the bloodstream to the milk is too slow and the immune cells are also less active. This gives bacteria the opportunity to adhere, grow and multiply in the udder. Cows with an impaired immunity eventually need more cells to eliminate a certain infection from the udder. Neutrophils play a crucial role in the elimination of intramammary infections though might cause quite some damage as well due to the oxidative burst. It is therefore not surprising that most clinical mastitis cases in dairy cattle, especially those with strongly pronounced clinical signs, are mainly seen in the first few weeks after calving. Immune suppression makes cows more vulnerable to infectious disease and can occur as a consequence of several factors. Natural physiological conditions such as pregnancy, parturition and peak lactation and primary infectious disease predispose cattle to mastitis and other infections. Various types of stress (natural or induced) and environmental factors such as nutritional deficiencies, shipping, commingling, and heat stress (see below) also have influence.

This paper focusses on the negative impact of heat stress and on how mastitis is controlled (or not controlled) in those countries that have to deal with often arduous environmental conditions.

WHAT IS HEAT STRESS?

Heat stress occurs when an animal is unable to maintain an equilibrium between heat accumulation and the transfer of heat to the surrounding environment (2). In other words, individuals experience heat stress when they are exposed to environmental conditions above their thermo-neutral zone. The thermoneutral zone is defined as the range of ambient temperatures where the heat production and heat loss are perfectly balanced and where the cow's do not have to spend energy to maintain the normal body temperature. In Holstein cows under desert environment conditions, the highest milk production was observed during optimal thermal neutral periods characterized by ambient temperatures below 21°C throughout the day (3).

FIGURE 1: Temperature Humidity Index

	% Relative humidity																
Temperature (°C)	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	
25.0						72	72	73	73	74	74	75	75	76	76	77	**MILD**
25.6		**NO STRESS**			72	73	73	74	74	75	75	76	76	77	77	77	**STRESS**
26.1				72	76	73	74	74	75	76	76	77	77	78	78	79	
26.7		72	72	73	76	74	74	75	76	76	77	78	78	79	79	80	
27.2	72	72	73	73	74	75	75	76	77	77	78	78	79	80	80	81	
27.8	72	73	73	74	75	75	76	77	77	78	79	79	80	81	81	82	**SEVERE**
28.3	73	73	74	74	75	76	77	78	78	79	80	80	81	82	82	83	**STRESS**
28.9	73	74	75	75	76	77	78	78	79	80	80	81	82	83	83	84	
29.4	74	75	75	76	77	78	79	79	80	81	81	82	83	84	84	85	
30.0	74	75	76	77	78	78	79	80	81	81	82	83	84	84	85	85	
30.6	75	76	77	77	78	79	80	81	81	82	83	85	85	85	86	87	
31.1	75	76	77	78	79	80	81	81	82	83	84	85	86	86	87	88	
31.7	76	77	78	79	80	81	82	83	84	85	86	86	87	88	89	89	
32.2	77	78	79	79	80	81	82	83	84	85	86	86	87	88	89	90	
32.8	77	78	79	80	81	82	83	84	85	86	86	87	88	89	90	91	
33.3	78	79	80	81	82	83	84	85	85	86	87	88	89	90	91	92	
33.9	79	80	80	81	82	83	84	85	86	87	88	89	90	91	92	93	**VERY**
34.4	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	**SEVERE**
35.0	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	**STRESS**
35.6	80	81	82	83	85	86	87	88	89	90	91	92	93	94	95	96	
36.1	81	82	83	84	85	86	87	88	89	91	92	93	94	95	96	97	
36.7	82	83	84	85	86	87	88	89	90	91	93	94	95	96	97	98	
37.2	82	83	84	85	87	88	89	90	91	92	93	94	96	97	98	99	
37.8	83	84	85	86	87	88	90	91	92	93	94	95	97	98	99	100	
38.3	83	85	86	87	88	89	90	92	93	96	95	96	97	99	100	101	
38.9	85	85	86	87	89	90	91	92	96	95	96	97	96	99	101	102	
39.4	85	86	87	88	89	91	92	94	95	96	97	98	100	101	102	103	
40.0	85	86	88	88	90	91	93	94	95	96	97	99	100	101	103	104	
40.6	86	87	88	89	91	92	93	96	96	97	98	99	100	101	104	105	**DEAD**
41.1	86	88	89	90	91	93	94	95	97	98	99	101	102	103	105	106	**CATTLE**
41.7	87	88	89	91	92	94	95	96	98	99	101	102	103	105	106	107	
42.2	87	89	90	92	93	94	96	97	98	100	101	102	104	105	106	108	
42.8	88	89	91	92	94	95	96	98	99	101	102	103	105	106	107	108	
43.3	88	90	91	92	94	96	97	98	100	101	102	104	105	106	108	110	
43.9	89	91	93	94	95	96	98	99	101	102	103	105	106	107	109	111	

Heat stress is however determined by 3 more other factors than the ambient temperature. Heat stress is determined by a combination of ambient temperature, relative humidity, solar radiation, air movement, and precipitation. Of course, the risk of suffering from heat stress also depends on the cow's genotype, health, and immune status (4). In fact, the relative humidity of the air is of utmost importance since it can drastically reduce the ability of the animal to use evaporative heat loss through the skin and lungs. Cattle can tolerate much higher temperatures at lower relative humidity because they are able to transfer excessive heat more effectively to the surrounding environment by sweating. Still, the opposite is true as well, during hot and especially humid conditions the natural ability of cattle to transfer heat to the surrounding environment is compromised due to the lowered ability to utilize evaporative cooling.

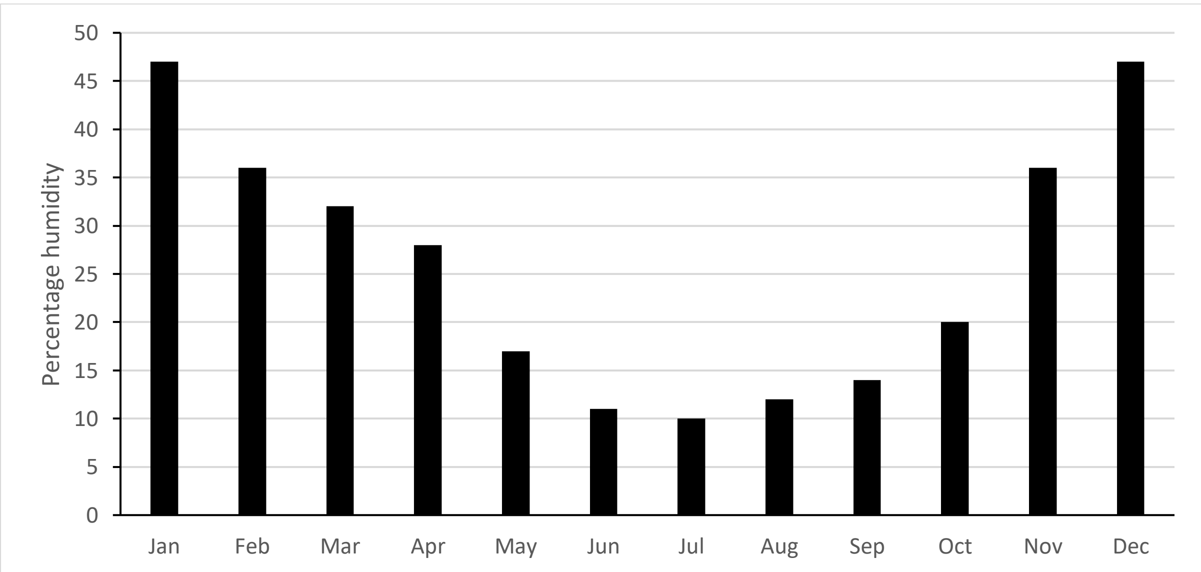
A commonly used measure to assess the risk of heat stress in dairy cattle is the Temperature Humidity Index (THI) (Figure 1). It accounts for the combined effects of environmental temperature and relative humidity and is a useful and easy way to assess the risk of heat stress.

Also, dairy cattle are nowadays more susceptible to heat stress than the cows of the 1950s due to the increased milk production and feed intake. The initial research studies performed in 1950s at the University of Missouri indicated a stress threshold of a 71 THI, so animals were suffering from heat stress at a THI of 72 and greater. The levels of stress were separated into:

- Mild (72 to 79 THI)
- Moderate (80 to 89 THI)
- Severe (90 THI or greater)

The more recent studies show that modern cows become heat-stressed starting at an average THI of 68 with the levels of stress increase with increasing THI. High yielding cows are obviously more susceptible to heat stress than low yielding cows, as feed intake and milk production and thus the heat production results in a shift of the thermoneutral zone to lower temperature. In fact, when cows that were nonlactating, or at low (18.5 kg/d) or high (31.6 kg/d) milk yield were compared, low and high yielding cows generated 27 and 48% more heat than nonlactating cows despite having a lower body weight (5).

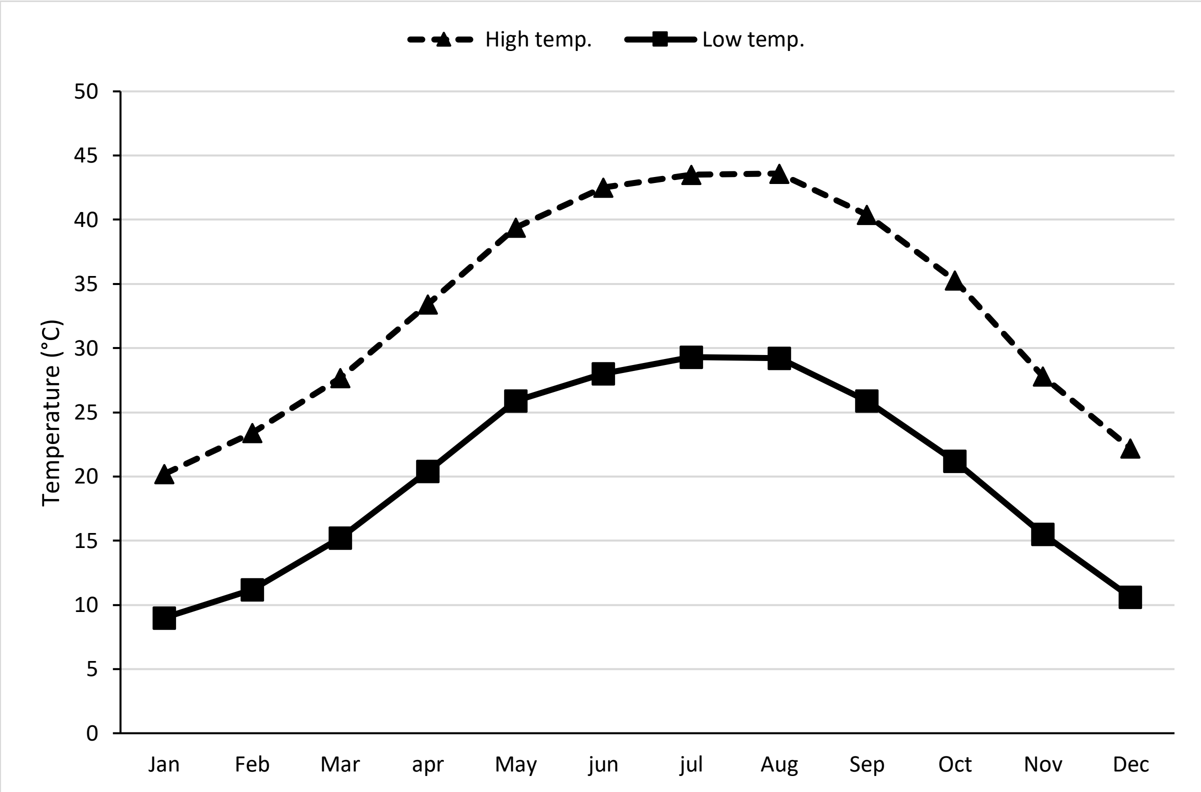
FIGURE 2. Average humidity Riyadh, Saudi Arabia in 2018



Given the relative humidity (Figure 2) and the ambient temperature (Figure 3) and throughout the year in dessert conditions as is the case in e.g. Saudi

Arabia, cows are almost constantly exposed to a mild up to severe heat stress status. Luckily, the relative humidity is lower than in most European countries, protecting the cows at least partly from a very severe heat stress (Figure 1).

FIGURE 3. Average minimum and maximum temperature (°C) in Riyadh, Saudi Arabia in 2018

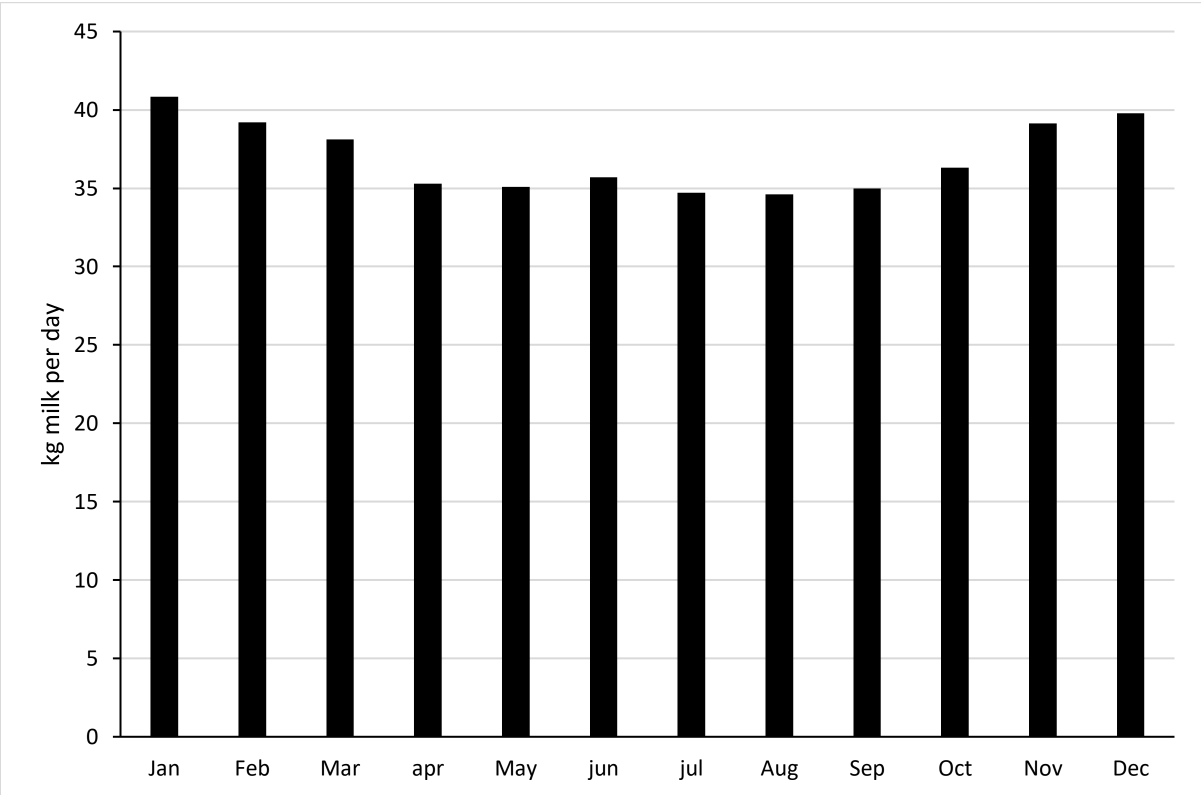


IMPACT OF HEAT STRESS

Heat stress has a detrimental effect on milk production performances. Although many farms suffering from arduous environmental conditions are equipped with evaporative cooling systems to improve the cows' heat dissipation, a reduction in milk production can never be completely prevented (Figure 4). The negative impact of heat stress on the milk production can be easily explained as elevated temperature and humidity negatively affect the feed intake affecting the reproductive performances which ultimately decrease milk production. Per unit increase in the THI beyond 69, milk production drops by 0.41 kg per cow per day in the Mediterranean climatic regime (6,7). Also, every 1°C in air temperature above the thermal neutral zone causes a 0.85 kg reduction in feed intake which results in a 36% decline in milk production (8). Still, only 35% of the reduction in milk yield is due to decreased feed intake remaining 65% reduction is due to direct physiological effect of heat stress including decreased nutrient absorption, alteration in rumen function, and hormonal imbalance. Even late-gestation heat stress has a profound effect on milk production in the subsequent lactation (9). Indeed, heat stress during dry period may trigger mammary gland involution accompanied with apoptosis and a reduced amount of mammary epithelial cells.

Heat stress makes cows also more susceptible for infectious diseases such as mastitis (5). First of all, high temperature combined with a high humidity are very much favourable for the growth of mastitis causing bacteria like streptococci and coliforms. Also, heat stress can lead to higher udder temperature favouring the growth of bacteria in the mammary gland and making it more difficult for the cow to overcome the intramammary infection. Additionally, because of the cooling systems with sprinklers and evaporation, there might be more moisture in the environment, increasing the bacterial population (5). Therefore, evaporative cooling is preferred above cooling with fans and sprinklers.

FIGURE 4. Average daily milk yield (kg per day) throughout the year on a farm equipped with an evaporative cooling system



During periods of heat stress, increased levels of cortisol have been observed (10). The production of cortisol during periods of acute stress acts as a stimulus for the immune system. Still, chronically elevated levels of cortisol have been associated with immune suppression. Heat stress has an impact on both the innate and adapted immunity. Neutrophils exposed to higher temperatures show a lower respiratory oxidative burst and phagocytotic activity compared to neutrophils exposed to the normal body temperature. Neutrophils are the first line of defence when it comes to mastitis (10). On the other hand, based on graphs representing the monthly incidence of clinical mastitis throughout the year on dairy farms that struggle with often arduous environmental conditions, it is again reinforced that mastitis is a multifactorial disease and that other factors, except from the heat stress, are involved as well. On some farms, the monthly incidence of clinical mastitis is not per se substantially lower in months where cows experience a mild heat stress compared to months where cows undergo severe up to very severe heat stress. The association between heat stress and the bulk milk somatic cell count is often more obvious (Figure 6).

FIGURE 5. Monthly incidence of clinical mastitis on a farm dealing with arduous environmental conditions

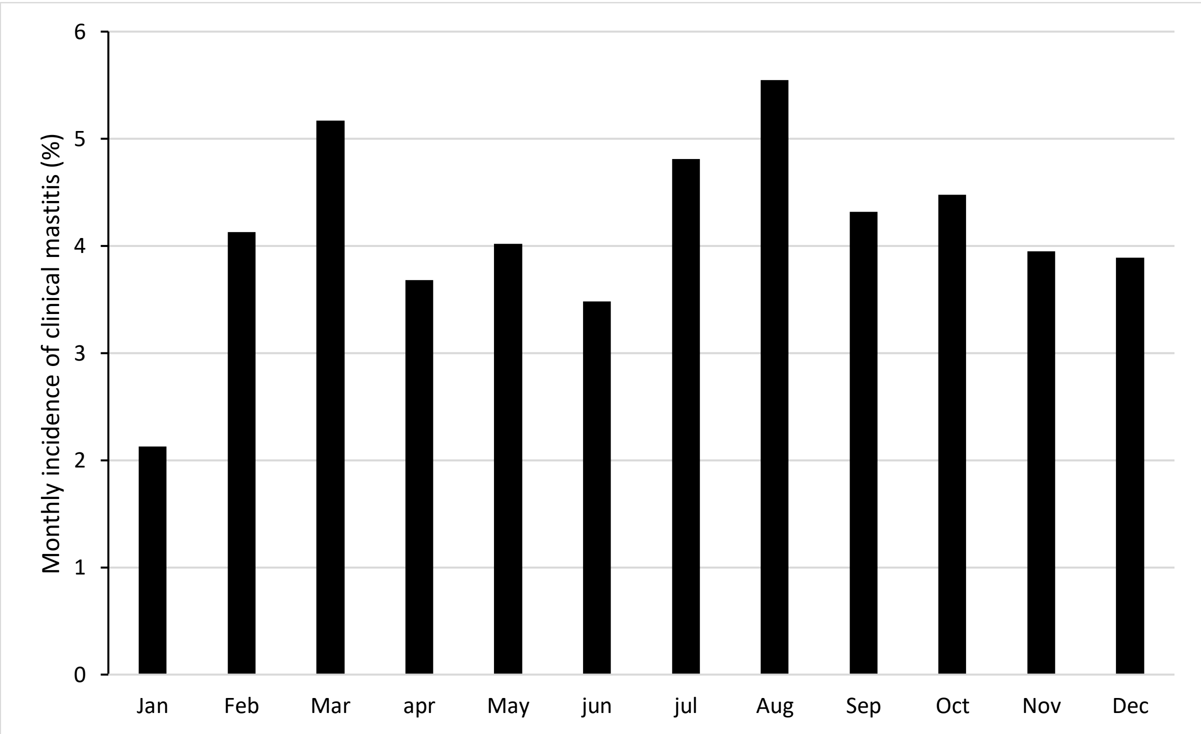
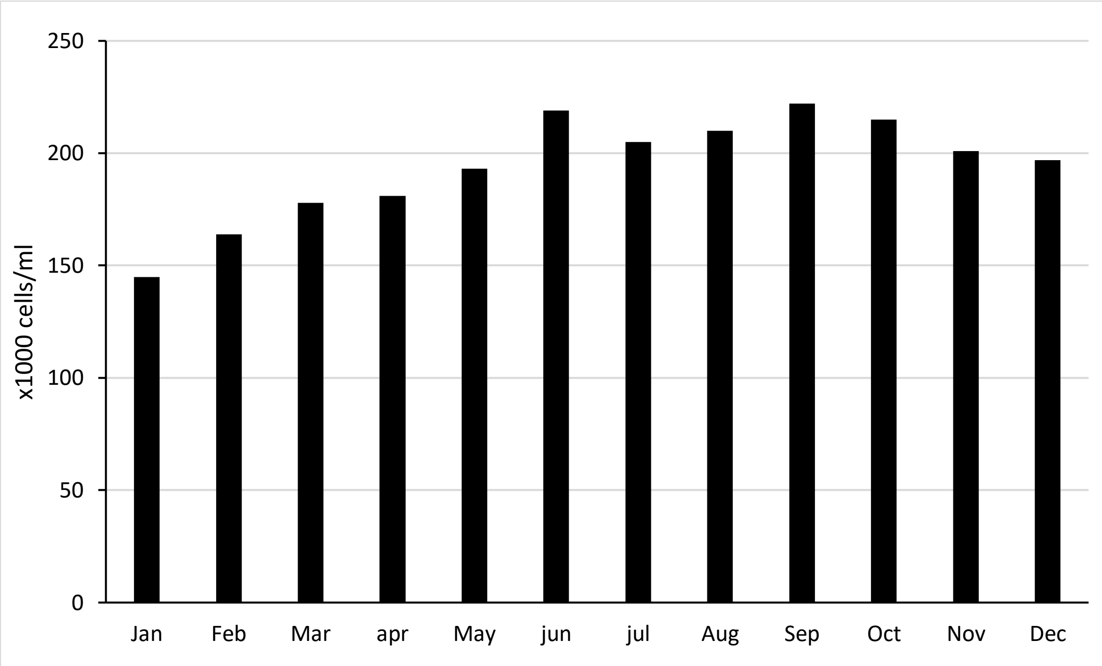


FIGURE 6. Bulk milk somatic cell count throughout the year on a farm dealing with arduous environmental conditions



DEALING WITH HEAT STRESS

Effective cooling is one of the most commonly and most effective practices applied to reduce the risk and negative impact of heat stress (11). Cooling of cows can help to reduce the detrimental effects in both lactating and dry cows (9, 10). Indeed, prepartum cooling improves both the immune status of transition cows and the immunity of the offspring. Evaporative cooling is an effective way of cooling cows (11) (Table 1). The fine mist particles stay suspended in the air and evaporate before being deposited on the ground, thus cooling the surrounding air. This kind of cooling system is often combined with a weighted curtain on the prevailing wind side of the shade helping to contain the cooled air in the area occupied by the cows. The curtain is rolled up automatically to eave height when the cooling system is off or in the presence of high wind. Less expensive cooling systems such as fans in combination with sprinkles are less often seen as excess of water on the floor surface cannot be accommodated in large compost barns (11). The advantage is that the larger water droplets completely wet the cow's hair coat, providing direct evaporative cooling on the cow surface rather than depending upon convection cooling with evaporatively cooled air.

Table 1 presents the results of research trials conduct in United States, Mexico and Saudi Arabia and estimates the milk production response by cows of varying milk production to two cooling methods, evaporative and spray and fans, in a range of daily high temperatures in a dry climate [Adapted from (11)]

Production and daily high temperature	Daily increase in milk production (kg)	
	Evaporative cooling	Spray and fan
High producing (38.5 kg/day)		
> 40,5 °C	7.5	4.3
35 to 40°C	6.0	3.2
< 34,5°C	5.3	2.8
Medium (29.5 to 38.5 kg)		
> 40,5 °C	6.4	3.5
35 to 40°C	5.2	2.8
< 34,5°C	4.5	2.5
Low (29.5 kg)		
> 40,5 °C	5.6	3.2
35 to 40°C	4.5	2.6
< 34,5°C	3.9	2.3
Dry		
> 40,5 °C	2.0	1.4
35 to 40°C	1.4	0.9
< 34,5°C	0.9	0.6

Other measures that can help to reduce the impact of heat stress on the milk production performances as much as possible are:

- Adapting the feed energy level to compensate for the lower dry matter intake. A good and often used source of energy is bypass fat in the diet.
- Providing extremely high-quality forages. During heat stress conditions, there is obviously a greater risk for rumen acidosis due to slug feeding and a decreased dry matter intake. In order to reduce the latter risk, maintaining the fiber levels in the ration is crucial. However, as is well-known, forages have a higher heat increment, so the quality and degradability of the forage should be monitored and kept at a high level.
- Increasing the feeding frequency. Animals are several times a day and especially also late in the evening, when it is cooler.
- Providing adequate feeding bunk space so that all animals get the chance to eat whenever they want (without crowding).
- Providing plenty of cool and clean water. Cows can drink up to 50% more water when the THI increases.

In order to reduce the impact on the udder health performances, it is of course important to have a decent mastitis prevention and control program in place. As the cows experience already a constant stress because of the high THI, and thus suffer from an impaired immunity, the infection pressure needs to be kept extremely low during milking as well as in-between two milkings. As shown above, the farm's udder health status is even under arduous environmental conditions not only determined by the heat stress and its negative effects.

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NOTES

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ENVIRONMENTAL MANAGEMENT OF DAIRY COWS

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SUMMARY

Most of the design features of a competent cattle building were established more than 30 years ago, based on empirical datasets and the presence of independently funded farm building design experts. The independent funding has gone, and the farm building sector has progressed into the 21st century in a stilted manner, sometimes adopting designs from overseas which became a fashion but have no basis in objective design.

Modern dairy cattle are the pinnacle of decades of genetic improvement, nutrition and agronomic support, and practical farming knowledge. They are the athletes of the modern dairy world, and are subjected to significant physiological demands. The backdrop to this modern dairy system is an apparently random collection of buildings, of various ages, materials and designs that can only serve to support or hinder production and health. The key requirements of a building for dairy cows are to prevent the accumulation of heat and moisture, to provide access to fresh air changeovers, and to protect from high wind speeds. The industry is urged to look at all the freely available independent literature to question and assess and revitalise the built component of the dairy farm environment.

INTRODUCTION

The requirements for modern dairy cows are well documented, and in our 21st century age of communication, freely available to all. The information available comes from a variety of sources, but objective information based on empirical studies and the collected experience of industry is easy to find (1-6). The emphasis of the current paper is to act as a reminder of what the basic building design requirements are for modern dairy cattle.

Environment and health

Livestock systems have a low frequency of exposure to the situation where a health/disease issue has a probability of zero or one; all or nothing. A herd may be negative to common pathogens such as IBR or TB, or at a national level to Foot and Mouth disease or Schmallenberg virus. The 'All or nothing' pressures are typically managed by herd biosecurity and vaccination. However, the disease issues that are costing the industry production, health, welfare and finance every day are those where the pathogens are already present on farm. Successful management of these pathogens is the target for today; elimination is for the future or maybe not at all.

Management of cattle pathogens is easier if their behaviour and survival mechanisms are understood. Environmental conditions that favour or restrict a bacterial/viral population outside the host will have a direct impact on the quantity/concentration/dose of viable organisms that remain in that environment. Environment will influence dose rates of pathogens.

Environment also has direct and indirect impacts on animal physiology, whereby conditions outside a range of 'normal' conditions may exert a physiological pressure that constitutes stress. Stress is a body's method of reacting to a condition such as a threat, challenge or physical and psychological barrier. Stress is a normal event and the body reactions are also normal, for a while. The problem in our livestock systems occurs when the duration of stress is sufficient to create a significant, negative impact, such as energy deficit or depression of immune function.

The role of environmental factors in the environment/pathogen/host interfaces is most easily seen in the successful or unsuccessful management of hygiene on livestock units. Once animals are placed inside a building there is a natural restriction in how an individual can choose to react to the built environment, and a natural increase in the duration that any animal might be exposed to stress from that environment. Flight is not an option, so a body has to fight pathogen presence as well as the environmental conditions that support the pathogen in the first place.

Environmental management ~ moisture

Cattle systems are wet systems, with a 200 cow cubicle house easily turning over 10,000 – 12,000l of water a day. Drinking water intake is processed into milk, faeces, urine and expired moisture. A moisture balance model in equilibrium will state that all the inputs balance all the outputs. Milk is the product carefully collected, and the rest goes……… where? If the building component of the cattle system is not functioning correctly, and not removing the moisture output of the cattle at the same rate at which it is produced, moisture *must* accumulate in the system. And it is at this point that the system environment is likely to change into one that is more beneficial to increased survival times of a whole range of bacteria and viruses. Managing moisture is a key requirement of successful management of any livestock system.

Environmental management ~ energy

Food is energy, with the cow but one part of an extraordinary energy chain that is agriculture. The diet of dairy cows is widely discussed and manipulated, and energy is part of the conversation. The idea of energy deficit or occasionally excess is recognised, and to a certain extent managed. The discussion needs to be usefully widened to include the energetics of the whole local 'system', which in the case of a 200 cow herd will include the building, its contents, and the location.

The cattle are the easy part of the energy dynamics to understand, with MJs of energy entering the system and the output as energy for maintenance, growth, production (milk, foetus) or as energy in waste. The sensible energy production, the heat radiated from the body, will be 1.2 – 1.5KW per cow dependant on the production level of the system. The 200 cow herd may produce 240KW per day as radiant energy, enough to provide power to more than 24 homes.

The energetics of the building part of the system, the thermal dynamics, are well understood but are massively not applied in our current housing of cattle. The thermal dynamics of any building will be influenced by:

- Materials used in construction
- Orientation of the building
- Slope of the roof
- Design of the roof
- Rooflights
- Design of side cladding
- Surrounding topography

The livestock industry creates problems on a daily basis by failing to recognise the longer term impact of all of the above building features on cattle health and performance. The target for the building is to provide a safe environment for the cattle that stays (mostly) within parameters that do not cause physiological stress and do not enhance the survival of pathogens outside the host. Not too hot, not too cold, not too windy, not too wet, not too dry, not too dirty. Table 1 is an attempt to form an assessment list of building features that impact on the thermal dynamics of a building.

Table 1. Building features: thermal dynamics

	Impact	**Examples # problems**
Materials used in construction	The rate of thermal loss from a structure is directly related to the thermal conductivity of materials. The amount of thermal energy retained within a structure will have a direct impact on thermal buoyancy to drive the stack effect	Tin roof sheeting. Used because of 'low cost' but has significant negative effect on moisture management and natural ventilation rates. Exaggerates natural diurnal temperature variation inside buildings.
Orientation of the building	Daily duration to solar gain Annual exposure to winds from all direction	Failure to recognise predictable weather impact

Slope of the roof	Low slope = increased solar gain Increased slope = increased capacity for thermal loss through ventilation	Reduced slope on very wide buildings to accommodate planning requirements, with life-long negative impact on stock. Continued focus on building volume and eaves height, when roof slope is the major design parameter.
Design of the roof	The design and location of apertures in the roof impacts on the effective exhaust of system by-products. The design of the ridge cap impacts on the natural exhaust capability of the roof	All naturally ventilated cattle buildings need a competent area of roof outlet; less than 50% do, including newbuilds. Upstands along an open ridge create a negative pressure at the ridge for >80-90% of time per year; not universally applied
Rooflights	Natural light as a benefit. Increased solar gain in summer months	Give valuable health and welfare benefits but caution is required on AYR housing.
Design of side cladding	Wind is the primary driver of ventilation, with 100% mediation from sidewall design. Zero cladding; no control of air speed, significant energy loss	Objective requirements established >30 years ago for any naturally ventilated building; widely ignored. Fashion for open-sided buildings; excellent in the summer, serious energy loss in the winter due to wind speeds
Colour	Lighter materials: less thermal gain	Roof colour conflict with planners
Surrounding topography	Presence of topographical features that significantly influence impact of weather	Surrounding vegetation can extend local RH% and drying times, but can help to mediate excessive wind speeds. Adjacent buildings can protect or exacerbate local weather features, air speed, moisture.

The system is energetic, and the flows of energy are to a large extent predictable. The producer and veterinarian is perhaps only aware of the systems effects when there is an excess or a deficit, so that if the cow/building system gains too much energy there is a rise in ambient temperature within the building that influences animal behaviour, respiration rates, feed intakes and moisture throughput. The main beneficiaries of increased energy and moisture in cattle systems in the UK are the pathogens (7).

The design of the roof has significant importance for any livestock building and even more so for buildings housing stock all year round. Attention is required to moderate absorptance of solar radiation (fraction of solar radiation energy absorbed from all wavelengths and directions). Cement fibre roof sheeting is significantly superior for livestock housing in the UK than a metal (tin) roof cladding, for a number of reasons, not least that daily energy gain will be less in warmer ambient air conditions. Colour of roof sheeting has an even greater impact on solar gain, with absorbance of a medium colour (eg. green, red) being 27% higher than a light colour (eg greyish white, light yellow). The difference is even greater for a dark colour (e.g. grey, black). Roof sheets with an initial absorptance of 0.18-0.21 exhibited an average 0.12 increase in absorptance after 3 years weathering (8). With a daily average solar radiation in southern England of 10MJ/m^2, the effect of a dirty roof on a 200 cow cubicle shed of 1200m^2 could be an increase in thermal gain of 1440MJ.

Energy losses in UK cattle systems can cause production and health problems and are directly related to loss of control of air speed, as seen in the design of open sided cubicle houses imported from the southern United States. The predicable weather conditions in the UK means that adult cattle on high levels of energy intake will avoid specific parts of the building space and feeding space purely due to the combined impact of low air temperature and high air speed (wind chill). Elevated air speeds may be beneficial in the warm summer months, but when ambient temperatures decrease towards freezing wind speeds over 4-5m/s will force behavioural changes that cause milk yields to drop and energy losses to become significant.

Environmental management ~ fresh air

Ventilation is a descriptor of an essential part of livestock systems that is of marginal use because it has no values attached. A system can have too little or too much ventilation, when what is being described is 'not enough fresh air' and 'too much air speed'. The target is to have fresh air across as much of a livestock building floor area as possible, and as all livestock systems will constantly produce the by-products of energy, moisture, faeces and urine there is a design need to have a constant flow of fresh air entering a building. Air is moved by pressure differences, and the main driver of air movement is wind energy as it moves from areas of high pressure to low pressure. All totally predictable. It is also totally predictable when assessing a naturally ventilated building that areas behind a solid wall, a parlour or silage pit for example, will not be a region of fresh air delivery when the wind is blowing from specific directions. Any area of building with a reduction of fresh air delivery will have an elevated risk of firstly, moisture accumulation and then secondly, increased pathogen survival rates.

Fresh air is a free biocide, with the capacity to reduce the survival times of viable aerosols by 10-20 times compared with 50% fresh air (7). The health benefits and impact on the available numbers of pathogens in the livestock environment is massive. Enclosing buildings to keep the wind out is understandable but not ultimately productive.

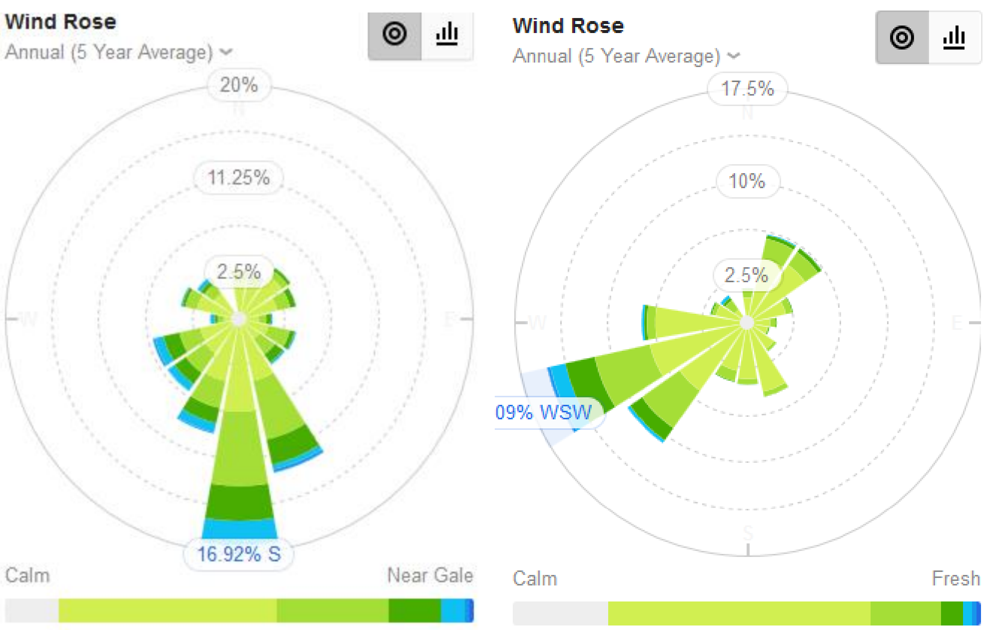
Environmental management ~ fresh air vs air speed

The target for the design of sidewall cladding on any building is to maximise the duration that the system can benefit from wind-driven fresh air delivery whilst managing the negative impact of elevated air speeds and rainwater ingress. The total area of void (holes) on any one sidewall is defined by the calculated minimum area of outlet in the roof for the stack effect (for when wind speeds drop for any reason). The area of inlet in the sidewall can exceed the minimum calculated value completely with regard to fresh air delivery (100% open sidewall cannot deliver more than 100% fresh air), but will lose control of air speeds entering the building and any rain water ingress.

Choice of sidewall design is facilitated by reference to a windrose from the local area, which describes the historic annual pattern of wind direction and wind speed. It is common to find buildings that are solid clad on the side or gable end of a building that faces the predominant wind direction, commonly the south westerly direction. To put this in business terms, a solid cladding on the side facing the predominant wind direction is similar to saying "I do not want free fresh air delivery into my livestock building for 50-60% of time per year".

Figure 1 shows the wind roses for Worcester and Monmouth, based on 5 years data (9, 10). The distance between the two locations is 34 miles (54km) but the direction of the predominant winds and the duration of calm (<0.1m/s) are significantly different.

Figure 1 Wind Rose: a) Worcester (9) b) Monmouth (10)



The target for naturally ventilated buildings is to have the appropriate cladding on each sidewall to:

- satisfy minimum inlet areas for the stack effect to operate
- control excess wind speed entering the building
- minimise unwanted ingress of rainwater.

A method for calculating the total area of inlet for adult cattle can be found in AHDB Dairy Housing Guide (2) and AHDB better cattle housing guide (5), with a rule of thumb that adult cattle require four times as much inlet area in the sidewalls as the calculated outlet area in the roof.

DISCUSSION ~ Theory into practice

A considerable number of naturally ventilated cattle buildings are not fit for 365 day housing of cows due to non-competent inlets and outlets. The results are an inevitable accumulation of energy as heat, of increased moisture levels, and increased survival rates of a range of commensals and pathogens. The internal building environment is also dragged down by non-competent floors, with pooling and inadequate drainage adding to problems with hygiene and overall moisture levels.

A rapid assessment of the ventilation capacity of a building is based on an outlet area requirement in the ridge of $0.1m^2$ per adult cow, and 2-4 times that in the sidewalls. It provides a rapid assessment of what the building needs and can be compared with what is actually in front of you.

Open the sidewalls

The difficulty of specifying sidewalls for UK cattle buildings is how to make them competent for most of the time in a highly variable climate? The leading edge of the industry is using flexible side curtains, but a major improvement can be made to many buildings by using true Yorkshire Boarding. UK building companies have been selling space board to the farming sector as Yorkshire Board for 20 years, demonstrating lack of knowledge of the significant differences between the two design. The maximum gap between boards should not exceed 25mm width, and can still create significant wind chills in winter conditions.

Yorkshire board is highly rated for high yielding cattle because it is possible to double the inlet area compared with space board (typical gap width is 50mm) whilst maintaining control of wind chill and rainwater ingress. Yorkshire boarding is formed from two parallel rows of vertical boards with gaps, separated horizontally by a tantalised batten of a specified width or greater. A typical specification would be for the two lines of 150mm boards with 50mm vertical gap between, separated by a horizontal batten of at least

50mm depth. This gives a cladding porosity of 25%, ie. there will be 0.25m^2 of inlet for every 1.0m^2 of Yorkshire boarding.

Open the ridge

An adequate area of outlet in the roof is a prime requirement of any competent building, just as much as effective drainage, suitable cubicle dimensions, feed face per cow and other definable building dimensions. The designs for open and covered open ridges have been available for more than 30 years, yet producers and builders still manage to create buildings that are not fit for purpose. The outlet area is defined by stocking density and slope of the roof (and nothing to do with xxmm per 5m width of the shed or other outmoded ideas). Upstands on either side of the open ridge are the best investment of the whole building, as they help to create a building that has a negative pressure at the ridge (a sucking ridge) all the time that there is a discernible wind, >90% of time per year.

Get mechanical assistance

In the complex of farm buildings and structures that make up most dairy farm facilities it would be unusual to find a layout of buildings where they can all be competently ventilated by the wind. It is common to find two or more buildings with common walls or adjacent to solid structures that prevent the ingress of fresh air. Where the natural dynamics of air movement cannot be improved, it is time to consider using fans to move air.

Mechanical ventilation can help improve air movement and, by default, improve the exhaust of energy, moisture and other by-products. They can also help cattle to lose heat when ambient temperatures increase by increasing air speed over their backs. There are three provisos:

1. Ensure that the opportunities to improve natural airflows are examined first (hole in the roof, opening up sidewalls)
2. Ensure that entrained dirty air leaves the animal space
3. Check the daily running costs

Mechanical ventilation can be very useful in managing hotspots within buildings, for example in the lounging area around robots.

CONCLUSIONS

Information on competent design of buildings for dairy cows is freely available. The industry is stubbornly persisting in ignoring design guidance created by independent sources and is heavily influenced by building fabricators who do not have the knowledge, or don't care, about how livestock and buildings interact.

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NOTES

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IMPLEMENTATION OF THE AHDB DAIRY MASTITIS CONTROL PLAN TO REDUCE DRY PERIOD INFECTION RATE AND IMPROVE SOMATIC CELL COUNT

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SUMMARY

The AHDB Dairy Mastitis Control Plan was implemented in the autumn of 2017 for an all year round calving Gloucestershire dairy herd as part of an overall review of herd health. Following analysis of individual cow somatic cell count data and clinical mastitis cases from the milk recording organisation database, and use of the new AHDB Dairy Mastitis Pattern Analysis Tool, the herd mastitis 'pattern' was one of environmental infections of dry period origin, with lactating period origin infections more seasonal and associated with periods at pasture. A focus on dry cow management was prioritised through 2018 and 2019, and included a review of drying-off technique, availability of loafing and feed space, improving ventilation and assisting with advice around the client's longer term aspiration to move away from loose yards to housing dry cows in cubicles. Whilst the *herd average* somatic cell count (SCC) has remained similar at 193,000 cells/ml for the 12 months ending autumn 2017 and 187,000 cells/ml for the 12 months ending autumn 2019, there has been a dramatic improvement in control of dry period new infections. The dry period new infection rate has decreased from an average of 21.6% during summer 2017 to 11.4% for the three recordings to September 2019. Between the autumn of 2017 and the autumn of 2019 the incidence rate of clinical mastitis has decreased from 64 cases per 100 cows/year for the 12 months ending September 2017 to 47 cases per 100 cows/year for the 12 months ending September 2019. Similar to the cell count control, the rate at which cows were detected with a new case of clinical mastitis during the first 30 days of lactation reduced from 2 in 12 cows affected at the end of summer 2017 to 0.62 in 12 cows affected for the end of summer 2019. Comparing the 12 months ending October 2018 with the 12 months ending 2019, the total mg of antibiotic used per Population Corrected Unit (PCU) has remained increased, averaging 31.6mg/PCU and 29 mg/PCU respectively, although the average Defined Daily Dose (DDD) of antibiotic has so far reduced from 8 to 6 daily doses over the same period. Implementation of this structured approach to mastitis control continues and provides a platform for future progress.

INTRODUCTION AND BACKGROUND

The AHDB Dairy Mastitis Control Plan (DMCP) and was launched in 2008 following publication of a randomised controlled trial that showed a significant decrease in the proportion of cows affected with mastitis for those herds that received a structured, specific plan compared to control herds that did not receive this approach (1). The DMCP was subsequently rolled out to more than 1000 herds between 2009 and 2012 during a period of close support from the original authors of the research and funding from AHDB Dairy. The initial progress with the scheme and some of the challenges faced have been reported elsewhere and a full report of the first three years of the scheme is available online (2). After the initial three-year period, the impact of the DMCP was monitored for a further three years between 2013 and 2016, although this relied heavily on individual trained Plan Deliverers to feedback data and Plans; these were subsequently anonymised and analysed. The overall estimated benefits of implementing the DMCP in herds have been calculated at approximately £40 per cow in herd per year, after costs of implementation have been deducted (3). This approach has continued to be used by veterinary surgeons and consultants who have been trained to deliver the DMCP, which has become recognised as a route to mastitis control by the industry, milk buyers and retailers.

A focus on the reduction and rationalisation of antimicrobial use (AMU) in dairy herds in recent years has thrown mastitis control back into the spotlight, particularly as four of the six RUMA task force targets relate to lactating and dry cow intra-mammary therapy (4). Improvement in herd mastitis control is likely to have benefits with both a reduction in the use of intra-mammary and parenteral antibiotic use if control of new intra-mammary infections in the herd is reduced, and a previous case report delivered to the British Mastitis Conference highlighted the impact of the DMCP on herd AMU (5). During 2017 and 2018, AHDB Dairy have continued to develop resources for the Plan, notably around analysis of cell count and mastitis data as well as factsheets for implementation of control priorities on farm. The former is particularly important, as the assessment of the current herd mastitis "pattern" remains a fundamental starting point for implementation of structured mastitis control Plans. To this end the Mastitis Pattern Analysis Tool has been developed by the University of Nottingham and QMMS Ltd to provide a rapid and automated approach for veterinary surgeons and herd advisors to assess the current herd mastitis pattern (6).

This paper presents an ongoing herd example where use of the Mastitis Pattern Analysis Tool and implementation of the DMCP has begun to see benefits in mastitis control as well as begin making inroads into improvement in herd AMU. Discussions were had during the autumn and winter of 2017 in response to ongoing concerns with cell count and mastitis, as well as the potential for a future supermarket aligned milk contract. These discussions continued during 2018 and early 2019. Initial analysis of data are presented as well as key interventions and follow up during 2019.

DATA ANALYSIS (2017)

Somatic cell count (SCC) and clinical mastitis data were downloaded from the milk recording organisation in CDL format (National Milk Records, Chippenham, UK) and analysed using the TotalVet software (QMMS Ltd and SUM-IT Computer Systems Ltd). Initial analysis is shown in Table 1.

Regarding the somatic cell count data, the 12-month average cell count was close to 200,000 cells/ml, with little variation in individual herd test-days. During the initial meeting in the September of 2017, the importance of dry period infections were highlighted as the 'dry period new infection rate' (*i.e.* proportion of those cows dried off below 200,000 cells/ml and first calving heifers that are recorded >200,000 cells/ml at the first test-day post-calving) averaged 19.5% in the last year (achievable target <10%) and 21.6% in the last three recordings. Clearly a significant contribution to herd SCC came from dry period infections.

The clinical mastitis incidence rate was increased at more than 60 cases per 100 cows/year, putting this herd well above the mean incidence rate for herds currently followed as part of the AHDB Dairy Sentinel Herds project (7). The index (new) case rate in the first 30 days of lactation (*i.e.* these cases are likely to arise as a result of dry period origin infections) had increased in the last three months, to twice the target of 1 cow affected for every 12 cows eligible, although the rate of new cases in cows more than 30 days in milk (*i.e.* likely lactating period origin) was also increased above target, averaging nearly twice the target of 2 in 12 cows affected in the last year.

Table 1: Mastitis key performance indicators at Church Farm (Autumn 2017)

Parameter	Rolling 3-recording average	Rolling annual average	Target
Herd average SCC ('000 cells/ml)	175	193	<200
% herd >200,000	18.5	18.2	<20
% herd chronic*	12.4	11.8	<5
Dry period cure rate (%)	62.5	72.7	>85
Dry period new infection rate (%)	21.6	19.5	<10
Lactation new infection rate (%)	7.7	7.9	<5
Clinical mastitis rate (per 100 cows/year)	75	64	<25
Dry period origin 1st cases (per 12 cows at risk)	1.99	1.17	<1
Lactating period origin 1st cases (per 12 cows at risk)	3.47	3.90	<2

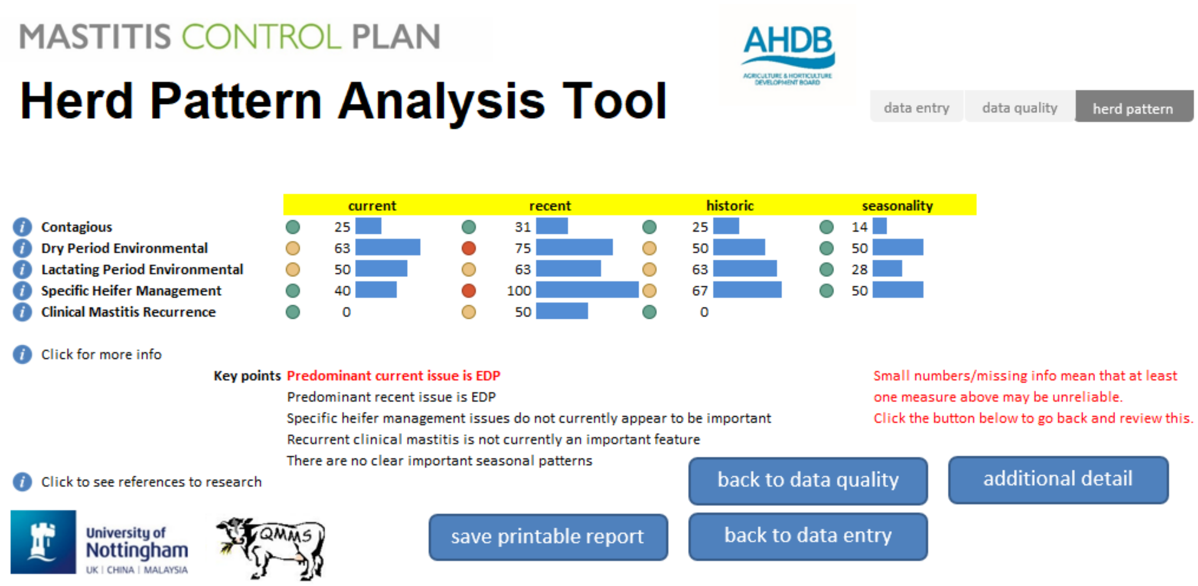
* Proportion of cows with more than one of the last three SCC>200,000 cells/ml

MASTITIS PATTERN ANALYSIS TOOL (2018)

The Mastitis Pattern Analysis tool and the "CDL Mastitis Data Converter" tool (QMMS Ltd and SUM-IT Computer Systems Ltd) were downloaded from the AHDB Dairy web page and used in conjunction with the milk recording organisation CDL file. Access to both these tools and accompanying 'teach' videos was via the AHDB dairy web page (http://dairy.ahdb.org.uk/mastitis-pattern-tool). The Mastitis Pattern analysis tool output for data in spring 2018 showed a pattern of predominantly environmental mastitis of dry period origin for both the last three months ('current') and last 12 months ('recent'), and a very low score for a 'contagious' mastitis pattern (Figure 1).

Based on the output of the Mastitis Pattern Analysis Tool and the importance of herd somatic cell count control, a presumptive herd mastitis pattern 'diagnosis' was made of predominantly environmental mastitis of dry period origin. Use of the Mastitis Pattern Analysis tool every three months during 2018 confirmed the continued importance of the dry period in mastitis epidemiology of the unit.

Figure 1: Mastitis Pattern Analysis Tool output using individual cow somatic cell count and clinical mastitis data (Spring 2018)



IMPLEMENTATION OF THE PLAN: OBSERVATIONS AND QUESTIONS

The DMCP software ('ePlan', SUM-IT Computers, Thame, UK) was used to generate the full DMCP questions and observations, and these were worked through with the herd owner. Areas covered included lactating and dry cow environment management, milking routine, basic milking machine function, treatment, biosecurity, youngstock management and monitoring. The aim was to capture current herd management and husbandry practices that may be relevant to mastitis control, for example frequency of bedding in dry cow yards, teat preparation, stocking rate in cubicle housing *etc*. In all, more than 350 questions and observations were asked or made. All responses were captured electronically as a series of Yes/No responses and entered into the ePlan software and the Plan 'locked' to prevent further amendment. Finally, a herd diagnosis of 'environmental' infection patterns of predominantly 'dry period origin' was entered.

IMPLEMENTATION OF THE PLAN: SELECTION OF CONTROL PRIORITIES

Following entry of the herd mastitis pattern the ePlan software was used to filter out areas of management not directly related to the herd diagnosis (*i.e.* any deficiencies in lactating cow management or parlour routine were initially ignored). This stage resulted in removal of 'incorrect' responses, leaving 42 potential items that directly related to the current herd mastitis pattern. From these, clinical judgement was used to prioritise nine of these for discussion with the farm. These priorities fell broadly into three categories, namely management of the dry cow environment, management and husbandry of calving cows and general items including treatment of clinical mastitis and monitoring. The INITIAL priorities selected are shown in Figure 2 and included:

1. MUST add new clean dry straw to the close to calving cow yard DAILY
2. The close to calving cow yard MUST be completely cleaned out every 3-4 weeks
3. Close to calving cow areas MUST be scraped out at least daily
4. The provision of outdoor loafing space for the close to calving group is essential
5. Review ventilation for the close to calving cow building, with opening up of the ridge gap to provide suitable outlet (15cm/6" gap required)
6. Cows MUST calve in the two individual calving pens as discussed, these must be bedded each time and cleaned out as frequently as possible, ideally between calving cows
7. Administration of ALL dry cow therapy must be done following an aseptic protocol as demonstrated
8. Any 'doubtful' clinical cases should be confirmed with the California Mastitis Test, and all cases treated initially using lactating cow therapy once daily for 4 days in conjunction with your veterinary surgeon
9. Review treatment protocols for both the use of injectable antibiotic (as this is driving the overall herd mg use) and lactating cow tubes (as these drive

the daily doses) with your veterinary surgeon particularly long courses of treatment with the latter in apparently unresponsive cows

Following initial discussions, the farm owner and herd manager put in place several of these control measures, and a cycle of feedback based on monitoring of the clinical mastitis and cell count data every 3 months or so coupled with telephone discussions around management continued. Use of the new AHDB Dairy Dry Period resources aided discussion, particularly when advising on dry cow therapy infusion technique (http://dairy.ahdb.org.uk/dry-cow-management). A follow up meeting with the farm and the herd's own veterinary surgeon also addressed other management items, particularly the possibility of switching to deep sand cubicle housing for the transition cow group. This latter point arose as despite improvements in loose yard management, the herd struggled to control dry period infections consistently.

Figure 2: AHDB Dairy Mastitis Control Plan for Church Farm in 2018

Section 7 - Management of the Dry Period					
Qu	182.	Dry Matter Intake (DMI) in the late dry period is critical and MUST be maximised. Any constraints to DMI must be addressed and should include any or all of the following points:-			
Qu	196.	If limited space is available, priority SHOULD be given to the space allowances for transition cows and bedding frequency should be increased.			
Qu	206.	Alleyways, loafing and feed areas SHOULD be scraped at least twice daily.			
Ob	210.	There MUST be at least 2sq.m. per cow.			
Ob	211.	There MUST be good ventilation, but without draughts in all dry cow housing.			
Qu	224.	Dry cow therapy (DCT) MUST be administered hygienically, as detailed in the standard operating procedure provided. (section 6.9 of the AHDB mastitis control plan folder)			
Section 8 - Calving Cows					
Qu	238.	Cows SHOULD calve in individual pens rather than yards.			
Section 9 - Treatment of Mastitis					
Qu	276.	An aseptic milk sample MUST be collected from every case of clinical mastitis.			
Qu	280.	Cases which are doubtful but that have an increased CMT reading (or conductivity) MUST be treated.			

OUTCOME AND DISCUSSION

The summary clinical mastitis and cell count figures for 2019 are shown in Table 2. The herd average SCC has remained relatively unchanged, highlighting the relative difficulty in using this as a sensitive outcome measure particularly in the early periods of implementing the DMCP. More important is the relative improvement in the 'dry period new infection rate', which has fallen steadily through the last 18 recordings from a rolling three-recording average of 30% in spring 2018 to 11% for the three recordings to September 2019 and close to the target of <10% (Figure 3). The overall clinical mastitis rate has also fallen in the last 18 months or so, reaching 15 cases per 100 cows/year at the end of the summer in 2019. The reduction in clinical mastitis rate was driven by a sustained reduction in the rate at which cows were reported with a new clinical case of mastitis in the first 30 days after calving AND a reduction in the rate at which cows were reported with a new case after 30 days in milk. The former reflects the introduction of deep sand cubicles and improved ventilation for the close to calving group, whilst the latter reflected a different approach to the management of early lactation cows following the very hot summer of 2018, and a conscious decision to house an early lactation group in the summer of 2019.

Figure 3: Dry Period New Infection Rate. Yellow bars shows cows eligible for a new infection (*i.e.* dried off <200,000 cells/ml and/or a first calving heifer). Green bars show those cows or heifers that are >200,000 cells/ml at the first milk recording post-calving. Blue bars show these as a percentage and the horizontal line represents a 'target' rate of less than 10% new infections (©TotalVet, QMMS Ltd and SUM-IT Computer Systems Ltd)

Table 2: Mastitis key performance indicators at Church Farm (September 2019)

Parameter	Rolling 3-recording average	Rolling annual average	Target
Herd average SCC ('000 cells/ml)	209	187	<200
% herd >200,000	16.2	18.3	<20
% herd chronic*	9.9	12.2	<5
Dry period cure rate (%)	66.7	66.7	>85
Dry period new infection rate (%)	11.4	17.2	<10
Lactation new infection rate (%)	4.3	5.9	<5
Clinical mastitis rate (per 100 cows/year)	15	47	<25
Dry period origin 1st cases (per 12 cows at risk)	0.62	1.00	<1
Lactating period origin 1st cases (per 12 cows at risk)	1.25	2.15	<2

Reviewing the current herd mastitis pattern Mastitis Pattern Analysis Tool shows the relative reduction in the contribution from environmental dry period infection, to more of a 'mixed' environmental pattern for the three months to September 2019 (Figure 4). Somewhat frustratingly, herd AMU data is proving harder to impact, although a comparison of the 12 months ending September 2018 with the 12 months ending September 2019 shows the total mg of antibiotic used per Population Corrected Unit (PCU) has essentially remained unchanged at 29mg/PCU although the average Daily Defined Dose (DDD) of antibiotic has reduced from 7.9 to 5.9 (Figure 5). The contribution of lactating cow intra-mammary therapy has reduced from 4.7 daily doses to 3.5 daily doses over the same period. Injectable antibiotic use is generally unrelated to mastitis, instead being employed for issues around foot health and fresh calved cow disease.

In conclusion, the implementation of a structured approach to mastitis control reduces new intra-mammary infections and mastitis rate and leads to a reduction in antibiotic use as measured by daily doses. Environmental mastitis patterns continue to be extremely common and often require a combination of management changes, including housing, ventilation and bedding.

Figure 4: Mastitis Pattern Analysis Tool output using individual cow somatic cell count and clinical mastitis data (Autumn 2019)

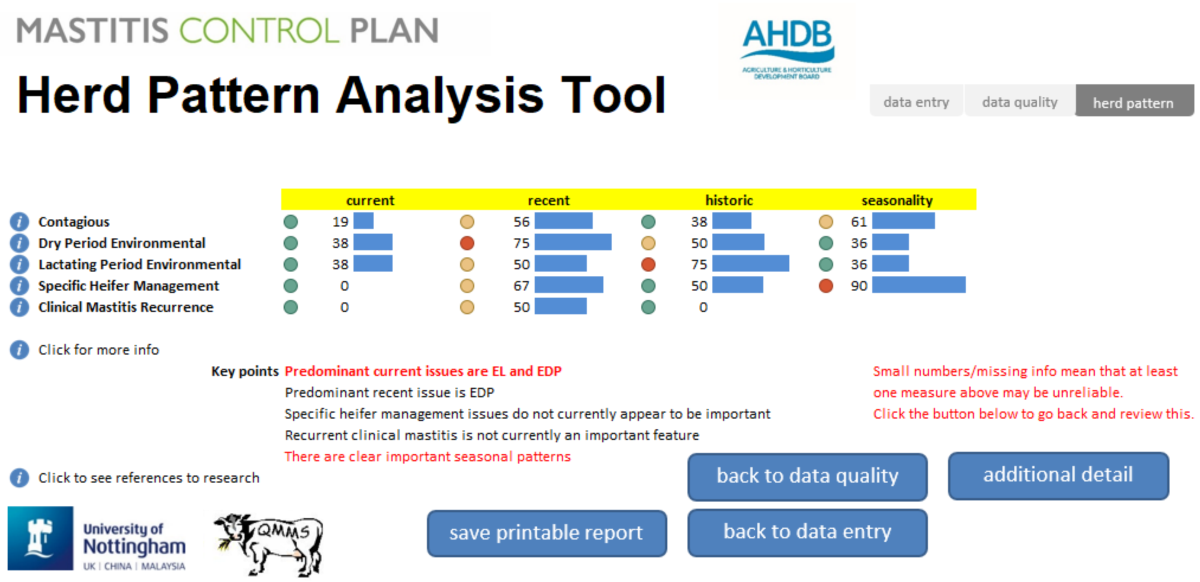


Figure 5: Antimicrobial Use (AMU) breakdown comparing 12 months ending September 2018 (top) with the 12 months ending September 2019 to show itemisation of antibiotic products, Defined Daily Dose (DDD) and total mg/PCU

	TOTAL	Critical
Total mg/PCU in herd	31.61	0.90
Total DDD	7.87	0.63
Total DCD	2.64	0.17

Route	Product	Amount used	Units	mg/PCU	Critically important?
Injectable	Alamycin 100mg/ml Solution for Injection	150.00	ml	0.18	
Injectable	Alamycin LA 300 Solution for Injection 300mg/m	200.00	ml	0.71	
Injectable	Betamox LA 150mg/ml Suspension for Injection	4525.00	ml	7.99	
Injectable	Bimotrim Co Injection	200.00	ml	0.56	
Drytube	Cepravin Dry Cow 250 mg Intramammary suspe	140.00	Tubes	0.41	
Injectable	Draxxin 100 mg/ml solution for injection for catt	13.50	ml	0.02	
Injectable	Excenel Flow 50 mg/ml Suspension for Injection	900.00	ml	0.53	CRITICAL
Injectable	Marbonor 100mg/ml Solution for Injection for C	318.00	ml	0.37	CRITICAL
Injectable	Norodine 24 Solution for Injection	628.00	ml	1.77	
Injectable	Pen & Strep Suspension For Injection	3530.00	ml	15.45	
Lactatingtube	Tetra-Delta Intrammary Suspension	24.00	Tubes	0.10	
Lactatingtube	Ubrolexin Intramammary	920.00	Tubes	3.52	

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	TOTAL	Critical
Total mg/PCU in herd	29.16	0.00
Total DDD	5.85	0.00
Total DCD	2.02	0.00

Route	Product	Amount used	Units	mg/PCU	Critically important?
Injectable	Alamycin LA 300 Solution for Injection 300mg/i	100.00	ml	0.35	
Injectable	Betamox 150mg/ml Suspension for Injection	4058.00	ml	7.06	
Drytube	Cepravin Dry Cow 250 mg Intramammary suspe	140.00	Tubes	0.41	
Injectable	Engemycin 10 % (DD) Solution for injection	100.00	ml	0.12	
Injectable	Norodine 24 Solution for Injection	1200.00	ml	3.34	
Injectable	Pen & Strep Suspension For Injection	3400.00	ml	14.66	
Injectable	Pharmasin 200mg/ml solution for injection for	200.00	ml	0.46	
Lactatingtube	Tetra-Delta Intramammary Suspension	192.00	Tubes	0.81	
Lactatingtube	Ubrolexin Intramammary	520.00	Tubes	1.96	

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NOTES

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A RETROSPECTIVE HERD STUDY OF TARGETED ANTIBIOTIC DRY COW TREATMENTS AT COW AND QUARTER LEVEL AND THE EFFECT ON THE SUBSEQUENT LACTATION SOMATIC CELL COUNT AND MASTITIS RATES

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METHOD

A retrospective study was carried out to investigate the potential benefit of using selective dry cow therapy (SDCT) at quarter level vs cow level with regards to post calving somatic cell counts (SCC) and early lactation mastitis. We also investigated whether the use of blanket antibiotic dry cow therapy (aDCT) in "low risk" cows has an overall negative effect and increased likelihood of early lactation mastitis compared to applying internal teat sealant (iTs) only. A total of 692 cows from a single farm were studied over a ten year period, split into four different groups dependent on their criteria at drying off (SCC, mastitis history for the current lactation, outcome of California milk test and treatment received).

Group Number	SCC Criteria	Mastitis History for current lactation	CMT	Treatment given
1 (high risk)	>150,000	+/- case	Positive/Negative	Antibiotic DCT and iTs in all quarters
	<150,000	+ case		
2 (high risk)	>150,000	+/- case	Positive	Antibiotic DCT in positive quarter/s only. iTs in all quarters
	<150,000	+ case		
3 (low risk)	<150,000	No cases	Negative	iTs in all quarters
4 (low risk)	<150,000	No cases	Negative	Antibiotic DCT and iTs in all quarters

RESULTS

High risk cows:

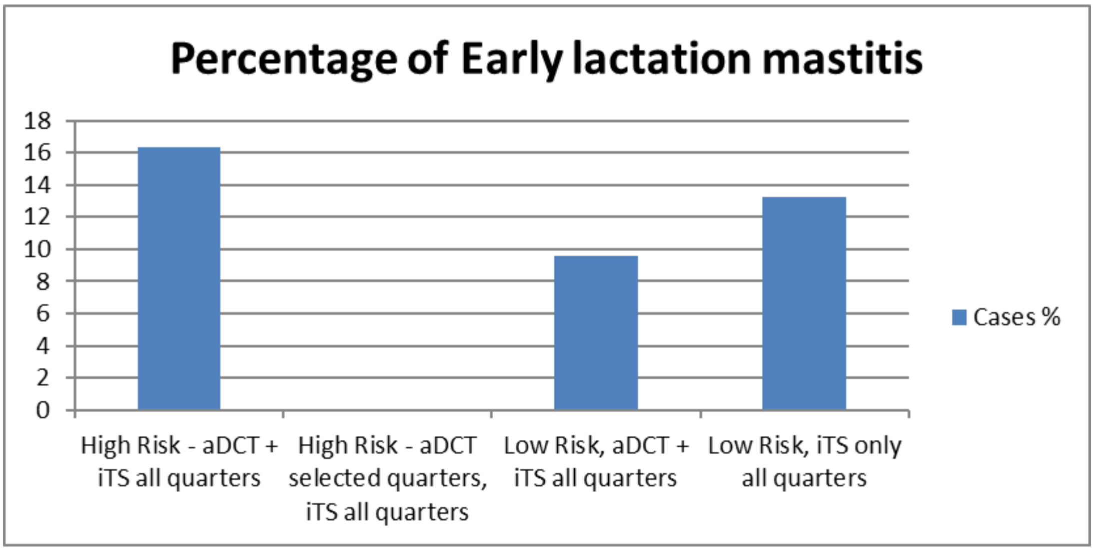
	n	Low SCC post calving
Group 1 (aDCT in selected quarters)	48	91.67%
Group2 (aDCT in all quarters)	294	82.31%
p-value (Kruskal Wallis test):		< 0.0001

Low risk cows

	n	**Low SCC post calving**
Group 3 (iTs only in all quarters)	121	86.03%
Group 4 (aDCT and iTs in all quarters	229	90.08%
p-value (Kruskal-Wallis test):		<0.0001

Overall, cows in the high-risk group treated with aDCT in selected quarters only were more likely to have a successful outcome than cows treated with aDCT in all quarters. Overall, cows in the low risk group treated with aDCT and iTS in all quarters were more likely to have a successful outcome than cows treated with iTS only.

Graph 1



The highest proportion of early lactation clinical mastitis (within the first 80 days in milk) occurred in high risk animals treated with aDCT and iTS in all quarters (16.33 %) (Graph 1). However, the high-risk group treated with aDCT only in positive quarters had 0% (N=48) early lactation mastitis. Analysis using a Fishers exact test found the difference between these groups significant (p= 0.0006). There was no statistical significance in the likelihood of early lactation mastitis between the two low risk groups (p= 0.3664).

CONCLUSION

Conclusion: In this study there appeared to be an advantage to implementing SDCT at a quarter level in high risk cows. However, we also found that in low risk cows a combination of aDCT and iTS was more effective in lowering SCC's in the next lactation compared to using just iTS alone, but with no significant effect on clinical mastitis in early lactation. Different dry cow treatment combinations had been given over the period of the study, so other factors may have influenced outcomes, and further research is needed to support these findings.

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CLARIFIDE PLUS® ACCURATELY PREDICTS MASTITIS EVENTS IN UK DAIRY HERDS

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SUMMARY

Genomic testing of dairy animals enables dairy farmers to accurately predict future performance of their livestock. The ability of the CLARIFIDE Plus wellness traits to effectively predict subsequent health events has been evaluated in both the US[1,2] and European Holsteins, including the Holsteins in the UK. The results of this UK study demonstrate that there is a significant difference in the incidence of mastitis between the best 33% and worst 33% as ranked by MAST_STA (Mastitis Standardised Transmitting Ability). Contrasting the incidence of mastitis in the best 33% with the incidence of mastitis in the worst 33% was associated with a 49% difference in incidence of mastitis, representing a savings of almost £2000 per 100 cows.

INTRODUCTION

CLARIFIDE Plus is the genomic test from Zoetis that enables farmers to accurately predict an animal's genetic potential using their DNA. The results contained within CLARIFIDE Plus provide producers with predictions for wellness, health, production, fertility, longevity, type, and milk component traits, as well as parentage.

To demonstrate the effectiveness of CLARIFIDE Plus Wellness Traits in UK Holsteins, a retrospective demonstration study was performed using Zoetis Wellness Traits and lactation records (i.e. mastitis) collected from on farm herd management software.

MATERIALS & METHODS

Health record data was collected from on herd management software (e.g. Dairy Comp 305, Uniform Agri, etc.). Genomically enhanced standardised transmitting abilities (STA) for the wellness traits were used to assign cows to genetic groups of relative risk (Worst 33%, Middle 33% and Best 33%) within herd. For CLARIFIDE Plus Wellness Traits, STAs of 100 represent average relative risk for the corresponding health event with larger values communicating lower relative risk. Statistical analysis was conducted using a general linear mixed model (Proc GLIMMIX) in SAS 9.4 (SAS Inc., Cary, NC, USA).

RESULTS

Table 1. Average Standardised transmitting ability means, disease incidence and estimated disease cost per 100 cows

Mastitis - Genetic group	Number	Mean STA	Disease incidence	P-value	Disease cost per 100 cows[3] (£)
Worst 33%	197	95	22.34	0.0259	4025
Middle 33%	201	100	12.52		2256
Best 33%	186	105	11.31		2038

DISCUSSION

These findings support our hypothesis that greater MAST_STA values would be associated with a lower incidence of clinical mastitis compared to animals with a lower MAST_STA value. This demonstrates the effectiveness of CLARIFIDE Plus MAST_STA in predicting mastitis events in commercial UK dairy herds. The results of this study are consistent with findings from other demonstration studies we have conducted globally. These findings highlight the importance of predicting health events as a means of increasing the profitability of dairy cows within the herd.

In conclusion, this study provides UK dairy producers with a compelling opportunity to proactively reduce the incidence of health events in their herd through direct selection of replacement animals for lower relative risk of mastitis. Including direct selection for the wellness traits to a farm's genetics program using CLARIFIDE Plus allows producers to select and breed replacement animals for greater wellness, health, production, fertility, longevity, milk components, and type.

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THE USE OF VETSCAN DC-Q™ AS AN AID TO SELECTIVE DRY COW THERAPY DECISION MAKING: THREE UK FARM CASE STUDIES

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SUMMARY

Decision making for selective dry cow therapy treatment is a complex and daunting task for some dairy farmers. VetScan DC-Q is a cow-side rapid mastitis detection test from Zoetis that uses fluorescent microscopy to deliver a milk leukocyte differential (MLD) result on individual quarter milk samples. Three farm case studies are presented to demonstrate their use of VetScan DC-Q.

FARM CASE STUDIES

Farm 1

Vetscan DC-Q quarter results	Positive	Negative	% quarters infected	% quarters uninfected
At dry off	117	331	26	74
On day 4 post calving	30	418	7	93

Treatment success: 117 positive quarters at dry off (in 59 cows), post calving 10 quarters infected = 91% cure rate.

<u>Overall verdict from farmer</u>: confident using Vetscan DC-Q for selective dry cow therapy and making quarter level treatment decisions

Farm 2

		% Positive	% Negative
SCC	Cows	42	58
	Heifers	39	61
Vetscan DC-Q	Cow level	53	47
	Quarter level	27	73

The farm was keen to understand the number of cows with different results from the Vetscan DC-Q compared with milk recording.

		Milk recording	
		% Positive	**% Negative**
Vetscan DC-Q (cow level)	**% Positive**	86	15
	% Negative	14	75

The farm decided to use the Vetscan DC-Q results to perform quarter level dry off and assess the dry period cure rate, dry period new infection rate and reduction in ADCT.

Dry period results
Cure rate outcomes at quarter level: 95%
New infection rate at quarter level: 7%
Reduction in ADCT: 35%

Overall verdict from farmer: confident using Vetscan DC-Q to perform quarter level dry off, pleased with ADCT reduction. Will continue to assess.

Farm 3

	Prior to using Vetscan DC-Q	**Following use of Vetscan DC-Q**
% High SCC cows	2	21
Incidence early lactation mastitis (/100 cows)	32	19
Incidence of mastitis following dry off (no. cases)	29	1
Dry period cure rate (%)	71	84

Overall verdict from farmer: confident using Vetscan DC-Q quarter level results to perform selective dry cow therapy at the cow level. Antibiotic usage slightly increased from previous year but significantly fewer mastitis cases with much lower lactating cow antibiotic use and beneficial effects for productivity and reduced culling/losses due to mastitis. The farm will continue to do the additional quarter level check at the point of dry off.

ACKNOWLEDGEMENTS

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VETSCAN DC-Q™ – AN EASY TO USE COW SIDE MASTITIS DETECTION TEST

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SUMMARY

VetScan DC-Q is a cow side rapid mastitis detection test from Zoetis that uses fluorescent microscopy to deliver a milk leukocyte differential (MLD) result. The VetScan DC-Q analyses quarter level milk samples with rapid, accurate results that can be displayed or printed from the machine or viewed online. The thresholds for diagnosis of infection and deciding treatment protocols are customisable allowing farms to determine the most appropriate way to treat mastitis on the farm and then to generate bespoke treatment reports. The principal use of the test results in UK pilot farm studies has been to help with decision making for selective dry cow therapy.

MILK LEUKOCYTE DIFFERENTIAL (MLD) TEST

Early detection of intramammary infection (IMI) is advantageous to prevent the spread of infection and to reduce the severity of some mastitis infections. Many mild infections will resolve or self-cure and in some cases will not generate a significant immune response. The immune response due to IMI follows the trigger of the host's defence system (which can be detected for example using milk amyloid A). The onset of the immune response may still mean that infection is self-limiting but, depending on the timing or nature of infection, therapeutic or preventative measures may become a consideration on some dairy farms. The immune response is most commonly diagnosed through the measurement of somatic cell counts (SCC), comprising of leukocytes and epithelial cells. Measurement of the milk leukocyte differential (MLD) involves determining the cell populations for the leukocytes – the lymphocytes, neutrophils and macrophages. These cell populations change with IMI and the differential count provides a tool for diagnosis that is predictive of infection at the quarter level[1,2]. The Vetscan DC-Q produces quantitative test results that allows infection to be diagnosed and threshold levels for the severity of the infection to be identified.

EASE OF USE OF VETSCAN DC-Q MILK ANALYSER

- The quarter milk samples are collected into the Vetscan DC-Q collection vessel (this can be stored up to 12 hours)
- The collection vessel is agitated and then flipped over to fill the test area in the sample pots

- A slide is placed over the test pots with a barcode that can be used to identify samples, manual identification is also possible
- The collection vessel is inverted and then returned to an upright position
- The collection vessel is immediately inserted into the Vetscan DC-Q analyser, up to 20 vessels (cow test) can be inserted for unattended operation
- The Vetscan DC-Q test is selected on the analyser
- Vetscan DC-Q results are provided on screen, printed or via an online database (DC-Q central) which can be accessed by vets/farmers
- Thresholds for the interpretation of the results can be adapted according to the farms requirements to produce bespoke treatment lists

CONCLUSIONS

The VetScan DC-Q analyses quarter level milk samples with rapid, accurate results that can be displayed or printed from the machine or viewed online. The thresholds for diagnosis of infection and deciding treatment protocols are customisable allowing farms to determine the most appropriate way to treat mastitis on the farm and then to generate bespoke treatment reports.
The principal use of the test results in UK pilot farm studies has been with decision making for selective dry cow therapy.

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UDDER HEALTH PARAMETERS FROM UK SENTINEL HERDS FOR 2018

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The AHDB Dairy Sentinel Herds project aims to monitor trends in clinical and subclinical mastitis over time. In 2016, 118 Sentinel Herds reflecting the geographical distribution of dairy farms in England, Wales and Scotland, were recruited with the criteria of 1) reliable electronic recording of clinical mastitis and 2) preferably monthly Individual Cow Somatic Cell Count recording. An additional six herds were recruited in 2017, to maintain numbers in case of 'wastage'. Participating farms provide data on clinical mastitis cases, and milk recording information, in electronic format. Data are "cleaned" to remove implausible values, using standardised thresholds, resulting in different numbers of observations for individual parameters. Key udder health parameters have been calculated annually for the years 2012 - 2018 using TotalVet software (www.total-vet.co.uk). The AHDB Mastitis Pattern Analysis Tool http://dairy.ahdb.org.uk/mastitis-pattern-tool was used to detect the predominant pattern of origin of new cases of mastitis (Environmental Lactation, Environmental Dry Period, or Contagious) for each herd each year.

Key results for 2018 are summarised in Table 1, for the 113 farms with robust data sets for both 2017 and 2018. Since distributions for all parameters were left skewed, data for 2017 and 2018 were compared using the Mann-Whitney test. No significant changes in median values ($P < 0.05$) were observed. Sixty-percent or more of the herds demonstrated an improvement in clinical mastitis indicators. In contrast, no more than 50% of herds showed an improvement in somatic cell count indicators reflecting dry period infection status. This may or may not be related to the challenges associated with recent changes in dry cow management, aiming to reduce antimicrobial use.

Lactation period environment origin patterns predominated in 45% of herds and dry period environment patterns in 25%, while in 23% of herds, lactation and dry period environment were of equal importance. As in 2017, contagious patterns appeared as a small minority, in 1.2% of herds as the predominant pattern, and in 7.1% at equal importance with environmental patterns.

The Sentinel Herds continue to provide a valuable insight into udder health trends in the UK.

Table 1. Key farm indices and udder health indicators 2018

Variable	N	Mean	Median	SE mean	Min	Max	% herds improving since 2017
Herd size	113	312	255	14.3	63	1683	
Mean annual rolling 305 day yield (l)	108	8681	8825	1808	4365	12020	
Calculated bulk milk SCC (,000/ml)	108	159	149	4.7	52	415	54
Clinical mastitis (CM) rate (cows affected /100 cows/ year)	113	30.3	26.0	3.3	2	96	61
Dry period origin CM rate (cows in 12)	113	0.7	0.6	0.6	0	3	60
Lactation origin CM rate (cows in 12)	113	1.8	1.7	0.7	0	6	61
Lactation new infection rate (%)	111	6.7	6.4	1.2	2	20	58
Dry period new infection rate (%)	108	16.0	15.1	1.9	2	41	46
Dry period cure rate (%)	107	78.8	79.1	1.2	43	100	50
Fresh calver infection rate (%)	108	17.4	17.3	1.9	3	44	47
% chronically infected	111	8.9	8.3	1.7	0	33	54
% > 200,000 cells/ml	111	15.9	14.9	1.7	5	46	51

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OPTIMISING ANTIBIOTIC USE AT DRYING OFF - A QUARTER BASED APPROACH.

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SUMMARY

Pressure on the use of antimicrobials in food producing animals, and prophylactic use in particular, has brought the use of antibiotic dry cow therapy (DCT) into focus. Whilst the selective use of antibiotic DCT at the cow level is now well established, the selective use at quarter level is less well understood. This abstract summarises the findings of a large UK study investigating selection of antibiotic treatment at the quarter level in both low and high SCC cows at drying off using the California Mastitis Test (based on its widespread availability and low cost) and builds upon the preliminary report presented at the 2018 conference. Analysis suggests that in herds with a low SCC and low prevalence of contagious pathogens there is scope to further reduce antibiotic use by withdrawing antibiotics from low SCC (CMT negative) quarters in high SCC cows, though no justification could be found for the general use of supplementary antibiotics in CMT positive quarters in low SCC cows at drying off. Any approach to selective DCT should be implemented with care, in consultation with the prescribing veterinary surgeon and only when a mechanism for monitoring the likely impact is in place.

MATERIALS AND METHODS

A full description of the methods was outlined in the British Mastitis Conference proceedings of 2018. Eight hundred and seven cows from six, low SCC commercial herds in the south-west of England were recruited to the study. Cows, within herds, were stratified ('infected' or 'uninfected') using somatic cell count and clinical mastitis history, before being randomly allocated to one of three treatment groups: CLT, QLT0 and QLT1. The CLT (Cow Level Treatment) group were allocated, using somatic cell count and clinical mastitis history, into animals eligible for the use of an internal teat sealant alone (Cepralock™) or an internal teat sealant in combination with antibiotic DCT (CEFA-SAFE™). Within the QLT0 (Quarter Level Treatment - CMT>0) and QLT1 (Quarter Level Treatment - CMT>1) groups, quarters within cows were allocated (based on a CMT score of >0 or >1 respectively) to receive an internal teat sealant alone (score below the threshold) or an internal teat sealant in combination with antibiotic DCT (score above the threshold) depending on the quarter California Mastitis Test (CMT) score at drying off.

Intramammary infection status was assessed using bacteriology and SCCs at drying off and post calving. Clinical mastitis was monitored for the first 100 days of the subsequent lactation. Univariable and Multivariable analysis was undertaken to understand the impact of the three different approaches on udder health.

RESULTS AND DISCUSSION

This study is the first large scale investigation into the selection of DCT at the quarter level in the UK. Historically, such approaches have not been favoured on the basis of the lack of independence of quarters within cows, particularly with respect to contagious mastitis pathogens. For this reason, this study focussed on relatively low SCC herds.

The prevalence of infection in this study at drying off was low, with classic contagious pathogens such as *S. aureus* identified in less than 1% of quarters. The aetiology was clearly 'environmental' and minor pathogens predominated both at drying off and post calving. Cure rates and apparent 'self-cure' rates in this study were very high.

Analysis suggests that the impact of selecting treatments at the quarter level is different in high and low SCC cows. Overall, in herds of the type in this study, the main effect appears to be on SCC and minor pathogens, rather than major pathogens. There appears to be little justification for superimposing antibiotic treatment on a teat sealant in high SCC quarters in "uninfected" (low SCC) cows at drying off, as self-cure rates appear to be very high and major pathogen prevalence is low - importantly adding antibiotic was not associated with any improvement in major pathogen cure rates and had minimal impact on SCC. In herds such as the ones in this study, there appears to be little risk associated with the removal of antibiotic from very low SCC (CMT score 0) quarters in "infected" (high SCC) cows, as there is minimal impact on SCC post calving and little effect on apparent cure rates of major pathogens. In this subset of cows, the targeting of antibiotic DCT to high SCC quarters resulted in a 49% reduction in the number of antibiotic tubes used per major pathogen cure.

This study suggests that there is scope to further reduce the use of antibiotic DCT in low SCC, well managed herds and that the CMT offers a cheap, rapid and viable, albeit imperfect, way of targeting infected quarters at drying off.

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PRECISION LIVESTOCK: WHAT CHALLENGES CAN THESE TECHNOLOGIES OVERCOME AND WHAT PITFALLS ARE THERE?

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To some, precision livestock farming is the revolution the dairy, beef and sheep sectors need to meet the future demands of a growing global population (2). To others it is going a step too far in automation (1). Irrespective of what your view is, precision livestock technologies are a new set of tools that like all tools, are only as good as the person using them. In the right hands, they provide huge potential to improve the efficiency and sustainability of the livestock industry.

IBERS Distance Learning has been delivering postgraduate level courses to the dairy, beef and sheep sectors since 2012. Our aims throughout are to inject the latest thinking into the industry in an accessible format. The development of each module involves a detailed review of current thinking from both scientific and industry perspectives.

Spotlight on precision livestock

Our new module 'Precision Livestock' forms part of the suite available. Its creation has identified ways in which precision, linked with the internet of things (IoT), can help meet the challenges of producing more from less through:

1. Constant monitoring to overcome missed individuals
2. Multiple sensor systems for proactive planning and targeted management (less firefighting)
3. Automatic issue identification
4. Better traceability and information for advisory services and supply chains

These approaches allow food production to become more efficient without the need to adopt labour intensive monitoring systems.

We have also identified issues still to be overcome for precision technology to fulfil its potential. These fall into four areas:

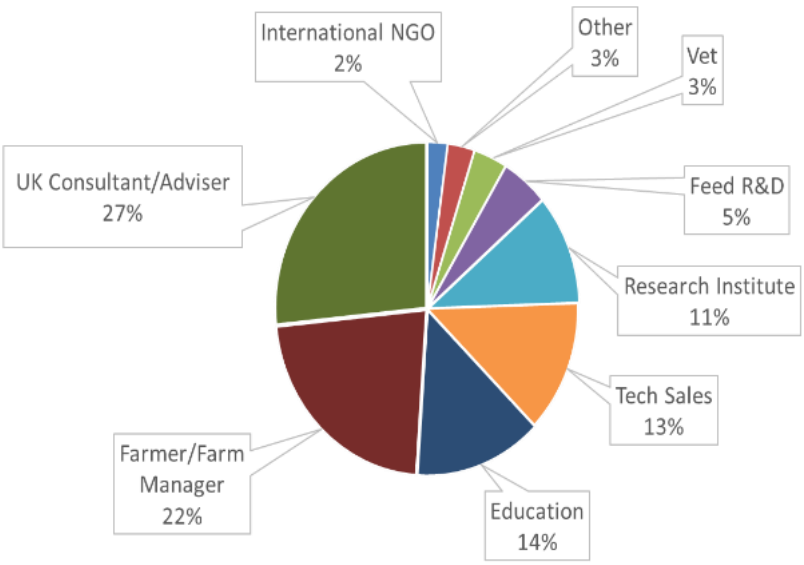
1. **Under analysis of data** – this presents a huge area for improvement
2. **Consolidated Software Platforms** - There needs to be one software platform for a farmer where all data is analysed and presented
3. **Under-use of data** - Increased use by supply chains would help to improve food security
4. **Training** - The industry needs clear generic training in how to implement, interpret and develop precision livestock systems

These areas must be looked at by all involved in livestock production to ensure innovative solutions to future industry challenges.

Getting the research out there

Although our courses were originally aimed at support industries (e.g. consultant/advisor) sectors, and these do represent approximately 88% of our students, 22% of our students are farmers or farm managers. This allows research to connect directly with the producers affected by challenges, such as mastitis, to food production (Figure 1).

Figure 1: Type of employment as a percentage of total students at the point of initial registry onto the Institute of Biological, Environmental and Rural Sciences (IBERS) postgraduate distance learning modules from 2012 to 2019. To register people had to either have a level 6 qualification or be over 25 years of age and have at least 3 years relevant work experience.



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