2013

BRITISH MASTITIS CONFERENCE

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Topics:

- **Dutch experience of using less antibiotics**
- **Risks of feeding non saleable milk to calves**
- **Research updates**
- **Sensor technology for mastitis control**
- **Cow behavioural changes with mastitis**
- **AMS v conventional milking**

Wednesday 13th November 2013

Pitch View Suite, Worcester Rugby Club, Sixways Stadium, Warriors Way, Worcester, Worcestershire WR3 8ZE

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GENERAL INFORMATION

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TIMETABLE of EVENTS

09:00	**ARRIVE / REGISTRATION / COFFEE and POSTER DISPLAY**	
09:45	**CHAIRMAN'S INTRODUCTION**	**Brian Pocknee** *The* Dairy Group, UK
	Session One	
09:55	Experience of Dutch dairy industry to reduced antibiotic use.	**Tine van Werven** Utrecht University, Netherlands
10:25	Feeding non-saleable milk to calves. What are the risks?	**Karen Bond** Royal Veterinary College, UK
10.55	Questions and Discussion	
11:10	**COFFEE and POSTERS**	
	Research updates (also presented as posters)	**Brian Pocknee** *The* Dairy Group, UK
11:40	Rate of transmission and the cost of clinical mastitis.	**Peter Down** University of Nottingham, UK
12.00	The aetiology and significance of *Staphylococcus* spp of bovine mammary origin.	**Andrew J Bradley** QMMS, Wells, UK
12:20	Mastiplan: Complimentary act of antibiotic and corticosteroid in resolving coliform intramammary infections.	**Abhijit Gurjar** Cornell University, USA
12:40	A comparison of the bacteriology of recycled manure solids and other bedding materials.	**Roger Blowey** Wood Veterinary Group, Gloucester, UK
13:00	**LUNCH and POSTERS**	
14:15	**CHAIRMAN'S INTRODUCTION and VOTING ON POSTERS**	**Elizabeth Berry** DairyCo, UK
	Session Three	
14.20	Can sensor technology benefit mastitis control.	**Niels Rutten** Utrecht University, Netherlands
14.55	Behavioural changes in cows with mastitis.	**Jenny Gibbons** DairyCo, UK
15.30	AMS or conventional milk harvesting – what is best for udder health?	**Tom Oesch** SwissLane Dairy Farms, Michigan, USA
16.05	Questions and Discussion	
16:20	**POSTER AWARD and CLOSE**	
16:30	**TEA and DEPART**	

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(presenting author underlined):

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(presenting author underlined):

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CHAIRMAN'S INTRODUCTION

Welcome to the 25th British Mastitis Conference.

The Organising Committee has worked hard throughout the year to bring together a group of speakers, both international and home grown, that we believe will prove both thought provoking and stimulating.

Our first paper looks at the Dutch experience dealing with the challenges associated with the reduced usage of antibiotics. The second paper of the first session looks at the risks involved in feeding unsalable milk to calves.

As a change from the previous format, all presenters of the Knowledge Transfer section were given the opportunity to submit their posters for oral presentation. The scientific committee then selected which four would be asked to present at the research update. The four papers are followed by an opportunity for delegates to debate with the presenters.

After lunch, we will turn our attention to whether sensor technology can benefit mastitis control, followed by the behavioural changes that cows exhibit when suffering from mastitis. The conference is closed with a paper on managing mastitis in large AMS milked herds.

This year has seen the largest submission of posters for many years, covering a wide range of topics. As always, I would urge you all to make time to review the posters and speak with the authors.

We continue to strive to find you the best speakers with the most relevant (and latest) information. This is achievable only thanks to all our generous sponsors, a number of whom are first time supporters. This year our sponsors are: Lely, Elanco Animal Health, Milk-Rite, Evans Vanodine, ADF Milking Ltd, Ambic Equipment Ltd, Fullwood Ltd, DeLaval Ltd, Zoetis and Norbrook Laboratories (UK) Ltd. As usual the event could not happen without able administration, provided by Karen Hobbs and Anne Sealey at *The* Dairy Group.

Finally, as always, thank you for attending and supporting the conference. I trust you will have an enjoyable and worthwhile day.

Ian Ohnstad
British Mastitis Conference Chairman
The Dairy Group

FURTHER INFORMATION

Organised by *The* Dairy Group, DairyCo and University of Nottingham

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Chairman: Ian Ohnstad
Conference Secretariat: Karen Hobbs
Editor: Brian Pocknee

Scientific Committee

Ian Ohnstad, *The* Dairy Group
Elizabeth Berry, DairyCo
Brian Pocknee, *The* Dairy Group
Martin Green, University of Nottingham

Copies of these proceedings may be obtained from:

Karen Hobbs
The Dairy Group
New Agriculture House
Blackbrook Park Avenue
Taunton
Somerset
TA1 2PX
UK

Tel: +44 (0) 1823 444488; Fax: +44 (0) 1823 444567
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- Helps fund the National Mastitis Research Foundation

A commitment to reducing mastitis and enhancing milk quality

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- To support education and research efforts that help raise awareness and understanding of milk quality issues

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- NMC annual meeting and regional meeting proceedings, containing all of the papers and posters presented at the meetings
- The NMC printed and electronic newsletters, addressing the latest information on udder health, milking management and milk quality
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- Opportunities to network with other dairy professionals concerned with milk quality

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PAPERS

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Proceedings of the British Mastitis Conference (2013) Sixways, Worcester, p 1 - 6
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EXPERIENCE OF DUTCH DAIRY INDUSTRY TO REDUCED ANTIBIOTIC USE

Tine van Werven
Faculty of Veterinary Medicine, Department of Farm Animal Health, Utrecht University, Yalelaan 7, 3481 CL Utrecht, the Netherlands; University Large Animal Practice, Harmelen, the Netherlands. E-mail: t.vanwerven@uu.nl

SUMMARY

Signing the Dutch agreement on "Responsible Antibiotic Use" by all livestock partners at the end of 2008 was the kick-off of a cascade of changes in Dutch veterinary medicine. Forced by political rumours and by pressure from public health the demand for more transparency in the ise of antibiotics increased. Changes, driven by both legislation and rules from the private dairy industry, were accomplished. Increasing awareness on the prudent use of antibiotics in farmers and veterinarians resulted in a national decrease of the use of antibiotics of 50% in 2012. This decrease was measured over all the different species (pigs, poultry, veal calves and dairy cattle). Although the use of antibiotics in dairy is relatively low compared to the other species, the dairy sector accomplished a decrease of more than 40%. More than 65% of the total use of antibiotics in dairy is used for intra-mammary treatment, 45% for dry co treatment and approximately 20% for treatment of (sub)clinical mastitis. Advice of the Health Council of the Netherlands put in 2012 a ban on the prophylactic use of antibiotics. In November 2013 a clinical guideline will be released about selective dry cow treatment. Cows without an intra-mammary infection at the end of lactation will no longer be dried of with antibiotics. This will be the next challenge in the interesting but complicated way towards a more prudent and responsible use of antibiotics.

INTRODUCTION

The last decade the use of antibiotics in food-producing animals has been a frequently discussed topic in the Netherlands. In 2008 full attention was drawn to the use of antibiotics in veterinary medicine. First of all an increase of antimicrobial resistance in livestock was mentioned, especially the MRSA bacteria and the ESBL producing bacteria. Secondly articles appeared in the media about people who became ill or even deceased after infection with resistant bacteria, possibly related to the livestock industry. In the meanwhile, data on antimicrobial use in both veterinary and human medicine were released, showing a low human (the Netherlands were second best in a European ranking on prudent use of antibiotics in human medicine) and very high veterinary use of antimicrobials in the Netherlands. The veterinary use was measured in kilograms of active substance. This discrepancy between human and veterinary use caused public and political rumours. In December 2008 all partners in the animal husbandry sector (pigs, poultry, veal calves, dairy cattle signed an agreement in which was stated that steps should be undertaken to get more insight in the use of antibiotics in food-producing animals and to focus on a more prudent use of antibiotics. Mean reason for this agreement was the considerable concern from public health, food safety and regulatory perspectives about the use of antimicrobials in food-producing animals. In 2010 the minister of agriculture stated that the use of antibiotics in veterinary medicine should be reduced by 20% in 2011 and by 50% in 2013, compared to the use of antibiotics in 2009. August 2011, a report from the Health Council of the Netherlands was published in which recommendations were made that should result in a reduction in the use of antibiotics in general and some classes of antibiotics in particular for all food- producing animals.

The need for an independent authority on veterinary drug use resulted in the founding of the SDa (the Veterinary Drug Authority) in 2011. The independent SDa expert panel defines bench mark indicators for responsible use of antibiotics. The bench mark indicators serve as guidelines for farmers and veterinarians and are specified per animal species (poultry, pigs, dairy cows and veal calves).

In order to make the use of antibiotics more transparent a large study was undertaken to 1)get more insight in the total use of antibiotics and in the different routes of administration and 2) to motivate farmers and increase awareness of a more prudent use of antibiotics.

MATERIALS AND METHODS

Calculation of the Use of Antibiotics

The collection and analysis of veterinary use data is not yet standardized (4). Most European countries report data based on sales figures of the pharmaceutical industry or prescriptions by veterinarians. In some countries a specific veterinary antimicrobial use monitoring programme was developed like in the Netherlands and Belgium (1).

Essential for interpretation and for instance periodical or international comparisons of antimicrobial usage data is to express the amount of sold or prescribed antibiotics in a number of treatments (as opposed to mass like kg) and to relate it to a relevant denominator. In human medicine antimicrobial usage is expressed in defined daily doses per 1000 inhabitants for GP prescription and per 100 hospital bed-days for hospitals.

The calculations don't reflect the precise number of exposed inhabitants; drug consumption data presented in DDDs only give a rough estimate of consumption and not an exact picture of actual use. The DDD provide a fixed unit of measurement independent of price and dosage form (e.g. tablet strength) enabling the researcher to assess trends in drug consumption and to perform comparisons between population groups. For veterinary antimicrobial consumption evaluation, therefore, it is essential to define animal daily dosages (ADD) for each antimicrobial pharmaceutical compound per animal species (3).

Using ADD's and standardized average weights assigned for each animal species and age groups, the antimicrobial sales data (in kg) can be transformed to numbers of ADD's administered to a certain animal species per time period

In veterinary medicine also the denominator is not yet standardised. Grave et al. (2) related the sales of antimicrobials per country to the biomass (kg) produced. The biomass was estimated on the numbers of slaughtered pigs, cattle and poultry and the numbers of live dairy cows present in a certain year. However, in the EU millions of food-producing animals are annually exported as live animals and slaughtered abroad. Therefore, a more accurate denominator is the average biomass (kg) of live animals present in a country, based on the average numbers of animals present in a given time period, or the actual number of animals at farm level when analysing farm level data.

Further analysis of the prescription data is based on the ATC vet classification. In the Anatomical Therapeutic Chemical (ATC) classification system, the active substances are divided into different groups according to the organ or system on which they act and their therapeutic, pharmacological and chemical properties. Drugs are classified in groups at five different levels. The drugs are divided into fourteen main groups (1st level), with pharmacological/therapeutic subgroups (2nd level). The 3rd and 4th levels are chemical/pharmacological/therapeutic subgroups and the 5th level is the chemical substance (WHO 2010.). This classification, combined with administration route for systemic drugs enables characterization of prescriptions at therapeutic groups level and at administration route level, e.g. intra mammary (drying off and mastitis), intra uterine, oral and per injection (parenteral).

In the Netherlands the use of antibiotics is reported as animal Daily Doses per Animal Year (aDD/aY). For example, if the aDD/aY of a herd is 5.3 it means that on average each cow of the herd is exposed for 5.3 day per year to antibiotics.

Study design

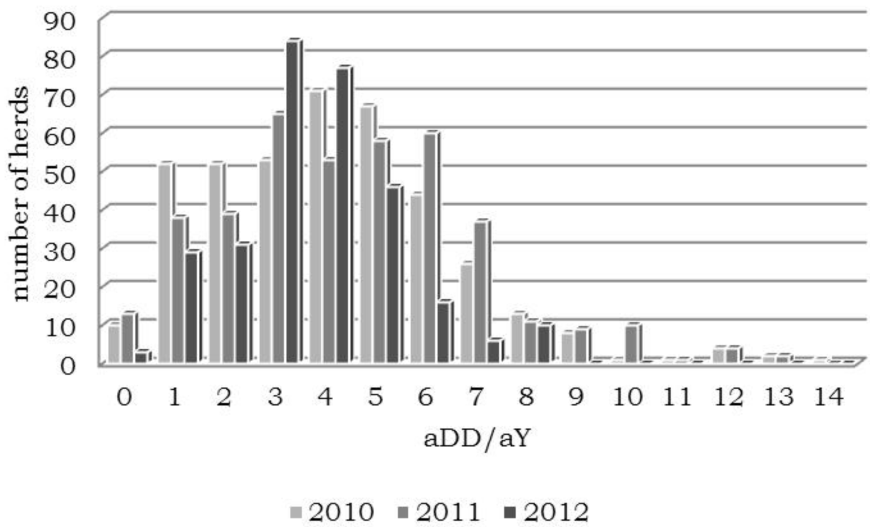
To get more insight and transparency in the quantitative and qualitative use of antibiotics a study was conducted in the University Farm Animal Practice (ULP) in the Netherlands. In this practice students from the Veterinary Faculty follow their ambulatory rotation. The practice consists of 385 dairy herds, representing approximately 28.500 adult cows. Average herd size is 71 cows (min= 18, max = 320). The use of antibiotics on this farms was calculated based on the information of the practice management system. Total amount of antibiotics and the route of administration was calculated.

Total use was divided in five different groups: dry cow treatment (DCT), mastitis, intra-uterine, oral and parenteral. After the so-called baseline measurements of 2009 and 2010 strategies were undertaken to make farmers more aware of prudent antibiotic use and to explain them the public health concerns about antimicrobial resistance. Written information, workshops and meetings were organised to explain the farmers the importance of prudent use of antibiotics in relation to the development of bacterial resistance and public health.

RESULTS

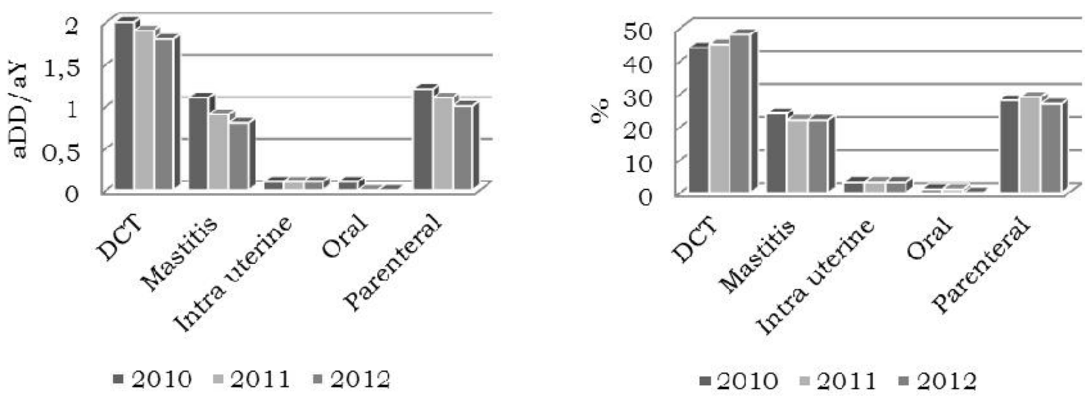
The mean use of antibiotics of all herds was 4.5, 4.2 and 3.8 aDD/aY, for 2010, 2011 and 2012 respectively. Frequency distribution of all herds is shown in Figure 1. Variation in the use of antibiotics between herds showed a broad range from 0 – 14 aDD/aY in 2010. In 2012 variation between herds decreased and varied between 0 – 8 aDD/aY.

Figure 1. Frequency distribution of antibiotic use on 385 herds expressed as animal daily dose per animal year (aDD/aY) over three consecutive years.



Based on the prescription use of the antibiotics, five routes of administration are defined. Figure 2 shows the use of antibiotics over the different routes of administration.

Figure 2. Distribution over the routes of administration expressed as daily dose per animal year (aDD/aY) (left figure) and as percentage of the total use (right figure) for the years 2010, 2011 and 2012 (n=385 dairy herds) (DCT= dry cow treatment)



The majority of the antibiotics are administered for intra-mammary use. More than 65% of the total use of antibiotics in dairy cows are used for intra- mammary usage, divided over dry cow treatment (more than 45%) and over treatment for (sub)clinical mastitis (more than 20%). On top of that about 5% - 10% of the parentally administered antibiotics are used to treat mastitis in addition to intra-mammary treatment. This implicates that more than 70% of the total antibiotic use in dairy is related to control or to treatment of (sub) clinical mastitis.

DISCUSSION

Large differences between herds are observed in the total use of antibiotics. These differences seem to be independent of milk production level (results not shown). The variation between herds has become less in the past three years. In 2012 the range in aDD/aY varied between 0 – 8, which means that the number of farms with very high antibiotic use showed a strong decline. On a national level the reduction of 50% was already achieved in 2012. This reduced use of antibiotics has been accomplished by increasing awareness in both farmers and veterinarians. In the University Large Animal Practice a lot of energy has been put in making farmers more aware in their use of antibiotics. Workshops were organized in which the mechanism of resistance was explained, combined with instructions on how to use antibiotics in a proper way. Being critical on diagnosis and treatment routines is essential for both farmers and veterinarians to minimize inappropriate use. Farm specific treatment protocols have been provided and proved to be a very helpful tool in decreasing the use of antibiotics. Besides that, inappropriate use of antibiotics like incorrect dosage or a too short duration of the treatment decreased spectacular because of the farm specific written protocols. Especially for udder health, the large-scale consumer of antibiotics, those protocols should be present on each farm.

Since antimicrobial dry cow treatment “consumes” the biggest part of the total antibiotic use, selective dry cow treatment will be the next challenge.

A report from the Health Council of the Netherlands in 2011 stated that the prophylactic use of antibiotics will be discouraged. Since January 2012 a total ban has been in place on the prophylactic use of antibiotics and the prophylactic indication was removed from the instruction leaflets of all dry cow treatments. A clinical guideline for selective dry cow treatment has been developed by the Royal Dutch Association for Veterinarians and will be released November 2013. The consequence will be that cows without an intra-mammary infections should be dried off without antimicrobial dry cow treatment. This will make heavy demands upon transition management and dry cow strategy in order to minimize the incidence of clinical mastitis around parturition.

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NOTES

Proceedings of the British Mastitis Conference (2013) Sixways, Worcester, p 7 - 13
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FEEDING NON-SALEABLE MILK TO CALVES. WHAT ARE THE RISKS?

Karen Bond
Royal Veterinary College, Hawkshead Lane, North Mymms, Hatfield, Hertfordshire, AL9 7TA, UK. E-mail: karenb@nmr.co.uk

SUMMARY

Mycobacterium avium paratuberculosis (*Map*), *Camplylobacter* spp., *Listeria* monocytogenes, Salmonella spp. and many mastitis causing pathogens including *Streptococcus agalactiae*, *Escherichia coli*, *Staphylococcus aureus*, *Streptococcus uberis* and *Mycoplasma* spp. are found in non-saleable milk which is fed to calves. These pathogens can produce immediate disease (e.g. enteritis or septicaemia) or may have longer term effects (e.g. Johne's disease). Milk from animals undergoing treatment which is fed may also contain antibiotics, raising concern of the potential to induce or transfer antibiotic resistance to the intestinal flora of the calves and cause antibiotic residue in tissue.

INTRODUCTION

The practice of feeding milk which is unfit for human consumption and therefore non-saleable, to calves is widespread both here in the UK and across the world (30). The economic argument for the dairy farmer is compelling when compared with the cost of purchased milk replacer, but we must be mindful of the potential for this milk to contain both pathogens and antibiotics.

Concern over the potential risks of this practice are nothing new and research into this topic has been ongoing for over 60 years. The main risks identified are two-fold: firstly, the presence of pathogens which may be harmful to the health of the calf and secondly, the presence of antibiotics which may destabilise the gut microflora, promote antibiotic resistance or lead to tissue residues.

In this review both issues are discussed in turn, looking at the published research into the potential risks.

PATHOGENS

It has been demonstrated that infected cows shed viable *Map* and *Salmonella* spp. into their colostrum and milk, whilst contamination with faecal matter during milk harvesting provides another source for these bacteria and also *L. monocytogenes* and *Campylobacter* spp. (15, 19, 23, 24, 25, 26, 27).

It has been demonstrated that the neonatal calf is most susceptible to infection with *Map* with approximately 80% of infections occurring in the first month of life, thus the feeding of contaminated milk and colostrum presents a substantial risk. *Map* is shed into the milk by both clinically and subclinically affected cows with the amount shed and the frequency of shedding increasing as the cow succumbs to the effects of the disease. *Map* has been recovered from the colostrum of 22% of clinically normal but *Map* infected cows. Of great concern also is the potential for the milk to be contaminated with *Map* which has been shed in the faeces of infected cows. Through faecal shedding a cow may contaminate not only her udder but the udders of other cows sharing her environment. Thus if milk is not harvested hygienically, with scrupulous teat preparation then it can be heavily contaminated before feeding (15, 26, 27). This applies not only to *Map* but also to *E.coli*, *Salmonella* spp., *L. monocytogenes*, and *Camplylobacter* spp.

These enteric pathogens have the ability to cause disease in the neonate. Neonatal enteritis and septicaemia cause significant morbidity and mortality in dairy farms. There is also evidence that bacterial contamination of colostrum may inhibit the uptake of immunoglobulins by the calf (8). The presence of bacteria in the small intestine may interfere with the systemic uptake of immunoglobulin molecules. This may be due to direct competition for transfer sites in the gut or because of the bacteria binding with the immunoglobulins making them unavailable for uptake. In a 2002 study in the United States 82% of colostrum samples were found to contain greater than 100,000 cfu/ml total plate count showing that calves will frequently be receiving heavily contaminated colostrum (19, 25).

Mastitis is one of the most common reasons for milk to be non-saleable, due to high somatic cell count, ongoing treatment or withhold period post treatment. It was back in 1942 that the potential for transfer of *S.agalactiae* from infected milk to the udders of neonatal calves via cross suckling was first proposed, with the resulting intramammary infection persisting until calving (21). Barto et al in a 1982 trail found that feeding milk which had been inoculated with *S. Aureus* did not increase the risk of heifer mastitis compared to those fed the control milk (2). However, a further study demonstrated a higher incidence of clinical mastitis in heifers on farms in New Zealand which use mastitic milk to feed calves (18). The evidence to prove a link between feeding mastitic milk and the subsequent development of mastitis in these heifers is equivocal.

Mastitis caused by *Mycoplasma* spp is recognised as being of growing importance in the UK (1). *Mycoplasma* spp have been shown to cause pneumonia, otitis media and polyarthritis in calves (3, 6, 13, 31) and an outbreak has recently been reported in the UK on a farm where the feeding of mastitic milk to these calves was considered to be a factor (1).

Much research has been carried out looking at the efficacy of on farm pasteurisation of both milk and colostrum in reducing the bacterial count of milk prior to feeding (3, 5, 15). This practice is growing in popularity here in the UK as an aid to the control of Johne's disease. Research has shown that *Mycoplasma bovis*, *L. monocytogenes*, *S. enteritidis* and *E. coli* could not be recovered from inoculated colostrum after pasteurisation at 60^0c for 30 minutes using a batch on-farm pasteuriser. This research also showed confidence that increasing the time to 60 minutes would be sufficient to eliminate *Map* and that the colostrum could be heated at 60^0c for up to 120 minutes without reduction in concentration or activity of IgG(5).

ANTIBIOTICS

The treatment of cows with antibiotics and the observation of the post treatment withhold period are major reasons for milk to be considered non-saleable. Thus much of the milk retained and fed to calves will contain antibiotics, however the dose received by an individual calf will be variable and determined by various factors including amount fed, antibiotics used, duration of treatment and withhold period.

The first consequence of this may be seen as an impact on calf health, as the antibiotics present in the milk alter the normal gut microflora causing digestive disturbances especially in very young animals. This was reported by Rollin et al in 1996 and Nord in 2003 however this effect was not seen in the 2003 work by Langford et al (11, 16, 20).

A further concern over the feeding of milk containing antibiotics is the potential for residue in tissue. This is particularly relevant in calves destined for veal production. Veal calves in the US have one of the highest incidences of drug residue violations and penicillin was the most frequently cited cause. The feeding of colostrum and milk containing antibiotics has been found to be the cause of some of these violations (7, 14, 17, 28).

The spectre of antibiotic resistance is a growing issue in both human and animal medicine and the feeding of antibiotics in milk to calves is of concern. The Veterinary Medicines Directorate issued a notice in May 2013 clarifying its position on the use of chlortetracycline (CTC) in calf milk replacer, stating that "There are no veterinary medicinal products containing CTC or any other antibiotic veterinary medicinal products, which are authorised for incorporation into dry calf milk replacer in advance of reconstitution and immediate feeding to calves. Thus it is illegal to prescribe, manufacture, supply, possess or use any calf milk replacer containing CTC or any other antibiotic prepared in advance of immediate feeding to calves." This sends a clear message on the broad prophylactic use of antibiotics in calf milk and was reinforced by a further notice in September 2013 (29). It should then be of note that whilst this legislation will reduce the amount of antibiotic intentionally added to calf milk, the feeding of non-saleable milk containing antibiotics will continue. The problem is compounded by the fact that the quantity of antibiotic fed will be unknown and will be variable. Also it will be unlikely that calves will be exposed to only one type of antibiotic in their non-saleable milk feeds during the period from birth to weaning. This feeding of low levels of different antibiotic types is of great concern in the development of antibiotic resistance in the gut flora of these calves.

Studies carried out in the late 1970s and early 1980s showed no effects on clinical health or growth of calves fed milk from antibiotic treated calves, but did not investigate the possibility of antibiotic resistance (4, 9, 10,1 2). Further studies have investigated the risk of antibiotic resistance in the gut flora of calves developing as a result of the feeding of milk containing antibiotics. The first looked specifically for differences in levels of antibiotic resistant *E. coli* in the faeces and found no difference between those calves fed milk from cows treated with antibiotics and those fed milk replacer. Unfortunately problems were encountered within this study of acceptance of the milk from the antibiotic treated cows due to the high bacterial count of this milk. This led to poor intakes and growth in this group of calves which may have affected the results (32). A second study in 1997 looked at the levels of viable bacteria and antibiotic resistant bacteria in milk fed to calves. They found high levels of antibiotic resistant bacteria along with high total bacteria counts, which also raises concerns over the quality of harvesting and storage of milk for calf feeding (22). A recent study by Langford et al in 2003 looked at the concentration of *ß*-lactam antibiotic in milk from cows after treatment and during the withhold period, this information was used to inform the selection of the four levels of inclusion of Penicillin G used in the experiment. They found that there was considerable variation in the baseline levels of resistance in the gut flora of the calves prior to the start of the experiment and considered that this may be due to the variable presence of antibiotics in colostrum from the use of dry cow therapy. However, despite this baseline variation they observed a strong relationship between the dosage of antibiotic added to the milk and the level of antibiotic resistance (11). There is also evidence that this resistance, once established, may persist for some time even after the selection pressure has been removed (16).

DISCUSSION

The reasons for a farmer to wish to feed non-saleable milk to their calves are many, including the desire not to throw away milk which it has cost them money to produce, the cost of purchased milk replacer, convenience and the belief that calves will be healthier and grow more rapidly. Therefore any move to cease this practice would need to provide compelling reasons to the farmer.

The presence of pathogens in this milk is well documented and the risks related to these various pathogens well recognised. The shedding of pathogens such as *Map* directly into milk and colostrum makes the feeding of non-saleable milk to calves a critical control point for those seeking to control Johne's disease. This direct shedding, along with the potential for faecal contamination of the milk during harvesting or storage, make the feeding of non-saleable milk a specific risk for the transfer of pathogens to the calf. There is evidence of immediate and long term risk to calf health.

The presence of antibiotics in non-saleable milk poses another risk to the health of the calf but also in the wider context of animal and human health due to drug residues and antibiotic resistance. The feeding of antibiotics in milk replacer is no longer permitted, however we continue to allow the feeding of low levels of antibiotics to calves in non-saleable milk. There is currently much discussion regarding the use of antibiotics in veterinary medicine, particularly in food producing animals and the potential for this use to facilitate antibiotic resistance. The feeding of antibiotics in non-saleable milk should perhaps be viewed in the same light.

CONCLUSIONS

The use of non-saleable milk for calf feeding is widespread and provides farmers with a way to utilise this milk and reduce the amount of milk replacer which must be purchased.

The risks of this practice have been well researched in terms of the presence of pathogens and, to a lesser extent, antibiotics. There are tangible risks involved which may impact the health of the calf directly and also have wider implications for human and animal health and the future efficacy of antibiotics.

Whilst the hygienic harvesting and pasteurisation of milk provide a way for farmers to reduce the pathogen load of non-saleable milk prior to calf feeding, these practices do little to address the presence of antibiotics and the inherent risks.

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RATE OF TRANSMISSION AND THE COST OF CLINICAL MASTITIS

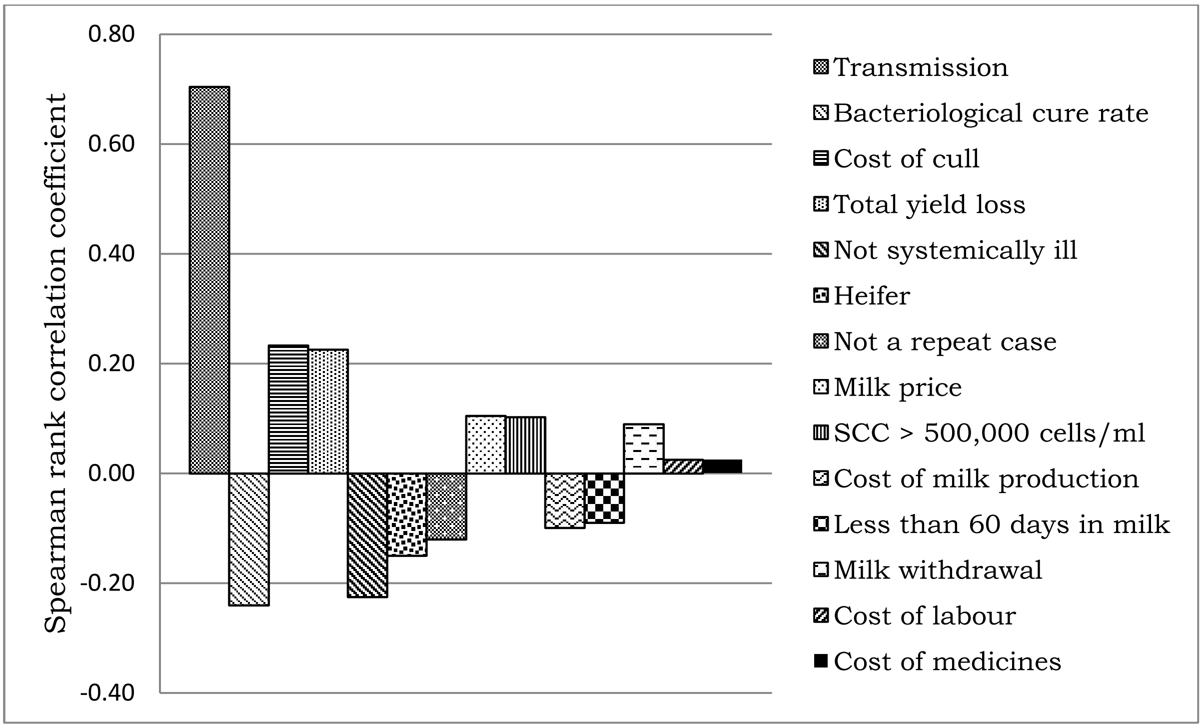
Peter M. Down, Martin J. Green and Chris D. Hudson
School of Veterinary Medicine and Science, University of Nottingham, Sutton Bonington Campus, Sutton Bonington, LE12 5RD, UK.

Mastitis remains one of the most common diseases of dairy cows and represents a large economic loss to the industry as well as a considerable welfare issue to the cows affected. Despite being an infectious disease, concentration is often focused on the individual animal with respect to treatment, cost, and management. The risk posed to the rest of the herd from infected individuals and the potential impact of disease transmission on the cost of a case of clinical mastitis (CM) is often overlooked.

The aim of this research was to use probabilistic sensitivity analysis to evaluate the relative importance of different components of a model designed to estimate the cost of CM. A particular focus was placed on the importance of pathogen transmission relative to other factors, such as milk price or treatment costs.

A stochastic Monte Carlo model was developed to simulate a case of CM at the cow level and to calculate the associated costs. Uniform distributions were used throughout the model to enable investigation of the cost of CM over a spectrum of clinically realistic scenarios without specifying which scenario was more or less likely. A risk of transmission parameter distribution, based on literature values, was included to model the effect of pathogen transmission to uninfected cows, from cows that remained subclinically infected after treatment for CM. Spearman rank correlation coefficients were used to evaluate the relationships between model input values and the estimated cost of CM.

Risk of transmission was found to have the strongest association with the cost of CM followed by bacteriological cure rate, cost of culling and yield loss. Other factors such as milk price, cost of labour and cost of medicines were of minimal influence in comparison.



The results from this study suggest that, when seeking to minimise the economic impact of CM in dairy herds, great emphasis should be placed on the reduction of pathogen transmission from cows with CM to uninfected cows.

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THE AETIOLOGY AND SIGNIFICANCE OF *STAPHYLOCOCCUS* SPP OF BOVINE MAMMARY ORIGIN

Andrew J Bradley[1,2], James A Bradley[1], Emily Coombes[1], Emma Lusby[1], Katherine Mining[1], Caroline Hunt[1] and Barbara Payne[1]
[1]Quality Milk Management Services Ltd, Cedar Barn, Easton Hill, Easton, Wells, Somerset, BA5 1DU, UK. [2]School of Veterinary Medicine and Science, University of Nottingham, Sutton Bonington Campus, Sutton Bonington, LE12 5RD, UK

SUMMARY

Despite implementation of the Five Point Plan, *Staphylococcus* spp remain a significant cause of intramammary infection both in the UK and overseas. Historically, attention has been focussed on *Staphylococcus aureus*; however more recently there has been increasing interest in the importance of the Coagulase -ve *Staphylococcus* spp. This abstract reviews the findings of the speciation of *Staphylococcus* spp of mammary origin collated from routine submissions to a UK laboratory. Coagulase -ve *Staphylococci* were more commonly isolated than Coagulase +ve *Staphylococci*, though *S. aureus* was the single most commonly isolated species.

INTRODUCTION

Staphylococcus spp are a significant cause of intramammary infection and the Coagulase -ve *Staphylococci* have been reported as the most common aetiological agents in a number of studies. The advent and increasing accessibility of molecular techniques means that it is now viable to speciate these organisms on a routine basis, which will enable a better understanding of the relative importance of the different species.

MATERIALS & METHODS

The vast majority of samples submitted to the laboratory were for the purposes of research; to minimise bias, these were excluded from this analysis with only submissions by third parties included. The bacteriological approach involved the plating of 10ul of secretion onto blood and Edwards Agar and 100ul on MacConkey Agar, to enhance the sensitivity of detection of Gram negative organisms and *Staphylococcus* spp. Species level identification of *Staphylococcus* spp was undertaken using MALDI-TOF MS which had been previously validated as an acceptable method for identifying *Staphylococcus* spp.

RESULTS

6,005 samples from 991 submissions from over 500 farms throughout the UK were analysed, of which 43.8% were from clinical cases. A *Staphylococcus* spp was isolated from 31.1% (1865) of samples (23.6% and 36.8% of clinical and sub-clinical isolates respectively). *Staphylococcus* spp isolated from 1262 samples submitted between July 2011 and August 2013 were available for species level identification (412 and 850 from clinical and sub-clinical cases respectively). Twenty different *Staphylococcal* species were identified and are summarised in Table 1 below.

Table 1 Summary of individual *Staphylococcus* spp as a proportion of all *Staphylococcus* spp isolated from clinical and sub-clinical samples.

Proportion of *Staphylococcus* spp isolates (%)	Clinical (n=434)	Sub-clinical (n=921)
Staphylococcus aureus	36.18	37.35
Staphylococcus haemolyticus	17.28	13.36
Staphylococcus chromogenes	14.06	14.88
Staphylococcus epidermidis	9.45	7.06
Staphylococcus equorum	6.22	7.38
Staphylococcus sciuri	4.61	6.41
Staphylococcus xylosus	3.23	4.56
Staphylococcus warneri	2.30	1.74
Staphylococcus hyicus	1.84	0.43
Staphylococcus simulans	1.38	1.09
Staphylococcus succinus	1.15	2.06
Staphylococcus capitis	0.69	0.54
Staphylococcus hominis	0.69	1.41
Staphylococcus fleurettii	0.23	0.33
Staphylococcus pasteuri	0.23	0.43
Staphylococcus saprophyticus	0.23	0.22
Staphylococcus vitulinus	0.23	
Staphylococcus auricularis		0.33
Staphylococcus cohnii		0.33
Staphylococcus condimenti		0.11

The somatic cell counts of samples positive for *S. aureus* (1,877 x 10^3 cells/ml) were significantly higher than for other *Staphylococcus* spp (361 x 10^3 cells/ml), which were not significantly different from each other. There was evidence of variation in the prevalence of different species isolated at different stages of lactation and in different seasons.

DISCUSSION AND CONCLUSIONS

Whilst *S. aureus* was the most common *Staphylococcus* spp identified in both clinical and sub-clinical samples, a large number of other species were also identified. *S. haemolyticus* was more frequently identified than has been reported in previous studies.

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MASTIPLAN: COMPLIMENTARY ACT OF ANTIBIOTIC AND CORTICOSTEROID IN RESOLVING COLIFORM INTRAMAMMARY INFECTIONS.

Anja Sipka,*1 Abhijit Gurjar,* Suzanne Klaessig,* Gerald E. Duhamel,† Andrew Skidmore,‡ Jantijn Swinkels,‡ Peter Cox,§ and Ynte Schukken*
* Department of Population Medicine and Diagnostic Sciences, and † Department of Biomedical Sciences, College of Veterinary Medicine, Cornell University, Ithaca, NY 14853, USA; ‡ Merck Animal Health, Global Ruminants Business Unit, Summit, NJ 07901, USA; § MSD Animal Health Innovation, 49070 Beaucouzé, France.

Bovine mastitis caused by environmental pathogens such as *Escherichia coli, Klebsiella spp., Enterobacter spp., and Citrobacter spp.* is usually high during the early postpartum period in dairy cows (1). Among gram-negative bacteria, *Escherichia coli* are the most important and best characterized pathogen (2). Mastitis in dairy cows is typically treated with intramammary antibiotics. The registered combination of antibiotics with corticosteroids tends to have a large market share. The objective of the current study was to investigate the effect of prednisolone in combination with cefapirin on the inflammatory response of experimentally induced Escherichia coli mastitis.

Six midlactating Holstein-Friesian cows were challenged in 3 quarters with *E. coli* and treated at 4, 12, 24, and 36 h post infection with 300 mg of cefapirin in 1 quarter and a combination of 300 mg of cefapirin and 20 mg of prednisolone in another quarter. At 24 h (n = 3) or 48 h (n = 3) post infection cows were euthanized for tissue sampling. Clinical scores, somatic cell count, and California mastitis test scores, as well as IL-1β, IFN-γ, IL-4, and IL-10 levels and bacterial growth in milk, were measured every 6 h. A moderate clinical mastitis in challenged, untreated quarters was observed in all cows after experimental inoculation. Challenged, untreated control quarters showed increased concentrations of all measured cytokines together with recruitment of polymorphonuclear neutrophilic leukocytes at 24 and 48 h post challenge. Treatment with cefapirin alone inhibited bacterial growth in milk and reduced the host inflammatory responses. Addition of prednisolone to cefapirin had a synergistic effect, resulting in a lower density of leukocytes in tissue and milk and thereby quickly restoring homeostasis in the udder.

The results in this study shows a potent bacteriological cure of cefapirin alone in displaying inhibition of bacterial growth after 36h in quarters treated with cefapirin alone, and after 18h in quarters treated with cefapirin plus prednisolone. Furthermore, cefapirin treatment induced a distinct cytokine profile with an increase in IL-4 concentrations and down regulation of all other measured cytokines. Prednisolone further supported the effect of cefapirin by reducing the density of PMNL in milk and tissue, and thereby quickly restoring homeostasis in the udder.

Based on our results, it can be concluded that quarters challenged with *E. coli* and treated with cefapirin and prednisolone more quickly resembled uninfected control quarters.

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A COMPARISON OF THE BACTERIOLOGY OF RECYCLED MANURE SOLIDS AND OTHER BEDDING MATERIALS

Roger Blowey, Jenny Wookey and Leanne Russell
Wood Veterinary Group, 125 Bristol Road, Gloucester, GL2 4NB, UK. E-mail: rogerblowey@mailbox.co.uk

Recycled manure solids (RMS) as a bedding material for dairy cattle is commonly used in many countries including mainland Europe, North America and Middle East countries such as Saudi Arabia. Within the UK, interest in RMS is increasing as other bedding materials become more expensive and are harder to source. Recent advice from DEFRA (1) indicates that manure should be categorised under Animal By-products (ABP) legislation, and that, although technically the use of DMS is illegal, there will be no prosecutions on the use of DMS in cow cubicles if the material used solely originates from the farm of origin; however, the material must not be used for calf bedding.

Many studies have shown a correlation between bacterial populations in bedding or at the teat end in relation to mastitis, and it is well accepted that 'clean' bedding is important for dairy cows in terms of mastitis control (2, 3, 4, 5). The risk of mastitis from deep straw beds was, of course, one of the reasons why many herds moved from yards and into cubicles. The use of beddings with a zero bacterial content has been shown to lead to a marked reduction in mastitis levels. In a detailed study of three large commercial dairy farms (6) comparing clinical mastitis incidence for the two years before and two years after a change to a zero bacterial content bedding, mastitis incidence in the first 150 days in milk fell by four fold in one farm of 650 cows (to 10 cases/100 cows per year), and by two fold in a second farm; there was no change in the third farm.

Due to our interest in bedding types in relation to both mastitis and lameness, over the past 10 years we have collected a considerable amount of data on the bacterial content of different bedding types. Examples of mean bacterial levels for a range of beddings are given in Table 1 (7, 8).

Anaerobic digestate, RMS and other forms of recycled manure have some of the highest bacterial levels that we have encountered, and must therefore presumably increase the risk of high levels of teat end contamination and subsequent mastitis. There must also be an increased risk of contamination of the milk with zoonotic and other pathogenic organisms, e.g. salmonella, coliforms and potentially Johnes, and a risk of transfer by bio-aerosols, similar to the effects of open windrow composting. Increased levels of Klebsiella mastitis have also been reported with RMS.

Risks can be reduced by ensuring that the bedding is regularly changed and kept dry. One option that has been discussed is to premix the material with a product that will totally desiccate the RMS and raise its pH. This could then provide all of the economic and environmental benefits plus the comfort of a deep bed of RMS without any of the potential disadvantages of a high bacterial load.

We would recommend continued regular monitoring of the bacterial levels of bedding as this has an important effect on animal health and welfare.

Table 1: Mean bacteria levels for a range of bedding

Bedding	Total bacteria (fresh wt)	Coliforms	Total staphs	Total streps	pH
sand	900	<10	<10	<10	6.9
straw	1.3m	79,000	n/d	800	7.2
sawdust	51,000	4,000	4,800	2,000	5.0
gypsum	7.8m	20,270	>160,000	>160,000	7.0
Paper	1,500	120	960	200	6.5
digestate	12.9m	<10	9,500	21,200	8.5
Recycled manure, RMS	160m	20	4,800	160,000	6.8
RMS fresh	110m	520,000			7.9
RMS dry from bed	1,100m	90,000			7.5
RMS + 25% udderbed	3.5m	<10			8.4
ash	10	<10	<10	<10	11.7

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CAN SENSOR TECHNOLOGY BENEFIT MASTITIS CONTROL

C.J. Rutten, A.G.J. Velthuis, W. Steeneveld and H. Hogeveen
Department of Farm Animal Health, Faculty of Veterinary Medicine, Utrecht University, Yalelaan 7, 3584 CL Utrecht, the Netherlands. E-Mail: c.j.rutten@uu.nl

SUMMARY

Since the 1980s, efforts have been made to develop sensors that measure a parameter from an individual cow. One of the first techniques was a sensor that measures the electrical conductivity of milk. Application of electrical conductivity in practice only took a start with the introduction of the automated milking system. The aim of this review is to provide a structured overview of the published sensor systems for udder health management.

The development of sensor systems can be described by the following four levels: I. techniques that measure something about the cow (e.g., milk electrical conductivity, EC); II. interpretations that summarize changes in the sensor data (e.g., increase in milk EC) to produce information about the cow's status (e.g., mastitis); III. integration of information where sensor information is supplemented with other information (e.g., economic information) to produce an advice (e.g., whether to treat a cow or not); and IV. the farmer makes a decision or the sensor system takes the decision autonomously (e.g., milk is discarded).

This review has structured a total of 31 publications from 2002-20012 describing 37 sensor systems for mastitis detection and compared them based on the four levels. Many studies presented sensor systems at levels I and II, but none did so at levels III and IV. Most of the work for mastitis (92 per cent) is done at level II.

The performance of sensor systems varies based on the choice of gold standards, algorithms used, and test sizes (number of farms and cows). Studies on sensor systems for mastitis have shown that sensor systems are brought to a higher level, however there is still a need to improve detection performance. No systems with integrated decision support models have been found.

INTRODUCTION

An important development in Western Europe is the use of automated milking systems (AMS). The first studies on the feasibility of an AMS were done in the mid-1980s, such as the initial preliminary study by Rossing et al. [1]. The first commercial farms introduced an AMS in the Netherlands in 1992 and by 2009 the number of farms using an AMS had increased to more than 8,000 worldwide (90 per cent of which were located in Western Europe) [2]. In the operational management of farms, the use of an AMS will require a different strategy for the detection of mastitis. When using an AMS, there is no milker present who could visually judge the cows' foremilk for the presence of clots to detect mastitis. Therefore, farmers must rely on alternative methods to detect mastitis. Since the 1980s, work has been done on devices that measure a health indicator in, up, on, or from an individual cow [3]. Examples of sensors include milk electrical conductivity and milk colour sensors [4]. However, these sensors were never commercially successful. Therefore, the introduction and success of the AMS was an important boost for the development of sensors for automated mastitis detection.

In general, there is a trend in dairy farming towards the automation of processes in order to reduce (physical) labour and labour costs [2,5]. This development is partly driven by the economic reality of increasing labour costs relative to capital costs. Automated systems enable dairy farmers to manage larger herds with lower labour requirements [2], which means that the application of both the AMS and sensor systems fits within the trend of increasing herd sizes.

The objective of this review is to provide a structured literature review of the sensors, sensor data, data algorithms that provide information, and the corresponding decision support systems to be used in mastitis management. This paper describes four key points: (1) Level I: 'Sensor technique': what sensor systems are developed for the detection mastitis; (2) Level II: 'Data interpretation'; (3) Level III 'Integration of information"; and (4) Level IV 'Decision making. Finally the system quality will be discussed in terms of sensitivity and specificity of the detection, how informative the system is for the farmer and what aspect of the system are important for considering its performance and information.

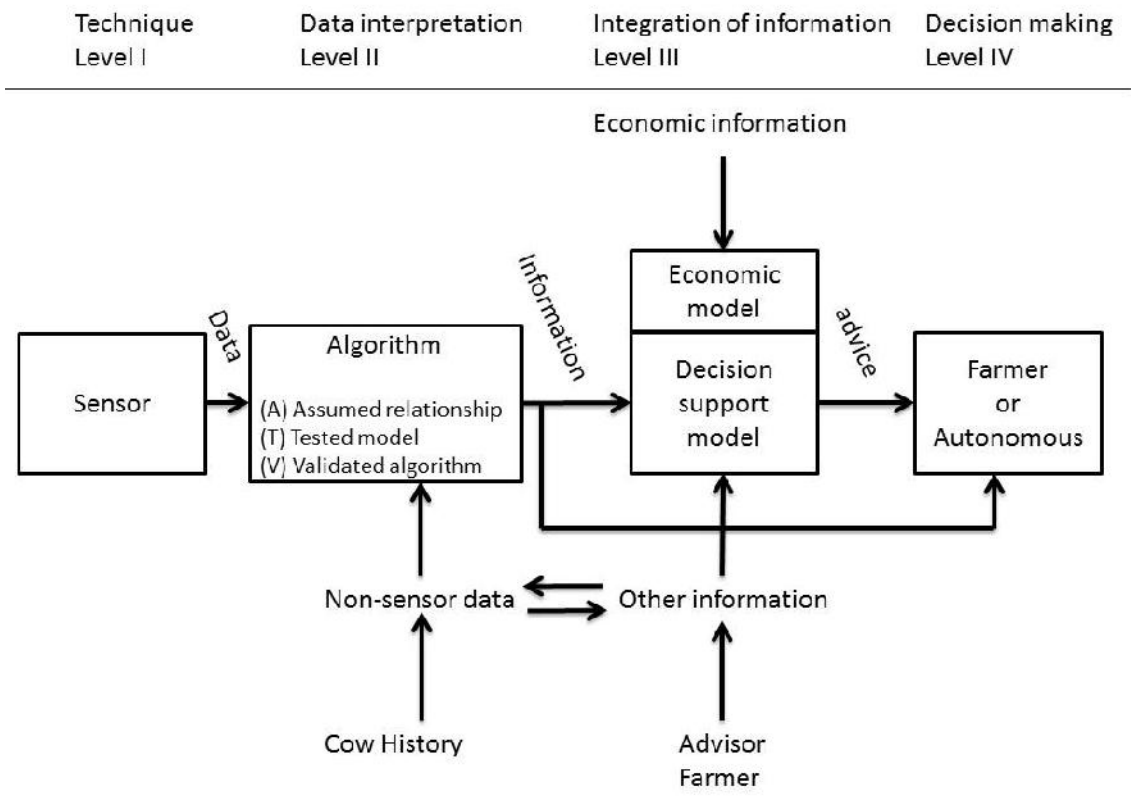
MATERIALS & METHODS

This study considers a sensor to be a device that measures a physiological or behavioural parameter (related to udder health) of an individual cow and enables automated, on-farm detection of changes in this condition that is related to a health event (such as mastitis) and requires action on the part of the farmer (such as treatment).

There are two categories of sensors: attached and non-attached. Attached sensors may be on-cow sensors that are fitted on the outside of the cow's body, or in-cow sensors that are inside the body (for example, rumen bolus or implant). Non-attached sensors are off-cow sensors that cows pass by, over, or through for measurement. Two specific forms of non-attached sensors are in-line and on-line sensors. In-line sensors take measurements in a continuous flow of a product from the cow. The only available option for in-line measurement is in the milk line. On-line sensors automatically take a sample (milk, for example) that is analysed by the sensor.

Framework

Figure 1 Framework of the development stages for sensor systems that can be used to support dairy farm health management.



This review has used the scheme shown in Figure 1 to categorize sensor systems. The scheme shows a framework that describes the steps from a sensor to a decision. Sensors are categorized in the levels of this scheme according to their description in the literature. Sensors are only described if they reach at least level I, known as "technique," which means that they measure an aspect of the cows' condition or status. The two categories identified within this level are solely measuring a parameter and an assumed relation. In some sensors the produced data is processed by a data algorithm (for example an AMS measures electrical conductivity of milk that flows through the milk line, the data algorithm calculates the average conductivity over the whole milking).

The next step (level II) is called "data interpretation" and measures changes in the sensor data to produce information about the cows' status (e.g., mastitis). The two categories identified within this level are an a statistically tested relation and a validated algorithm. From a statistically tested relation, it is possible to build a predictive model (detection algorithm) that classifies the cows' status (for example, mastitis or healthy). For validation, a data set (not the one used to build the detection algorithm) is used to assess the performance by comparing the classification of the algorithm with the gold standard. A further feature can be updating or resetting the detection algorithm with gold standard measurements during operation in practice, this would mean the algorithm adapts to an individual farm or changing circumstances.

Level III integrates the sensor information with other information (such as economic information), to produce advice for the farmer. Furthermore, information of individual cows can be aggregated by a monitoring algorithm at the herd level. The output of this algorithm can be seen as either general information on the herds health for the farmer or additional data input for the detection algorithm. The decision is eventually made either by the farmer or autonomously by the sensor system (level IV, known as “Decision making”).

Having gained a clear overview of the available sensor systems, the data and information produced by these sensor systems was compared. The quality of the data and information (that is, whether the data or information was fit for use by farmers) was assessed. The criteria for this assessment were whether the sensor system detects a clearly defined change in the cows’ health (such as clinical mastitis or high SCC) and presents this change clearly to the farmer (such as in the form of an alert rather than as a graph of sensor data). Also, detection sensitivity and specificity were discussed in respect to the used gold standard and the test scale. Furthermore, the added value of the sensor system for the farmer’s decision making was discussed. This comparison led to a discussion of what further research would be needed to improve performance of available sensor systems, develop new sensors and make sensor systems that can be used in practice for udder health management on farms and are of more practical value on-farm.

Literature selection

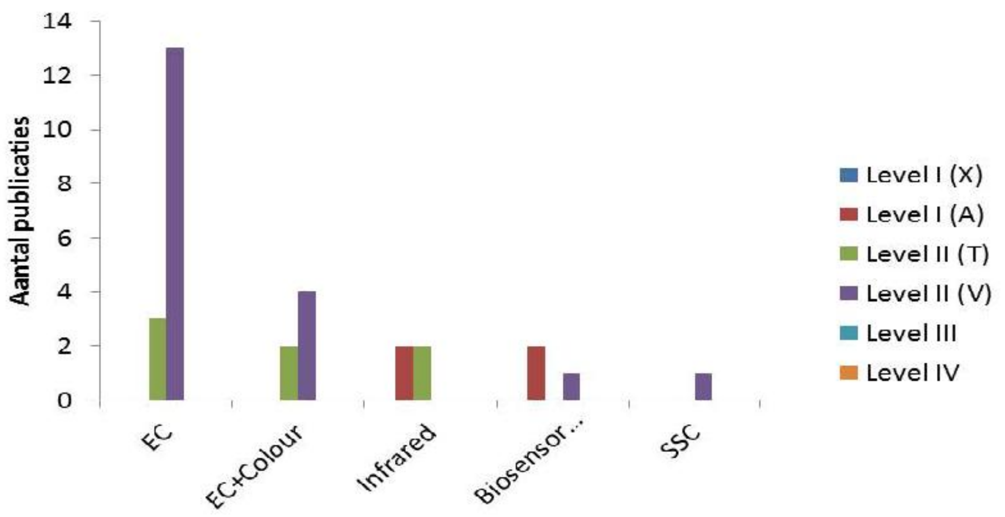
The relevant literature was searched based on keywords including sensors, dairy farming, and automated detection, in combination with words such as mastitis, and udder health. Literature was also identified by a forward search, using the citations and a backward search using the references of the papers found through the keyword search. Journals from the ISI database (Web of Science, Thomson Reuters, New York, USA) were used for the period from January 2002 until June 2012, and the proceedings of relevant scientific conferences held between 2007 and 2012 were searched. The conferences included the First North American Conference on Precision Dairy Farming (Toronto, 2010) and the European Conference on Precision Livestock Farming (Prague, 2011 and Wageningen, 2009).

RESULTS

Level I: ’Sensor technique’.

For automated detection of mastitis, 31 publications were found with 37 described sensor systems (some publications described multiple sensors, algorithms, or diseases). Four (11 per cent) of these publications were proceedings papers. Electrical Conductivity (EC) was the main sensor system studied (in 15 studies, 48 per cent), followed by a combination of EC sensors and milk colour sensors (seven studies, 23 per cent). Some other studies used a biosensor to detect certain enzymes, including haptoglobine, L-lactate dehydrogenase or NAGase (five studies, 16 per cent), an SCC sensor (two studies, 6 per cent), or a reticular bolus that measured temperature (one study, 3 per cent). The EC and milk colour sensors were in-line sensors, meaning that they measure in a continuous milk flow. The biosensors and SCC sensors took measurements from automatically collected milk samples, meaning that they were on-line sensors. The bolus was inserted in the cow's reticulum, which made it an in-cow sensor.

Figure 2 Sensor for automated detection of mastitis per level of development according to Figure 1.



Level II: 'Data interpretation'.

Figure 2 shows that 34 (92 per cent) published sensor systems for automated detection of mastitis included data interpretation, which means that the (statistical) relation between gold standard (e.g., the California Mastitis Test (CMT)) and sensor measurements (e.g., milk EC) was studied. For 27 (73 per cent) studies the algorithm was validated (that is, they used a data set to calculate predicted mastitis classification per cow and compare these with the gold standard). For 15 (41 per cent) sensor systems, the sensitivity and specificity of the detection algorithm were determined and reported; this is discussed further below.

Level III 'Integration of information'.

Figure 2 shows that none of the sensor systems integrated the sensor information with other information.

Level IV 'Decision making'.

Sixteen (43 per cent) sensor systems provided the farmer with a mastitis alert, while 12 (32 per cent) also provided a probability added to this mastitis alert to describe the certainty, and two (5 per cent) provided a degree or classification of mastitis. Eight (22 per cent) sensor systems provided the farmer with raw sensor data (such as milk NAGase concentration) and/or were unclear in describing what they provided to the farmer.

DISCUSSION

Literature has shown that mastitis is currently one of the main health issues on dairy farms [14,15,16]. Therefore detection of mastitis cases is important, especially in the light of increasing herd sizes and increasing application of the AMS.

For mastitis (92 per cent of the publications on mastitis sensors) most work is done on level II of Figure 1. Most studies on mastitis (73 per cent of the publications on mastitis sensors) described a validated algorithm. For mastitis 8 per cent of the studies describe a sensor with nothing more than an assumed relation between mastitis and sensor data. Test scales of the studies vary considerably. Studies on sensors for mastitis all included more than 10 cows, indicating that very small test scale were not found in current literature. The effect of test size on detection performance is unclear, as publications with different test sizes also vary in one or more other aspects (such as sensor type, algorithm, or gold standard).

A variety of mathematical models have been used to build algorithms for automated detection and these algorithms also vary greatly in reported sensitivity and specificity. No sensor systems have been found to match the ISO standard for sensitivity and specificity, which has been formulated as appropriate for automated detection of mastitis. Due to the large variation in performance, the algorithms used, and the study design, it is not possible to make general statements on the appropriateness of the algorithms.

The output (together with detection performance) of a sensor system determines the value for the farmer. Raw sensor data requires farmers to interpret the data themselves in order to determine whether something has changed in the cow's health status. When the sensor system contains an algorithm that produces an alert, the interpretation for the farmer is been made easier as it gives a clear statement about the cow's health status (the reliability of this statement is a different issue). Within the alerts, mastitis alerts are informative for the farmer as these alerts do regard a specific condition.

System quality

Detection performance, which is described by sensitivity and specificity, varies considerably. The reported sensitivities ranged from 55 per cent to 89 per cent, while reported specificities ranged from 56 per cent to 99 per cent. For the sensor systems studied, a trade-off exists between sensitivity and specificity as high sensitivity (> 80%) is combined with low specificity and vice versa. None of the studies reported a combination of high sensitivity and high specificity. Moreover, none of the studies met the ISO/FDIS 20966 limit of 80 per cent sensitivity with 99 per cent specificity. Although one sensor system reported a sensitivity of 100 per cent and a specificity of 99 per cent for a combination of SCC and EC measurements, these values were based on nine positive gold standard cases. Some variation in test scale was reported: 10 publications reported that their sensor system was tested on more than one farm, where the others tested their sensor system on only one farm.

EC is the most studied sensor technique for mastitis detection and in some cases it was combined with milk colour sensors. Algorithms have been built for most of these sensors, many of which have been validated. Although the biosensors and SCC sensor have been tested, it is unclear whether these sensors show a better performance than EC sensors. Infrared cameras have been tested, but only assumed relations with mastitis are available. Therefore, it is unclear how these could perform as a mastitis sensor. Even if systems do not meet the ISO limit, the value that an automated mastitis detection system provides to a farmer is obvious, as the alternative is having no automated detection at all. Especially for those farmers using an AMS or managing a large herd the need for a sensor system is present. However, the perfect mastitis alert does not seem to have been found.

Due to the large variation in reported performance, gold standards, test scales, and algorithms used, it is difficult to compare the performance of various sensor types. For example, sensitivity in the range of 83 to 92 per cent with specificity between 75 and 94 per cent were reported for a fuzzy logic algorithm with SCC as a gold standard [6]. Other studies using a fuzzy logic algorithm [7,8], do not report a comparable performance. When visual judgment of milk is used as a gold standard, naive Bayesian networks (70 per cent sensitivity and 97.8 per cent specificity) [9] and artificial neural networks (91 per cent sensitivity and 87 per cent specificity) [10] show the best detection performance. The detection performances under two different gold standards for different algorithms are hardly comparable. Of the used gold standards, visual judgment of milk and CMT had the advantage that they could be performed easily and on-farm, while SCC requires lab analysis. It is difficult to say which of these gold standards is the most appropriate; on one hand, SCC might be more accurate, while on the other hand, visual judgment and CMT might be done more frequently. For EC, in combination with milk colour sensors, good performance has been reported (84.6 per cent sensitivity and 99.4 per cent specificity) [11], with treated CM cases as a gold standard. Because it is not clearly known how many of the occurred cases of CM have been treated, this gold standard's reliability is questionable at best. As a result it is only sure that treated cases were CM cases, how many untreated cases of CM are detected or remain undetected by the sensor system remains unknown. Therefore, the reported performance of such a sensor system should be treated with caution. The Herd Navigator® (DeLaval, Tumba, Sweden), which automatically takes and analyses milk samples, seems to perform good (80–82 per cent sensitivity and 98 per cent specificity) [12,13], although this is only based on two non-peer-reviewed studies published in conference proceedings and the used gold standard is unclear. When EC is compared with EC in combination with milk colour sensors, sensitivity and specificity seem to be lower for the combination of the two sensor types. Accordingly the EC sensors are tested on a smaller scale (number of cows and/or number of farms) than the combination of EC and milk colour sensors. An explanation for this observation could be that variation between farms (and between cows) influences the detection performance of the sensor systems. However, it cannot be concluded whether this difference should be attributed to the sensor system or to the difference in test scale. The text should go in here.

Gold standard

The choice for a gold standard is important for the detection performance of a sensor system. How well a gold standard reflects reality determines the number of 'true' cases used for algorithm development and validation. If true cases of disease are missing, or false cases are included in the gold standard data (visual observation and scoring system are sensitive for this problem), then the processes of algorithm building and validation will be affected. As cases will be missing or false cases will be included in the data set the algorithm will be misspecified and in the validation some alerts will be wrongly classified as false positive or false negative. In a more practical sense, the intended purpose of a sensor system is important when choosing a gold standard. For the substitution of labour by capital – which means that the sensor system will do a farmer's job – a gold standard that reflects a farmer's detection capabilities could be appropriate. However, for an early warning system, the gold standard should be able to correctly pick up disease or oestrus at an early stage. Another example of the relation between gold standard and intended purpose is detection of clinical mastitis for which visual judgement of milk for clots is appropriate. By contrast, using SCC and CMT as gold standard would include detection of subclinical cases. It is also important to consider the frequency at which the gold standard is determined in the studies. Overly long intervals between gold standard assessments will result in missed true cases, whereas short intervals increase the workload involved, and consequently the cost of the experiments. An example of an overly long interval could be using monthly SCC estimates from milk quality controls as a gold standard. This would result in missed (sub)clinical mastitis cases or late detection of (sub)clinical mastitis cases in the reference data used to build and validate a detection algorithm.

Time resolution

Time resolution (also referred to in the literature as the time window of detection) can be split up into two slightly different concepts. The first is the time resolution of the sensor, including measurements, interpretation, and detection. The second is the time resolution of validation, which means matching of alerts to gold standard measurements in a defined time period.
The frequency used to record measurements of the sensor have an influence on the minimal time of detection. Furthermore, an increased number of measurements decreases the influence that erroneous measurements have on predictions of the detection algorithm. For the detection algorithm, the frequency with which it produces information about a cows' health, based on sensor data, partly determines the time between changes in the cows' physiology and the farmer being informed of the change. Obviously, the time between detection and informing the farmer also depends on the farmer. Technical innovations (like smartphones) might be able to help inform the farmer with sensor information more quickly. The time between the change in the cow's health in reality and informing the farmer is also important in relation to various diseases. For instance, a locomotion problem, although painful, does not require the farmer's immediate attention, whereas oestrus only has a limited period during which successful insemination is possible.
As both the gold standard and sensor system information are point estimates that are measured or determined with their respective frequencies, validation studies must match these point estimates to each other. For mastitis, an in-depth analysis has been conducted of the influence that "time resolution of validation" has on sensor system performance and its use in practice [3]. A longer time period for matching gold standard and alerts generally results in higher sensitivity and specificity. Early detection can be accomplished by producing information regarding the cows health before clinical signs of disease occur (Hogeveen et al., 2010). However, information provided by the detection algorithm after the onset of disease postpones treatment, whereas the farmer may perceive information prior to onset as a false alert, they consider a maximum 24 hours before onset of the disease as desirable [17]. For oestrus detection there cannot be much debate about the fact that a timeframe of about 24 hours is needed to enable insemination after an oestrus alert. For locomotion and metabolic problems the time component is less clear, as the detected conditions (diseases) of the cow remain unclear. Therefore it in unknown what a farmer should do with the information, let alone the farmers preferences can be studied.

In the literature used for this review, it was not always clear whether the term "time window of detection" referred to the "time resolution of the sensor" or the "time resolution of validation." In addition, for the "time resolution of the sensor," often only one or two single aspects, such as the frequency the sensor used to take measurements, were mentioned. What is more, the literature only discussed aspects of the time resolution briefly, if at all. So, considering the publications in the review, the time resolution of the sensor systems remains a greatly neglected aspect in publications.

Studies on decision support and economic considerations of management decisions are available for mastitis, but they are not integrated in a sensor system. For mastitis, decision support systems provide advice for clinical cases [16,18,19,20]. However, subclinical mastitis may be detected by a sensor system and could be relevant as a sub-clinical case could develop into clinical mastitis or chronic subclinical mastitis. Literature is currently available that describes the treatment effectiveness and economic implications of treating subclinical mastitis [21,22,23,24]. Treatment of persistent sub-clinical mastitis is economically profitable for many cows when indirect effects of cure are considered (that is, prevention of clinical flare-ups and transmission to other cows) [23]. However, most studies on sensor systems for mastitis still focus on detecting clinical mastitis and do not determine sub-clinical cases for which treatment would be profitable. Another limitation is that many decision support systems were developed to support cow health management when milking in a milking parlour. However, the current trend in Western Europe is the use of AMSs, which have changed the operational management on dairy farms dramatically. A few studies have focused on pathogen specific treatment of mastitis, although the economic merit of pathogen specific treatment seems to be absent [20].

CONCLUSIONS

Most of the work for mastitis (92 per cent) is done at level II. Most published studies for mastitis clearly describe what disease they are aiming to detect, and most of these studies focus on the performance of the sensor system

For sensors systems, there is no clear difference in the performance of various algorithms. Detection performance of the sensor systems varies based on the choice of gold standards, algorithms and test sizes (number of farms and cows). The most important remark for further sensor research is to have a clear aim of what information about the cows health should be produced by the sensor system under study. In respect to the aimed information an appropriate gold standard, algorithm, test size and time resolution should be chosen.

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NOTES

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BEHAVIOURAL CHANGES IN COWS WITH MASTITIS

Jenny Gibbons
DairyCo, Agriculture & Horticulture Development Board, Stoneleigh Park, Kenilworth, Warwickshire, CV8 2TL. Email: jenny.gibbons@dairyco.ahdb.org.uk

SUMMARY

Studies on pain assessment due to mastitis has primarily used models of experimental-induced mastitis. Both behavioural and physiological measures have been used as indicators of pain. However, due to impracticability and invasiveness that physiological measures involve, behavioural measures are currently the most used parameter to assess pain in cattle. To date, very little research has focused on developing objective methodologies of measuring pain associated with mastitis, and the possible benefits that analgesic therapy can have on dairy cattle well-being. This paper will review the scientific literature available on behaviours indicative of pain in dairy cows with mastitis.

INTRODUCTION

The effects of clinical mastitis regarding discomfort, pain, and reduced welfare are probably underestimated. In a study, it was found that on a 10-point scale, dairy producers ranked only severe cases of mastitis as one of the most painful conditions in adult cattle, with a pain assessment score of 7.6, in relation to other common health problems. Milder cases of mastitis were ranked much lower for the intensity of pain, with a pain assessment score of 5.7 (1). However, cows may experience pain in even mild cases of mastitis. The Farm Animal Welfare Council recently identified reducing the welfare impact of mastitis as an important contribution to dairy cows having a life worth living. The European Food Safety Authority (2) in their risk assessment of dairy cow welfare concluded that "pain management should be part of the treatment of cows with acute mastitis" and that inadequate analgesic treatment was one of the main risks that could compromise good cow welfare. Whilst efforts to reduce the incidence of this disease will continue to be important, reducing pain when it does occur should also be a priority. To date, the scientific assessment of pain in cattle has predominately focused on farm procedures that happen once in the animal's lifetime such as dehorning, branding and castration. Additional to this, there has been a large amount of research undertaken on the pain assessment of lameness. However, the behavioural assessment of pain due to mastitis has only been addressed in more recent years and has still not been adequately studied.

PAIN SPECIFIC BEHAVIOURS IN CATTLE

When researching pain in cattle, several biological indicators are used including production, behaviour and physiology. Physiological measures are particularly useful in cattle when behavioural changes are subtle. However, they are less useful for on-farm assessment due to their impracticability (e.g.

technology and equipment required) and invasiveness associated with processes (e.g. restrain for blood sampling) that can increase distress in cattle thereby, compromising the reliability of the results. The disadvantages of physiological measures have resulted in behaviour being the most useful parameter to evaluate pain in cattle and to test the efficacy of pain-relief therapies. A variety of behaviours can be used to assess pain associated with mastitis including lying, standing, walking, weight shifting and rumination. Automated methods of measuring these behaviours have greatly advanced in recent years.

BEHAVIOURAL CHANGES IN COWS WITH MASTITIS

Several studies demonstrate that mastitic cows appear to have reduced motivation for lying down than healthy cows, possibly due to pain experienced in the udder. The majority of the research in this field focuses on experimentally challenging cows with mastitis, commonly with either Lipopolysaccharide (LPS) or *E.coli*. This is an effective way to help understand the behavioural changes prior to and after the onset of clinical mastitis.

Lying is a high-priority activity for cows and they have a higher motivation to perform this behaviour than behaviours associated with feeding and social interaction (3). The time spent lying down, the number of lying bouts and the average bout duration can indicate underlying changes in cow health, comfort and well-being. In addition, changes in the side on which cows lie down (lying laterality) may be used as a measure to detect changes in health status, particularly for mastitis (4). Cows are reported to spend between 46.4% (5) and 51% (6) of their time lying on the right side. However, these studies reported the average of the group. Although, as a group, cows showed no overall preference for lying on any particular side, individual cows did show marked preferences with variation ranging from 10 to 95%. The variation that exists within a population highlights the necessity to record a baseline of the individual's lying side preferences. This is of particular importance in studies assessing deviations in side preference as a result of changes in health status, such as in the case of mastitis (7).

LPS infected cows spent less time lying in their stalls compared to the control cows (40.7 vs. 47.9%). These infected cows also reduced the time spent eating (16.9 vs. 21.0%) and cud chewing (35.8 vs. 39.8%) but dry matter intake was not affected (8). The lack of difference in intake was likely due to the feeding management, or the actual length of the infection time during the study. An *E. coli* infection induced similar responses as cows stood idly longer on the day of the infection with associated decreases in dry matter intake and feeding time (9). In a separate study, LPS-induced mastitic cows spent less of their time lying (47.2 vs. 55.6%), less time lying on the mastitic side (25.4 vs. 29.1%) and took more steps (1413 vs. 1160) after the induction of mastitis compared to the day before induction (4). Infusing *E. coli* into a quarter resulted in reduced lying time on the day of challenge compared to 2 days before (43.9% vs. 49.1%). However, no significant relationship was found between the mammary quarter challenged and cow preference for lying side throughout the episode of induced clinical mastitis (10).

It is important to also consider studies on naturally occurring cases of mastitis, however, there are far fewer studies on naturally occurring cases compared to experimental challenges. There are many similarities between clinical symptoms for natural infections and experimentally-induced infection. It may be inappropriate to directly compare cases of clinical mastitis resulting from experimental-challenge with cases of naturally-occurring mastitis, as severity and infective pathogen may cause differences in behavioural responses. In a recent study, cows suffering from naturally occurring mild mastitis spent less time lying down on the day after mastitis detection compared to their non-mastitic counterparts (49.1% vs. 51.5%) (11). Cows with high SCC had a higher rate of stepping during milking (12). In a separate study, mastitic cows displayed more kicking, lifting and stepping of the hind legs during milking on the first two days after mild mastitis diagnosis (11).

The hock to hock distance is a measure of hind leg stance, which has been reported to be wider in mastitic cows because of the inflammation present in the udder at the onset of a mastitis infection (13). Cows with mild and moderate clinical mastitis had significantly wider hock-to-hock distance by 272 mm and 271 mm respectively compared to control cows (225 mm). This indicated that cows with mastitis changed their posture as a result of the udder inflammation, and this measure was considered a reliable sign of mastitis severity. However, in a more recent study, no difference in hock to hock distance was found between cows with mild mastitis and control cows (11).

TREATMENT

Traditional antimicrobial treatment of mastitis has been and still is the generally recommended practice for clinical mastitis. Several non-steroidal anti-inflammatory drugs (NSAIDs) are available as supportive therapies for clinical mastitis. NSAIDs, such as flunixin meglumine, ketoprofen, or meloxicam, can reduce the clinical signs of mastitis (14, 15, 16). More recent studies investigating NSAID use, report ameliorating behaviours associated with pain and discomfort in cows with mastitis. Behavioural activity was monitored to examine the effects of flunixin meglumine given 4 hours post-infection during endotoxin-induced clinical mastitis. Treated-cows did show an increased eating time 9-12 h after administration, as well as an increase in cud chewing compared to the non-treated control group. While infected cows spent less time lying in the first 12 hours after infection, flunixin treatment had no effect on the lying behaviour (8). In another study, flunixin improved dry matter intake and milk production in cows induced with *E.coli* mastitis (17).

In a more recent study, weight shifting between the rear legs was reduced 7 hours after *E.coli* LPS induction compared to before induction and was not affected by treatment with flunixin meglumine. The authors concluded that it is likely that weight shifting increases friction between the swollen udder and the legs, increasing the pain experienced by the cow. Thus, cows with induced mastitis avoided shifting weight, particularly at the times when the most severe signs of inflammation occurred (18).

Ketoprofen is another NSAID utilised by the dairy industry. Pain responses to udder palpation were assessed in cows with LPS induced mastitis given Ketoprofen. Within 6 hours, ketoprofen-treated cows began to recover with full recovery by 24 hours whereas the control group did not recover until day 7. As the udder of the animals was palpated, a subjective pain score was used to assess the pain experienced. After mastitis induction, both control and ketoprofen-treated cows had an increase in the pain score, however, after 24 hours, treated cows scored significantly lower than control cows, showing that Ketoprofen had a positive effect on reducing pain sensitivity (15).

Pain sensitivity can be assessed by applying mechanical stimuli on the hind limbs or udder of cows. Cow with endotoxin-induced mastitis and treated with meloxicam after mastitis diagnosis returned to their normal pain thresholds faster than untreated cows (19). Another study, using a pressure algometer report an increase in udder pain sensitivity after mastitis induction in control cows but not in meloxicam-treated cows (20). In this same study, rumination time was reduced in the hours following infusion. Thus, pressure algometers and rumination loggers show promise as tools to monitor mastitis. Meloxicam had a beneficial effect in relieving udder pain in the hours following LPS infusion and reducing udder oedema and body temperature, although it did not alter rumination time or dry matter intake (20). Other studies that have treated cows with meloxicam have recorded the alleviation of pain and discomfort associated with mastitis by reducing heart and respiratory rates and pain responses (21).

The effect of NSAIDs on naturally-occurring clinical mastitis is not well documented in the literature. Early research in this area evaluated the therapeutic usage of flunixin meglumine administered intravenously to animals with naturally occurring clinical mastitis (22). Pain thresholds were determined using a mechanical device that exerted pressure to the hind limb of each cow. Cows with mild and moderate cases of clinical mastitis showed a heightened responsiveness to pain that persisted for days or weeks after onset. The cows with mild clinical mastitis had a reduced sensitivity to pain when treated with a flunixin meglumine intravenously. A beneficial effect of the relief of pain was documented. However, similar results were not found with the moderate cases of clinical mastitis, which may have been attributed to the dosage being too low. The single dose was only effective for mild mastitis cases, suggesting that repeated doses might be necessary for moderate-severe cases (22).

In another study, 100 dairy cows with both mild and moderate naturally-occurring cases of mastitis were assessed for pain (19). It was found that the respiratory rate, rectal temperature and heart rate were all significantly higher in cases of moderate mastitis, when compared to mild clinical mastitis cases. Animals were administered the NSAID, meloxicam, in either a single or a three-dose regimen. Pain threshold levels were then measured. Animals treated with NSAID returned to their normal threshold levels for these outcome variables significantly faster than untreated animals. The effect was similar whether an animal received one or three doses of meloxicam. It was concluded that by promoting recovery of moderate or mild mastitis by alleviating pain associated with a case of mastitis, cattle welfare would be improved.

Although, it is becoming common practice to provide severely mastitic cows with NSAID therapy in addition to antibiotics, this has not been widely adopted as a standard treatment for mild to moderate clinical cases. It is well recognised that for such cases, treatment decisions do not often directly involve veterinarians. Usually, the therapy of these cases at the time of their detection is at the discretion of the dairy producer or farm manager.

RECORDING BEHAVIOUR

Methods of assessing behavioural activity have changed in recent years, favouring automated techniques. Developments in sensor technology, mainly accelerometer technology, offer new opportunities of automatic monitoring and recording of animal behaviour. The development of these technologies may improve information on dairy cow activity and improve automatic livestock management systems efficiency relating to monitoring and control of modern and automated dairy farms. In future, novel mastitis detection tools should therefore be able to automatically detect and combine changes on both physiological parameters (i.e. fever) and complete behavioural patterns consisting of resting, standing and eating behaviours.

CONCLUSIONS

As mastitis is currently one of the most costly diseases for the dairy industry, prevention, control and treatment practices should receive utmost attention. It is clear that clinical mastitis has severe detrimental effects on the animal and negative economic impacts for dairy producers. Therefore, attention to behavioural and physiological indicators should be given to monitor animal health. New technologies may allow dairy producers to identify clinical mastitis in its very early stages, or even before clinical changes occur. Furthermore, automated measures of activity, such as step counts and lying time show promise as predictors of clinical problems. These new technologies, in addition to other automated measures, have the potential for improving the screening methods for pre-clinical mastitis and accurately predicting the onset of a clinical mastitis event. W

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NOTES

AMS OR CONVENTIONAL MILK HARVESTING – WHAT IS BEST FOR UDDER HEALTH?

Tom Oesch
SwissLanes Dairy Farm, Michigan, USA

No written paper has been submitted.

NOTES

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EFFECTIVENESS OF TEAT COVERAGE WITH POST MILKING TEAT DISINFECTANT USING A VACUUM OPERATED TEAT SPRAY SYSTEM

Brian Pocknee[1], Neal Thornber[1], Colin Kingston[2], Richard Hiley[2], Richard May[2], Mark Cinderey[2] and Alex Carlsson[2]
[1] The Dairy Group, New Agriculture House, Blackbrook Park Avenue, Taunton, Somerset, TA1 2PX – www.thedairygroup.co.uk. [2] Ambic Equipment Ltd, One Parkside, Avenue Two, Station Lane, Witney, Oxfordshire, OX28 4YF – www.ambic.co.uk

INTRODUCTION

In addition to the bacteriocidal properties of a post milking teat disinfectant, complete teat coverage with the product is essential to help ensure that the teat skin is as soft and supple as possible to withstand the rigours of milking. Anecdotal evidence suggests that dipping is more effective than spraying and is less operator dependent. There are an increasing number of automatic teat spraying systems available to dairy farmers, but it is difficult to compare teat coverage of these systems with that of manual teat disinfection. Ideally an automatic system will provide 100% teat barrel and teat end coverage 100% of the time. The purpose of this study was to measure post milking teat barrel and teat end coverage when manual spraying with disinfectant.

EVALUATION METHOD

Teat barrel and teat end coverage were assessed post application of the teat disinfectant product on ten farms, each with a minimum of 150 cows.

To assess barrel coverage, the front and back of the teat was scored as a maximum of 50, i.e. if all one teat side was completely covered this equated to 50 (100% coverage of that plane), whereas a score of 25 meant that only half of that plane was covered in chemical. If both sides of the teat barrel were completely covered this equates to 100% teat barrel coverage.

Teat end coverage was assessed as either covered or not covered (hit or a miss). The volume of teat disinfectant product applied during the monitored milking was measured and a calculation of chemical usage / cow / milking made.

RESULTS

Teat end and teat barrel coverage are shown in the following three tables. The amount of teat disinfectant used per cow ranged from 6.25 to 21.75 ml, with an average of 15.29 ml.

Table 1. Teat end and teat barrel coverage with disinfectant

	Average Number - Teat end coverage	Number for No teat end coverage	Number of missing quarters	Average % for Left teats	Average % for Right teats	Average % for Rear teats	Average % for Front teats	Average % for All teats
Study average	3.77	36.5	2.1	50.06	50.54	52.41	48.19	50.30
Minimum	3.2	0.0	0.0	18.7	20.9	20.6	18.9	19.8
Maximum	4.0	127.0	6.0	82.3	85.1	86.2	80.6	83.4

Table 2. Percentage teat end coverage

	Rear Left	**Front Left**	**Front Right**	**Rear Right**	**Average**
Teat end only covered	95.5	92.2	94.2	96.2	**94.5**
No teat end coverage	4.5	7.8	5.8	3.8	**5.5**
No teat *	0.3	0.5	0.4	0.1	**0.3**

*** three quartered cow and unit not applied**

Table 3. Teat barrel coverage

	Rear Left		**Front Left**		**Front Right**		**Rear Right**	
	Back	***Front***	***Back***	***Front***	***Back***	***Front***	***Back***	***Front***
Average teat coverage (score out of 50)	42.9	21.9	42.0	17.5	42.1	18.5	43.3	21.9
No barrel coverage (number)	7.1	40.9	8.3	60.2	6.6	58.2	6.2	42.7
Average number of cows scored	166.1		165.7		166.0		166.4	

Just over 80% of the rear of teat barrels was covered (Score 42 out of 50). However, only between 35% and 44% of the front of the teat barrel was covered. Coverage of the front of cows' teats tended to be worse where cows stand at 90° to the operator. There was little difference in the percentage of teat ends covered between teats on the left and right or front and rear.

CONCLUSION

There is a significant range in the skill with which post milking teat disinfectants are applied with a hand held, vacuum operated teat sprayer. This level of variation is worrying, and on many farms the objectives of teat spraying are not being achieved. An automatic system that applies the product consistently and achieves acceptable levels of teat barrel and teat end coverage would be advantageous to the industry.

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A HELPING HAND IN MASTITIS CONTROL

Judith Roberts[1], Andrew J Bradley[2], James E Breen[3]
[1] Zoetis, Walton Oaks, Dorking Road, Tadworth, Surrey, KT20 7NS, UK; [2] QMMS, Cedar Barn, Easton Hill, Easton Wells, Somerset BA5 1DU, UK; [3] Nottingham University, Sutton Bonington, LE12 5RD, UK. E-mail: judith.roberts@zoetis.com

OVERVIEW

Practical examples of data analysis and real life discussion make learning and developing mastitis control programmes on farm more enjoyable and engaging. Zoetis supported three groups of vets across the UK to come together with expert tuition to support and educate them in all aspects of mastitis control. As a result of this CPD, almost 70 farms have had mastitis investigations carried out and have been provided with practical advice and action lists to actively engage with the reduction of mastitis in their herds. Through sharing how the CPD was structured, we hope to allow more vets to become engaged with mastitis control and invite practitioners to come to us if we can offer more support.

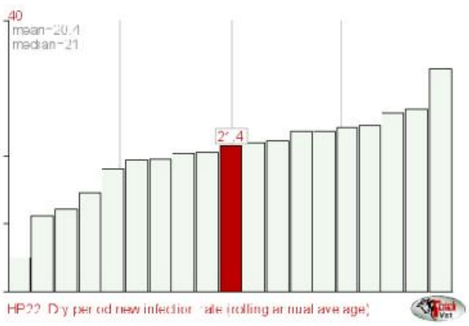
FORMAT

Zoetis invited vets to attend two CPD days six weeks apart in three separate locations throughout the UK with tuition from Andrew Bradley and James Breen on all aspects of mastitis problem investigation and evaluation. The first meeting educated vets in patterns of mastitis disease, on-farm mastitis investigation, mastitis data evaluation and advice about undertaking diagnostic bacteriology. Each delegate was tasked with using this knowledge to undertake a farm evaluation and collect bacteriology samples that would then be presented and discussed with the group at the second day of the CPD. The second day was therefore tailored to each group's specific herds and problems and allowed the opportunity to work through specific farm examples and to share experiences and advice between the group. As a specific example, the meetings in Northern Ireland had 20 delegates on both days and 20 farms were evaluated, presented and discussed to produce farm action plans and reviews as a result of the meeting. Both days contained lively debate, discussion and at times controversial conversations and opinions providing two days of enjoyable and stimulating CPD with well utilised opportunities for asking specific questions and advice from the tutors.

FARM EXAMPLES

Over the farms investigated during the training there was a wide variety of infection patterns, problems and potential solutions. This poster gives some examples of the farm data that was presented.

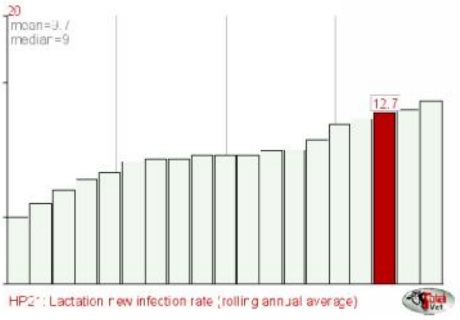
Dry period new infection rate variation



Sample ID	Cow ID	Qrt	Date	SCC ('000/ml)[1]	DIM	Sample Type[2]	Result	Penicillin Sensitivity[3]
1	460	FR	12/2/2013	Clots	74	C	****CONTAMINATED**** (*Staphylococcus aureus* isolated)	S
2	606	BR	12/2/2013	Clots	50	C	Mixed, heavy growth of *Streptococcus uberis* and *Staphylococcus epidermidis*	NT
3	812	FR	12/2/2013	Insuff	246	C	Mixed, heavy growth of *Streptococcus uberis* and *Staphylococcus warneri*	NT
4	131	FL	12/2/2013	Insuff	8	C	****CONTAMINATED****	NT
5	776	BL	11/2/2013	Insuff	72	C	Mixed, heavy growth of *Staphylococcus epidermidis* and *Trueperella pyogenes*	NT
6	590	FR	12/2/2013	Insuff	56	C	Mixed, heavy growth of *Streptococcus uberis* and *Staphylococcus epidermidis*	NT
7	56	FR	12/2/2013	Insuff	177	C	No significant bacterial growth after 72 hours incubation	NT
8	557	FL	13/2/2013	Insuff	138	C	Heavy pure growth of *Streptococcus uberis*	NT
9	796	BR	12/2/2013	Clots	65	C	Mixed, heavy growth of *Streptococcus uberis*, *Staphylococcus epidermidis*	NT
10	768	BR	18/2/2013	Clots	94	C	Mixed, heavy growth of *Streptococcus uberis* moderate growth of *Staphylococcus epidermidis*, and scant growth of *Bacillus licheniformis*	NT

Key: [1]Clot = Clotted, Insuff = insufficient volume [2]C = Clinical, S = Sub clinical, UK = Unknown, [3]S = Sensitive, R = Resistant, NT = Not Tested (only S. aureus tested)

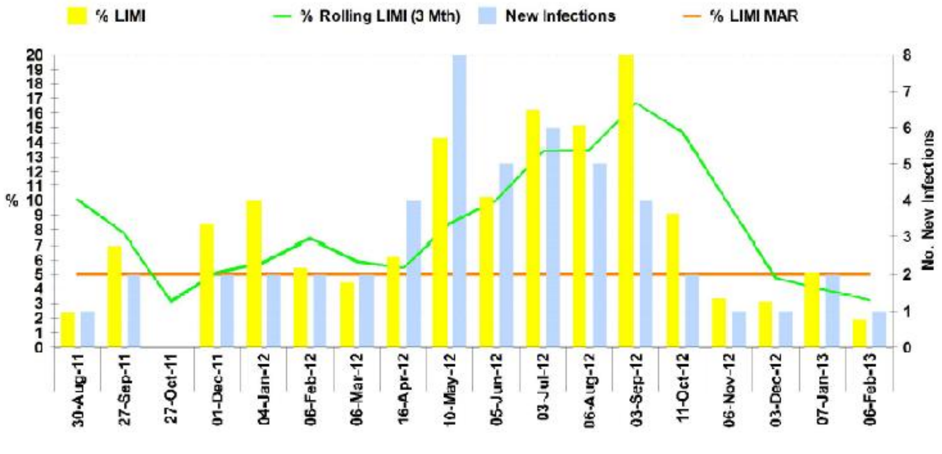
Lactation new infection



Sample ID	Cow ID	Qrt	Date	SCC ('000/ml)[1]	DIM	Sample Type[2]	Result	Penicillin Sensitivity[3]
1	1070	?	11/2/13	1076	30	S	Heavy, pure growth of *Pseudomonas* spp.	NT
2	1055	?	11/2/13	Clot	14	C	Heavy, pure growth of *Staphylococcus aureus*	S
3	1793	BR	20/2/13	719	-	S	Heavy growth of Staphylococcus chromogenes, scant growth of *E. coli*.	NT
4	719	BR	21/2/13	2227		S	Scant, pure growth of *Staphylococcus epidermidis*	NT
5	1793	BR	19/2/13	-	-	S	SAMPLE MISSING.	
6	460	ALL	20/2/13	121	-	S	Heavy growth of *Staphylococcus aureus*	S
7	2690	BR	19/2/13	209		S	Heavy, pure growth of *Staphylococcus haemolyticus*.	NT
8	713	BR	19/2/13	1696	-	S	Mixed, heavy growth of *Staphylococcus epidermidis* and *Staphylococcus warneri*.	NT
9	801	BR	20/2/13	Clot	-	S	Moderate, pure growth of *Staphylococcus epidermidis*	NT
10	035	BR	20/2/13	1481	-	S	Heavy, pure growth of *Staphylococcus aureus*.	S

Key: [1]Clot = Clotted, Insuff = insufficient volume [2]C = Clinical, S = Sub clinical, UK = Unknown, [3]S = Sensitive, R = Resistant, NT = Not Tested (only S. aureus tested)

Lactation new infection – seasonal pattern



ACKNOWLEDGEMENT

The CPD days, data analysis and bacteriology was fully funded by Zoetis. To register interest for the next mastitis CPD to be supported by Zoetis please contact your local account manager.

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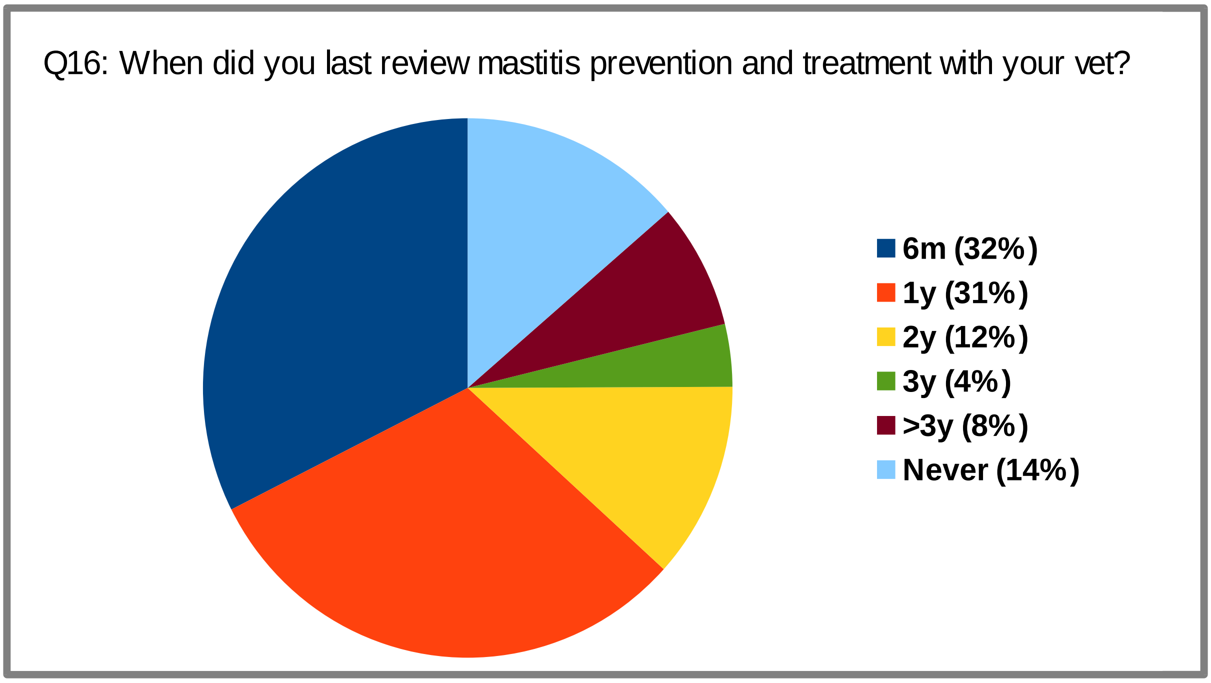
VETS INVOLVEMENT IN MASTITIS CONTROL – A GREAT OPPORTUNITY TO BE REENGAGED.

Phillip Christopher[1], Judith Roberts[2]
[1] RedRock Publicity Red Rock Publicity, E-mail: phil@redrock.uk.com; [2] Zoetis, Walton Oaks, Dorking Road, Tadworth, Surrey, KT20 7NS, UK. E-mail: judith.roberts@zoetis.com

INTRODUCTION AND METHOD

More than one-in-three dairy UK farmers could be missing out on the latest advances in mastitis prevention and treatment, according to results of a *British Dairying* survey carried in the July edition. The questionnaire was completed by more than 400 farmer readers, with average herd figures of 144 cows producing 7,648 litres/com with a mastitis somatic cell count of 165,000 cells/ml[1]. The survey was carried out by an independent contractor (commissioned by Zoetis) to gain a better understanding of how to help farmers and veterinary practices mutually to achieve lower clinical mastitis rates specifically, and better udder health in general. The survey results provide a route in to conversation about mastitis control and highlight the large and valuable opportunity available to vets to engage or reengage with farmers in tackling mastitis control.

RESULTS



Those farmers potentially missing out are the 37% who last reviewed mastitis prevention with their vets two years ago (12%), three years ago (4%), more than three years ago (8%) or have never done so (14%).

Clearly, the opportunity to re-establish and encourage farmers and vets to ask each other about taking advantage of all today's latest knowledge is vast. However, if it was that simple, all of the farmers rather than just 63% would be doing this already.

We all understand that farmers change treatment protocols and many use their intuition and experience to determine which of the treatments in their farm protocols will be most appropriate for the individual case of mastitis. This survey highlighted that 18% of farmers have changed their first choice treatment for clinical mastitis in the past year - yet only 47% of them had done so based on their vet's advice. Over the same period, a very similar number (20%), though not necessarily the same farmers, have reduced the number of tubes per treatment. However, just 19% of these decisions were backed by vets' advice, 13% were 'to reduce costs', 12% were 'to a different tube with fewer treatments' and 57% for a variety of other stated reasons among which there was no discernible pattern.

Of course, some farmers worry about the possible cost of asking their vet's advice but as vets many of us predict and share their concern and provide opportunity for discussion within the practice or during telephone calls. The opportunity to establish the current thoughts, experience and concerns that farmers have when selecting appropriate lactating cow therapy really cannot be underestimated. This can provide the initial steps in engagement in a mastitis control programme and ongoing dialogue between farmers and their vets regarding mastitis therapy. On a very positive note, the survey suggests that conversations around mastitis control and treatment are already happening in many farmer-vet relationships, with 63% of farmers responding to our survey having reviewed mastitis prevention and treatment with their vet in the past 12 months.

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ACKNOWLEDGEMENT

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HAPTOGLOBIN DYNAMICS IN A *STREPTOCOCCUS UBERIS* MASTITIS CHALLENGE

F.C Thomas[1], R.Tassi[2], T.N McNeilly[2], R.N Zadoks[2], M.M Waterston[1], H.Haining[1], P.D Eckersall[1]
[1]College of Veterinary, Medical and Life Sciences, Institute of Biodiversity, Animal Health and Comparative Medicine, School of Veterinary Medicine, Bearsden Road, University of Glasgow, G611QH, UK; [2] Moredun Research Institute, Pentlands Science Park, Bush Loan, Penicuik, EH26 0PZ, UK

The use of acute phase proteins (APP) in the diagnosis of mastitis, which is the most costly disease affecting the dairy industry, is becoming important as an alternative and complementary procedure to somatic cell counts (SCC) which have been shown to vary with other non-inflammatory conditions of the udder in the dairy cow. The most important APP in milk associated with inflammatory conditions of the mammary gland are mammary associated serum amyloid A3 (M-SAA3) and Haptoglobin (Hp) (1). *Staphylococcus aureus*, *Escherichia coli* and *Streptococcus uberis* have been recognized as some of the most prevalent causes of bovine mastitis. Streptococcal mastitis in particular has been observed to be difficult to control (2). Previous studies on *S. uberis* mastitis have shown the sensitivity of milk Hp in indicating the presence of inflammation in response to infection (3). The aim of this study is to evaluate the usefulness of the APP, Hp in indicating presence of infection and to gain a better understanding host response to *S. uberis* mastitis by assessing the milk Hp response following intramammary challenge (IMC). Hp was measured by an in-house, cost effective and robust enzyme linked immunosorbent assay (ELISA) protocol optimized and validated for milk Hp measurement.

Intramammary challenge of six udder quarters of six mid-lactation cows were carried out using a host-adapted *S. uberis* strain FSL Z1-048 (4). All quarters were shown to be free of *S. uberis* infection by bacteriology prior to challenge. Quarters adjacent to those challenged, were used as controls and inoculated with sterile phosphate buffered saline (PBS). Milk samples were collected at various time points; just before challenge (0 hours), 6, 12, 18, 24, 30, 36, 42, 48, 57, 72, 81, 96, 120, 144, 168, 192, 240 and 312 hours (h) post-challenge, defatted and stored at -20°C prior to assay for the APP, Hp using the ELISA.

Hp concentrations in milk peaked at 57 h in all infected quarters, increasing more than several hundred-fold from basal values (< 6 μg/ml). In control quarters, however, Hp remained at basal levels for the entire period of challenge. The Hp course for the IMC closely trailed the dynamics of cytokines such as TNFα, IL-8 and IL-1β in the milk as demonstrated by Tassi *et al.* (2013). The Hp concentration had not reverted to basal levels by the end of the collection period at 312 h (Figure 1).

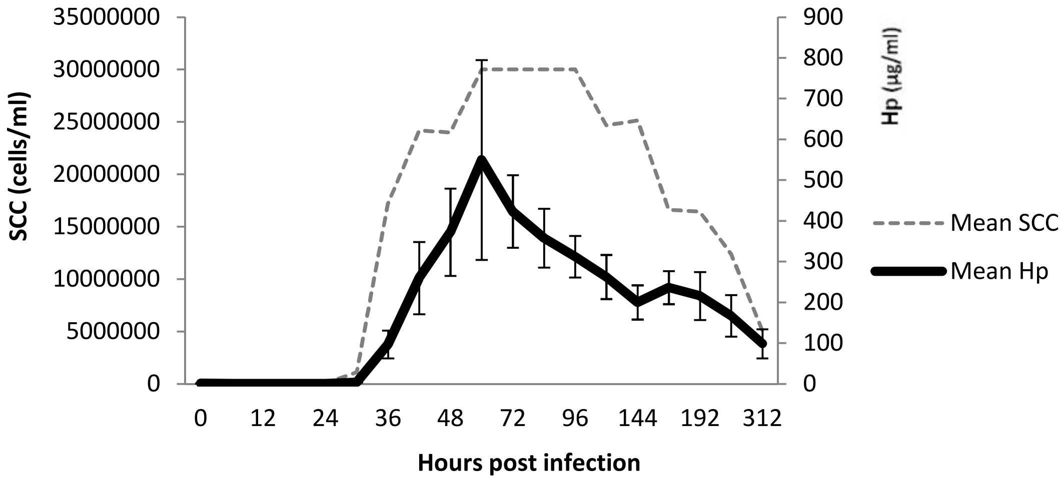

Figure 1:Mean ± standard error of mean (SEM) of Hp concentration (thick solid line) and mean of SCC (dashed line), during the 312 hour course of experimental *S. uberis* challenge (n=6)

Hp more closely mirrored the trend of bacteriological counts (not shown) as it dropped in comparison to SCC; hence, in addition to its potential as a marker for inflammation, Hp assay, could also be indicative of resolution in mastitis conditions. Further investigation is required by including non-resolving cases.

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CAN CMT BE A COST EFFECTIVE PREDICTOR OF EARLY LACTATION MASTITIS IN DAIRY HEIFERS?

R Drysdale, P Daly, M Tomlinson, K Baxter, P Elkins, P McIntosh
Milk Quality Team – Westpoint Vet Group, Dawes Farm, Warnham, W Sussex, RH12 3SH

OBJECTIVE AND INTRODUCTION

To evaluate the use of the California Mastitis Test (CMT) as a rapid cowside test offering an economic advantage to the dairy farmer for predicting heifers with the potential to develop mastitis in the first 30 and 60 days of lactation.

Dairy heifers have been shown often to have high levels of gram positive bacteria present in their udders at calving (1) that often cause mastitis in the first lactation and impact culling decisions (2). Reducing mastitis rate at 7 days can reduce culling due to udder health (3).

The CMT has been shown to be a useful, indirect, tool for monitoring fresh cows post calving to detect quarters with major mastitis pathogens present (4). Somatic Cell Count (SCC) ≥500,000 cells/ml/milk has been recognised as CMT score ≥1 (0-3 scale) with the SCC ≥800,000 for CMT ≥2. A CMT score ≥2 (0-3 scale) was shown to be 66.7% sensitive for detecting a major pathogen and SCC. Can this approach work for first lactation heifers?

MATERIALS AND METHODS

Two large block-calving dairy farms (700 B&W cows combined) with 204 heifer calvings between 28/08 and 05/11. Farms were visited once daily, 3 times/week. The fresh calved heifers were examined at day 4-6, checked by CMT (California Mastitis Test) and sampled for any subsequent SCC testing using DeLaval Cell Counter (DCC).

All samples were retained for subsequent testing should a quarter develop mastitis. The CMT score and bacteriology/PCR result was then cross matched with the SCC. CMT and sampling was repeated at 30 days calved.

RESULTS

Results are shown in Table 1. 200 of the 204 heifers were followed through the entire study (4 animals removed due to concurrent therapy within first 7 days of calving for metritis). Overall 797 quarters were followed through to 30 days with 2 sets of CMT scores and DCC results for each animal/quarter. Three blind quarters were found (1.5% heifers; 0.38% quarters).

In the first 30 days 27 cases of mastitis were seen from 21 (10.5%) animals. A further 13 (6.5%) animals had another 17 cases of mastitis case over the remaining 275 days of the lactation.

A total of 24 animals were affected by 1 or more case of mastitis to represent

12% of the population at risk treated for mastitis in their first lactation.

Table 1 – sample results	Day 4-6 score				Day 30 score				
CMT score	0	1	2	3	0	1	2	3	New #3
Number quarters found	376	309	66	46	497	187	81	32	11
Number quarters SCC <500,000	376	242	13	0	497	162	0	0	
Number quarters SCC 500-800,000	0	55	44	29	0	24	53	11	
Number quarters SCC >800,000	0	12	9	17	0	1	28	21	
Mastitis quarters in period	1	2	4	20	8	2	2	4	1
Mastitis animals in period	1	2	3	15	5	2	2	3	1
Culture from CMT sample	0	0	2	10	0	0	0	1	1
PCR from CMT sample	1	1	1	8	1	1	0	1	0
No result from CMT sample	0	1	0	2	7	1	2	2	0

DISCUSSION AND CONCLUSION

It has been reported that multiparous animals SCC and CMT sensitivity versus culture depended on user skill and background challenge level (high SCC herds with high levels of subclinical (SC) disease makes interpretation difficult). The purpose of this study was to evaluate cowside testing using CMT for early indication of heifers with SC mastitis in early lactation.

At 5 day testing 46 quarters were scored 3 on CMT. All 46 quarters showed SCC >500,000 in this instance, 20 of which then had a case of clinical mastitis in the first 30 days. 10 quarters produced a positive culture and 18/20 had an organism identified when PCR testing was included.

The correlation of mastitis cases in the first 30 days from these 200 heifers when ranked against CMT was 74% (20 cases CMT #3 from 27 cases overall). The chance any CMT positive quarter (#1, 2 or 3) showed mastitis in the first 30 days was 96% – suggesting the use of CMT soon after calving could help identify potential problem heifers before routine herd SCC sampling results may have been taken.

After day 30 whilst CMT is sensitive for SCC banding, using CMT to identify potential new mastitis cases becomes more problematic as environment and milking/management comes to bare more on the udder health of the heifer.

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A FIELD TRIAL USING PENETHAMATE IN DOWN-CALVING HEIFERS

R Drysdale, P Daly, M Tomlinson, K Baxter, P Elkins, P McIntosh
Milk Quality Team – Westpoint Vet Group, Dawes Farm, Warnham, W Sussex, RH12 3SH

INTRODUCTION AND OBJECTIVE

With the drive to responsible use of medicines vets and farmers need to work together to manage disease and reduce the need for high treatment levels. Strategic dry cow programmes are now becoming common place, whilst the advent of internal teat sealants has helped reduce new infections. However, down calving heifers could be considered one group that are still at risk. Heifers can have high levels of gram positive infection at calving (1) that often cause mastitis in the first lactation and impact culling decisions (2). Reducing mastitis rate at 7 days can reduce culling due to udder health (3).

Penethamate hydriodide (Mamyzin®, Boehringer Ingelheim) is a prodrug: releasing pencillin-G on hydrolysis, easily crosses the blood/milk barrier and concentrates in udder/milk. The spectrum of activity is mainly Gram-positive e.g. *Staphylococcus* spp., *Streptococcus* spp. Previous research has evaluated precalving use of penethamate on early mastitis in heifers (2, 3) but is this responsible use of an antibiotic and offer the farmer cost benefit?

MATERIALS AND METHODS

A trial was devised to follow heifers for udder health in the first 60 days of milk following treatment with penethamate at 7 days precalving. 117 heifers from a 350 cow block calving B&W herd (7,500L/cow/year) milked through a 20:40 swing-over parlour, were randomly allocated to one of two groups:

1. Control (n = 57) with no treatment but monitored from calving.
2. Treated (n = 60) with 15mg/kg of penethamate hydriodide (30ml of 10gm/head) by i/m injection at 8-9 days before expected calving date.

All heifers were pregnant to AI with expected calving date calculated as 280 days after service. Calving dates were from 28/08 to 02/11.

Heifers were examined at 7, 21 and 33 days post calving: checked by CMT (California Mastitis Test) and sampled for any subsequent testing. Any quarter with CMT response (#3 on 0-3 scale) had bacteriology undertaken on the corresponding sample. Somatic cell count was also recorded from every quarter using the DeLaval Cell Counter (DCC). Records of all treatments were kept, including metritis, mastitis and lameness. All medicines used (volume and duration) plus days of lost milk with any follow up/repeat therapies recorded.

RESULTS AND DISCUSSION

The results (summarised in tables 1 to 3) show 13 cases of clinical mastitis in the first 30 days, of which 6 were within the first 7 days. The control group had higher: average CMT score; cell count at animal/quarter level;

rate of mastitis in first 7 and 30 days.

Summary results *Table 1*	**Control**	**Treated**	
Number	57	60	
Removed	1	1	metritis
n = 115 (459 quarters)	56 (224)	59 (235)	1 blind
Days before calving	n/a	7	
Days calved early (mean)	4.05	0.5	all 2.25
Standard Deviation	6.21	4.04	
CMT score at 7 days			score 0-3
0	76	110	quarters
1	112	101	quarters
2	18	17	quarters
3	18	7	quarters
Average CMT	0.84	0.65	
Animals CMT #3	15	6	
Clinical mastitis first 7d	5	1	

Table 2 **Somatic cell counts**	**Control**	**Treated**
Average 7 days	334.95	228.66
Average 21 days	184.03	131.37
Average 33 days	99.89	61.43
Average 60 days	107.95	68.73
Average 90 days	83.13	80.33

Table 3 **Mastitis cases**	**Control**	**Treated**
Lactation total cases	20	7
Affected animals First (repeated)	13 (6)	3 (2)
≤7 days in milk	5 (3)	1 (0)
≤30 days in milk	6 (3)	1 (1)
>30 days in milk	2 (0)	1 (1)

DISCUSSION

Is this RUMA? As an approach to mastitis management in heifers precalving: comparing the trial groups there is reduced total antibiotic usage in lactation for mastitis treatment (120.23gm vs 380.15gm). However, as 590gms of penethamate had initially been used is RUMA really a viable argument for the strategy? Closer investigation does show the control group received 97gm of fluroquinolone within the higher number of mastitis cases for treatment that was not needed in the penethamate group.

Cost benefit to the farmer: 218 days of dumped milk was linked to mastitis cases from the first 30 days. Comparing the two groups shows mastitis in the first 7, and 8-30, days was responsible for total of 80 (+99) dump days against 10 (+29) between treated and controls. On cost vs return this strategy saw the farmer have £3 return for each £1 spent at 30p/litre sold.

Most farmers want their vet to produce protocols that see cost benefit through improved health. Reducing early mastitis in heifers does have a positive impact for the heifer (2, 3, 4) whilst reduced yield may well be a large secondary cost not considered here. Vets though must be aware of the responsible use of medicines in animals (RUMA) not just cost benefit.

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ASSOCIATIONS BETWEEN STREPTOCOCCUS STRAIN TYPE AND PATTERNS OF CLINICAL MASTITIS

Peers Davies and Martin J Green
University of Nottingham, School of Veterinary Medicine and Science, Sutton Bonington Campus, Sutton Bonington, Leicestershire, LE12 5RD, UK.
E-mail: peers.davies@nottingham.ac.uk

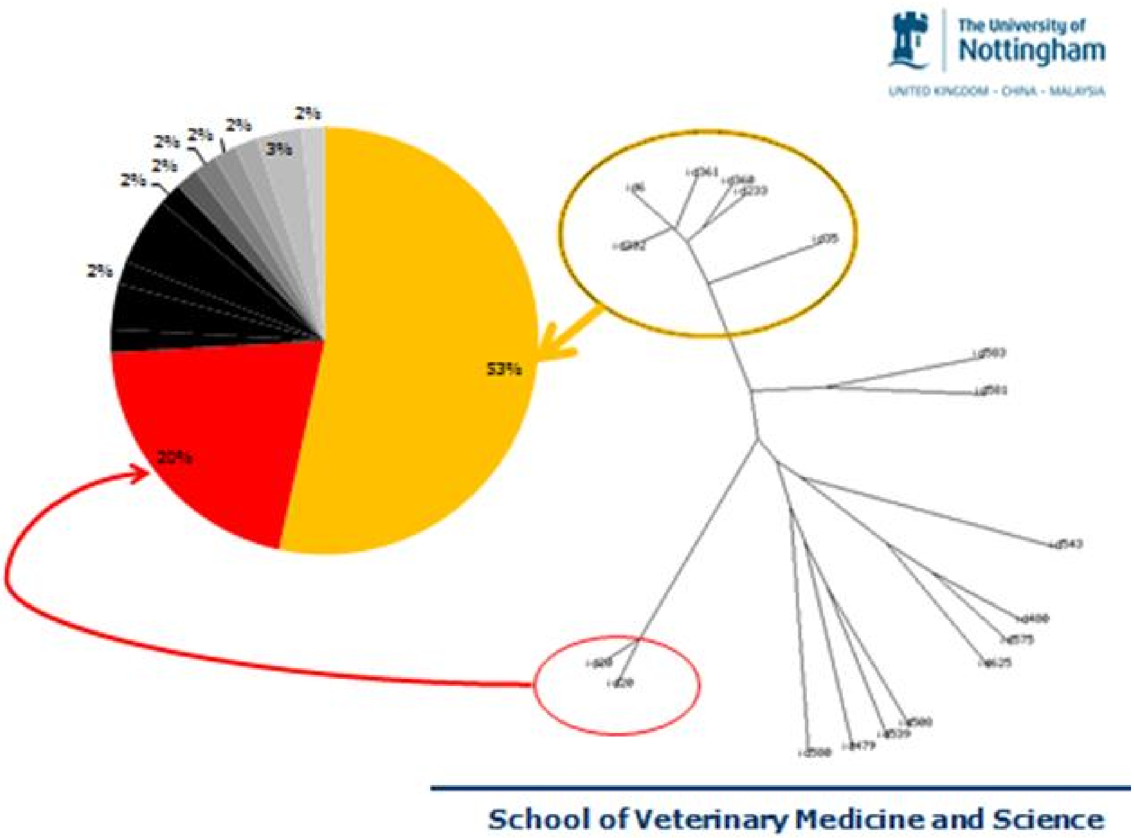
Streptococcus uberis is the most frequently identified 'major' pathogen in both clinical cases and HSCC (high milk somatic cell count) cases in the UK over the past decade representing approximately one third of sub-clinical HSCC diagnoses and one quarter of clinical mastitis diagnoses (1).

A very broad range of strains have been identified by every previous study which has sort to investigate the molecular epidemiology of the pathogen in clinical mastitis and high cell count cases (2, 3, 4).

The clinical presentation of intramammary infections caused by Strep uberis also shows significant variability. Traditionally Strep uberis infections were observed to be short-lived infections causing significant discomfort and obvious abnormality both to the gland (rubor, tirgor, oedema) and also to the milk with clots, discolouration and reduced viscosity. Elevated somatic cell counts were observed for several days before symptoms subsided due to a rapid and effective immune response and high susceptibility to intramammary antibiotics.

Traditionally prolonged high SCC, persistent or recurrent infections with standard treatment failure and were not regarded as a feature of the pathogen. However, there are now many case reports of disease patterns on farms which display these 'cow-adapted' characteristics. These cow adapted strains are a far greater potential risk for contagious transmission within a herd, presenting a more complex picture of the challenges in the control of S.uberis mastitis. Our study will investigate the predictive power of strain type, along with other cow and farm level factors for determining the likely course of a S.uberis outbreak on a farm at an early stage thereby allowing more informed decisions to be taken on the most appropriate control measures.

Below is an example of a clinical mastitis case history for strep uberis of a farm with 'predominant' strain types, a pattern associated with contagious rather than environmental transmission.



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THE AETIOLOGY OF BOVINE MASTITIS IN UK DAIRY HERDS

Barbara Payne[1], James A Bradley[1], Emily Coombes[1], Emma Lusby[1], Katherine Mining[1], Caroline Hunt[1] and Andrew J Bradley[1,2]
[1]Quality Milk Management Services Ltd, Cedar Barn, Easton Hill, Easton, Wells, Somerset, BA5 1DU, UK; [2]School of Veterinary Medicine and Science, University of Nottingham, Sutton Bonington Campus, Sutton Bonington, LE12 5RD, UK

SUMMARY

Mastitis bacteriology results were reviewed from third party submissions to QMMS Ltd between September 2010 and August 2013. The aetiology of mastitis was diverse, encompassing more than 100 different pathogens. Environmental pathogens were the predominant cause of both clinical and subclinical mastitis, though contagious pathogens were still implicated in over 10% of submissions. Penicillin resistance was identified in less than 15% of tested *S. aureus* isolates.

INTRODUCTION

The identification of the aetiological agent in bovine mastitis remains an important part of the diagnostic approach to mastitis control and is likely to become increasingly important with the growing concern about use of antimicrobials in food producing animals. Whilst a significant amount of bacteriology is still undertaken in the practice setting, compared to 20 years ago and following restructuring of the Veterinary Investigation Centres, less detailed mastitis bacteriology involving species level identification is now undertaken. The advent of PCR as a diagnostic tool, has further reduced the discriminatory ability of the diagnostic approach as it detects only a limited number of species. This abstract presents the findings from detailed analysis of mastitis submissions to a Somerset laboratory.

MATERIALS & METHODS

The vast majority of samples submitted to the laboratory were for the purposes of research; to minimise bias these were excluded from this analysis, with only submissions by third parties included. The bacteriological approach involved the plating of 10ul of secretion onto blood and Edwards Agar and 100ul onto MacConkey Agar to enhance the sensitivity of detection of Gram negative organisms and *Staphylococcus* spp. Prior to June 2011 all identifications were undertaken using standard biochemical techniques, including the use of API where appropriate. From June 2011, species level identification was primarily undertaken using MALDI-TOF MS and was only supplemented by biochemical means when an adequate identification score could not be obtained. No presumptive diagnoses were made and colony morphology on selective agar was not used as a diagnostic criterion. Penicillin sensitivity of *Staphylococcus aureus* isolates was determined using the Kirkby-Bauer disc diffusion method.

RESULTS

Mastitis bacteriology results were reviewed from submissions between September 2010 and August 2013. Results from 6,005 samples from 991 submissions coming from over 500 farms throughout the UK were analysed, of which 43.8% were from clinical cases. In excess of 100 different bacterial species were isolated, encompassing some unusual, though previously reported species such as *Mycobacterium smegmatis* as well as *Salmonella* spp and *Listeria* spp. Some key findings are summarised in Table 1 below.

Table 1 Summary of bacteriological findings from clinical and sub-clinical submissions

Diagnosis (%)	Clinical	Sub-clinical
E. coli	19.22	9.31
S. uberis	16.95	14.05
S. aureus	5.97	9.46
S. dysgalactiae	3.23	2.49
S. agalactiae	0.08	0.30
T. pyogenes	1.03	0.36
Other *Enterobacteriacae*	2.74	2.25
Other Major Pathogens	25.42	28.43
Minor Pathogens	11.28	17.91
No Growth	11.59	10.17
Contaminated	2.51	5.28

S. aureus was isolated from 207 clinical and 396 sub-clinical submissions and was sensitive to penicillin in 87% and 84.6% of cases respectively.

DISCUSSION AND CONCLUSIONS

Whilst inevitably these results reflect only a specific subset of cases, they were collected from over 500 farms throughout the UK and are probably a fair representation of the current picture. The aetiology of both clinical and sub-clinical mastitis in the UK is diverse and goes well beyond the pathogens traditionally considered. As described in other recent reports, environmental pathogens predominate, though classic contagious pathogens such as *S. agalactiae* remain and are still isolated on an ongoing basis. Whilst a high proportion of 'no growth' is often cited as frustration in mastitis bacteriology, this analysis demonstrates that that need not be the case if a fastidious approach is adopted. Of particular interest is the very low prevalence of *in vitro* penicillin resistance compared to historic reports.

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STANDARISED GARLIC EXTRACT IN LOWERING SOMATIC CELL COUNTS: A PILOT TRIAL IN DAIRY COWS

L Chew[1], P De Costa[1], M Willemsen[1], J J C van Hattum[2], J A L M de Kleyne[2]
[1]InQpharm Group Sdn Bhd, Kuala Lumpur, Malaysia; [2]Farma Research Animal Health B.V, Nijmegen, Netherlands

INTRODUCTION

Reduced milk yield and poor quality of milk due to a high somatic cell count (SCC) (Harmon, 1994; "National Mastitis Council Guidelines on Normal and Abnormal Raw Milk Based on Somatic Cell Counts and Signs of Clinical Mastitis," 2001) would cause the dairy farmer to suffer a 'silent' loss of potential revenue. It is estimated in the Netherlands alone, a farmer can stand to lose between € 17 to € 193 in a year for each cow experiencing subclinical mastitis (Hogeveen, Huijps, & Lam, 2011). An elevated SCC in the cow's milk, usually above 200,000 cells/ml would indicate a subclinical mastitis ("National Mastitis Council Guidelines on Normal and Abnormal Raw Milk Based on Somatic Cell Counts and Signs of Clinical Mastitis," 2001, "What You Should Know about Somatic Cells," 2009).

METHOD

A pilot trial with 10 cows in 3 farms was conducted in the Netherlands to assess the effect of administering a standardized garlic extract IQP-AS-101 to cows with elevated SCC. Cows with SCC above 250,000 cells/ml sampled on days 3 to 7 prior to start of administration were enrolled. IQP-AS-101 is a component in Vetrinol.

The primary endpoint was the % geometric mean reduction in SCC post treatment. Secondary endpoint included bacteriological examination and general health condition of the cows.

Ten cows received 75 ml of IQP-AS-101, twice a day, for 4 days. The test material was administered via graduated drench guns by personnel from the contract research organization. All cows were observed for 14 days from the day of test material administration.

Quarter milk samples were made on Days 4, 5, 8, 11 and 14. Samplings were made by the research personnel and transported to the laboratory in a cool box with refrigerating elements. Freezing of the samples were avoided.

Quarter milk samples collected were analyzed for SCC using the SomaScope (Delta Instruments). Bacteriological examination for each infected quarter based on total elimination of the pathogens was performed by means of culture and analyzed using the matrix assisted laser desorption ionization time-of-flight (MALDI-ToF) technique. The farmers carried out daily observations for general health.

RESULTS

A 40% reduction of mean SCC was observed after a 3-day administration of IQP-AS-101 in cows that had a baseline SCC above 300,000 cells/ml. Four out of 15 quarters showed bacteriological cure. Results from the other samples did not show a conclusive trend. There was no deviation in health conditions and no adverse events were observed.

DISCUSSION

These preliminary promising results suggest that administration of IQP-AS-101 contributes to lowering somatic cell counts in milk, and has potential to reduce economic losses of dairy farmers. In-vitro minimum inhibitory concentration studies on common mastitis-causing bacteria; *Strep agalactiae, Staph aureus* and *E. coli* showed that IQP-AS-101 has good antimicrobial properties. This is in agreement with a published paper by Safithri, Bintang, & Poeloengan (2011). Further research is warranted to confirm the efficacy of the product with a larger sample size and longer observation periods.

CONCLUSION

IQP-AS-101 showed potential to be safe and effective for lowering SCC in dairy cows.

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PRELIMINARY OBSERVATION OF MASTITIS PARAMETERS IN 3 HERDS BEFORE AND DURING THE FIRST 12 MONTHS OF A ROLLING 3 MONTH VACCINATION PROGRAM WITH STARTVAC ®

Andrew Biggs[1], Daniel Zalduendo[2]
[1] The Vale Veterinary Group The Laurels Station Road, Tiverton Devon EX164LF UK; [2] HIPRA ,Avda. La Selva, nº135 17170 – Amer (Girona) Spain

Monitoring the dynamic nature and magnitude of the mastitis challenge, prevalence and incidence within the modern dairy herd is becoming common place around the developed dairy industries of the world. The iterative process of regular interpretation of prevalence data (Individual Cow Somatic Cell Counts [SCC]), incidence data (Clinical mastitis records) and how these data change over time both within lactation and between lactations (over the dry period) can give much information about the transmission patterns and likely origin and duration of intramammary infections within a dairy herd. The transmission patterns can indicate whether new intramammary infections tend to be persistent and thus have the opportunity to spread in a contagious manner or transient and more likely to originate from the cows environment. The stage of lactation that new intramammary infections occur within a herd, either as increases in cow SCC above a threshold or the occurrence of a clinical episode, can help indicate their presumptive origin from the dry period or lactation.

Overall this approach is increasingly being used to help indicate the likely source and magnitude of the mastitis infection drive and spread within a dairy herd such that management advice can be given to control intramammary infection rate. The same approach can be used to measure the effects of interventions such as changes in management protocols for example improved transition cow management, improved milking routine or vaccination.

The aim of this project was to apply these diagnostic and monitoring techniques to three herds chosen for a high prevalence of *Staphylococcus aureus* over the 12 months prior to and during the 12 months of a rolling 3 month vaccination program with a polyvalent mastitis vaccine. Startvac©(Hipra) is an inactivated oil adjuvented vaccine containing Escherichia coli J5 and Staphylococcus aureus (CP8) strain SP 140 expressing Slime Associated Antigenic Complex (SAAC).

PRELIMINARY DATA OBSERVATIONS

Data is compared at 6 month intervals from 12 months prior to and 12 months after initiating a whole herd Startvac® vaccination policy. All cows received 2 vaccine doses 3 week apart followed by a rolling policy of quarterly boosters. In calf heifers were batched to receive 2 doses 3 weeks apart with the second dose no less than 10 days prior to expected parturition. Heifers then joined the rolling 3 month booster program.

- Herd screens - Individual cow bacteriological culture of all cows in milk.
    - *Staphylococcus aureus* prevalence reduced from 8.6% to 3.0% (Data from all 3 herds)
- Clinical mastitis incidence
    - Reduction in the clinical cases (in the 3 herds)
- Routine monthly individual cow SCC data – using a 200,000 cells per ml threshold to indicate infection status
    - Reduction in proportion of infected cows in the herd (% cows > 200,000 cells per ml)
    - Reduction in First infections in the 3 herds (high 1st cell count after parturition)
        - This effect was seen in both cows and heIfers
    - Reduction in New infections in two herds and increase in one herd (1st high SCC in current lactation but not 1st SCC after parturition)
    - Reduction in Chronic infections in two and increase in one herd (Two or more consecutive high SCC and currently high)

CONCLUSIONS FROM DATA TO DATE

- In general:
    - Better results after 6 months using the rolling protocol
        - In common with other studies the improvements take time
    - Vaccination is not a panacea and consistent good mastitis management is essential
        - Herd De (which saw some deterioration with mainly SCC parameters had issues with the milking parlour and cow environment)
- S. aureus prevalence reduced in the 3 farms
- Clinical mastitis reduced in the 3 farms
- From the SCC monitoring:
    - More healthy animals
    - First infections reduction in the 3 herds.

NOTES

NOTES

APPENDICES

NATIONAL MASTITIS SURVEY

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NATIONAL MASTITIS SURVEY RESULTS

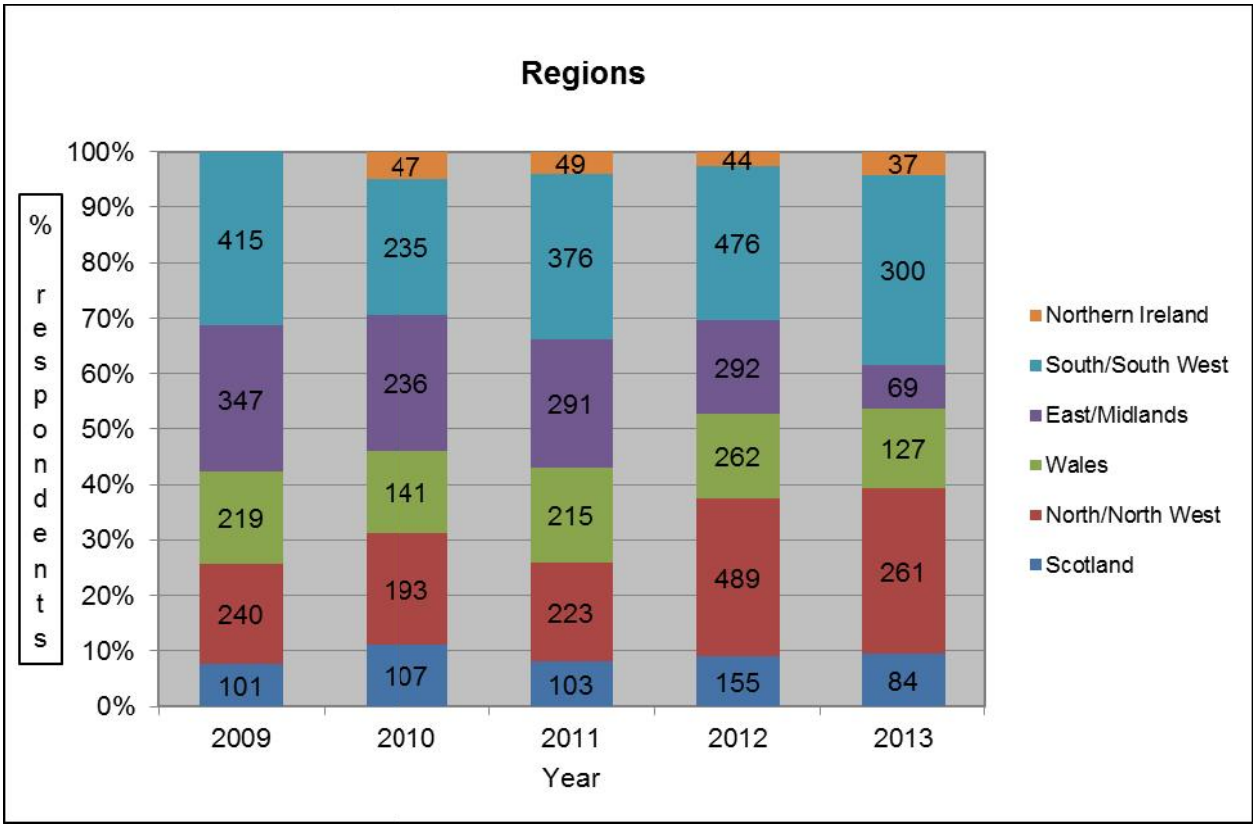
Andrew Biggs[1], MSD Animal Health[2]
[1] The Vale Veterinary Group, The Laurels Station Road, Tiverton Devon EX16 4LF UK.
Email ValeLab@btinternet.com; [2] Walton Manor, Walton, Milton Keynes, MK7 7AJ, UK.

The annual UK National Mastitis Survey is one of the largest surveys of its type and has attracted an average of 1200 respondents over the last 5 years. The survey aims to establish a true representation of the on farm situation and challenges faced by farmers on a daily basis by asking 28 questions requesting various data about their farm and management practices.

KEY FINDINGS

- Many findings are unchanged from previous years
- Mastitis remains a significant challenge on the majority of dairy farms
- In 2013 there were slightly fewer responses although still representative as many parameters such as herd size and yield are broadly similar to previous years.
- Unsurprisingly smaller herds tend to have lower yields
- BMSCC has improved overall and now 50% of herds responding have BMSCC < 150,000 cells per ml
- Bactoscans improved marginally from 2012 to 2013
- No association between BMSCC and herd size – if anything larger herds have lower BMSCC
- There was a very small increase in the number of three times a day (3X) milked herds
- There was a slight increase in herds routinely individual cow milk recording
- Lower BMSCC herds tend to have less clinical mastitis and overall there has been small improvement from 2012 to 2013
- There was a slight increase by herd and a bigger increase by cows of milking cows being housed all year implying larger herds are more likely to house their milking cattle
- In the milking parlour
    - There was a modest increase in the number of respondents wearing gloves during milking
    - A greater proportion of respondents in the lower BMSCC bands always foremilk
    - Over the last 3 years there was an increase in the proportion of respondents that use premilking teat disinfection with foam and spray both increasing whilst dipping remains the most common method used
    - Manual cluster disinfection is more popular with more respondents disinfecting clusters after both high SCC and clinicals and not just high SCC cows
    - Less than half of respondents (43%) have a dynamic milking machine test
- Bedding

- Most common beddings are Sawdust (45%) and Straw (33%)
- More herds with lower BMSCC are using sawdust (or sand but dataset is small) and more herds with higher BMSCC are using straw
- More herds with lower mastitis rates are using sawdust (or sand but dataset is small) and more herds with higher mastitis rates are using straw
- Bedding conditioners
  - Lime is the most common conditioner 80%


Regions
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100%
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107
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376
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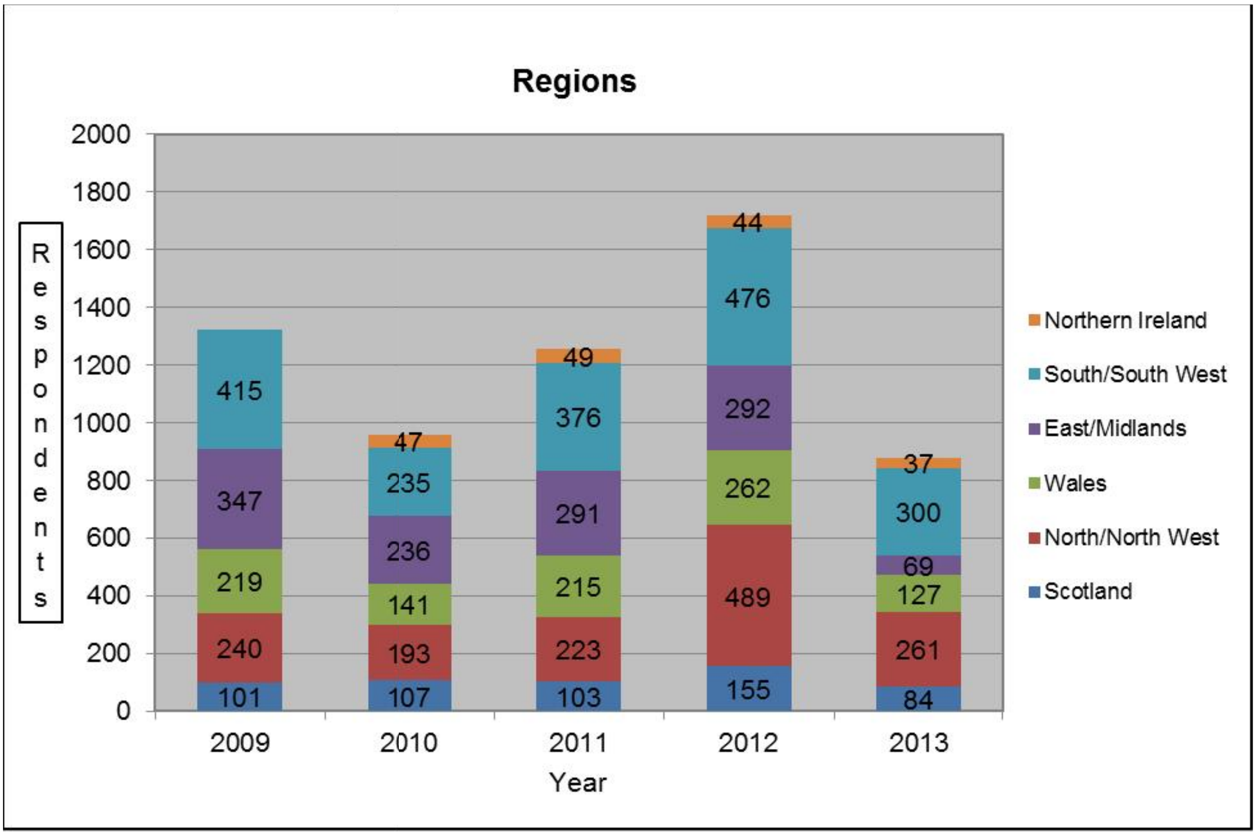
Regions
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223
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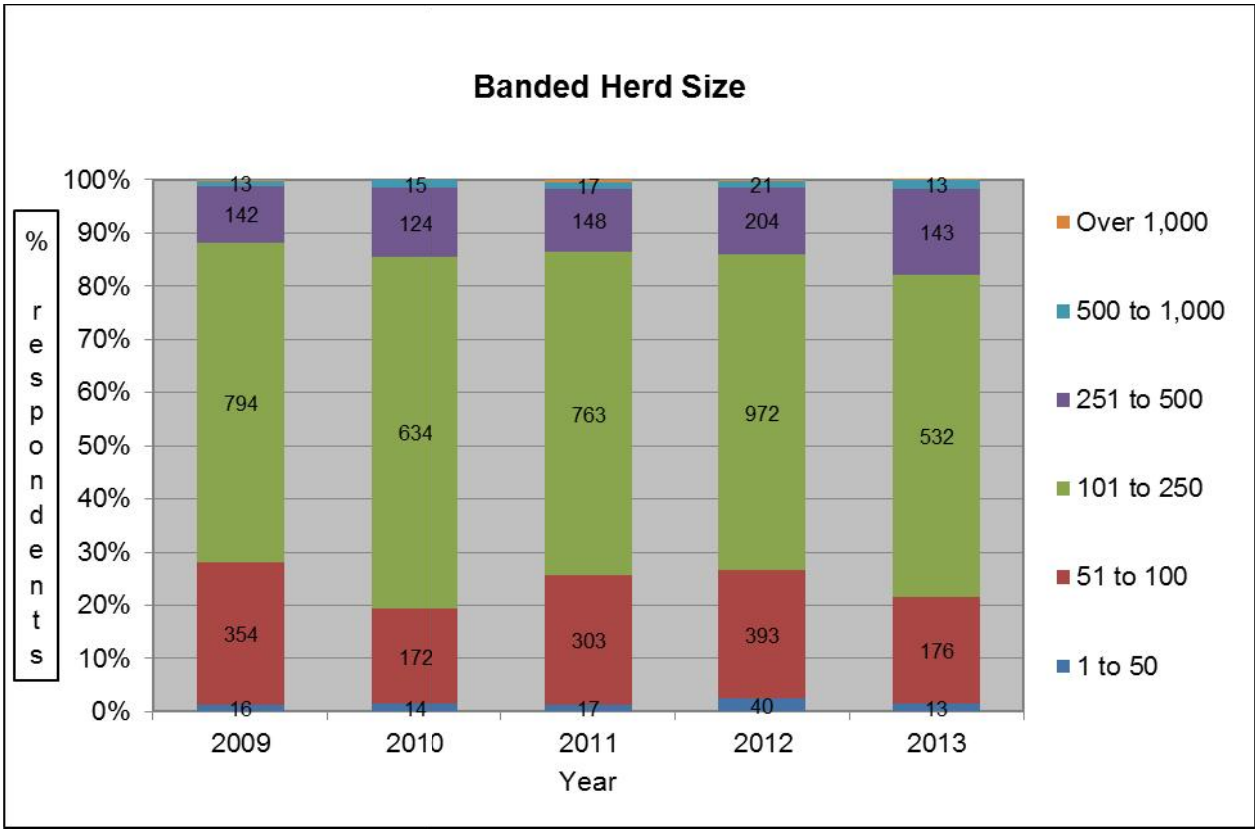
East/Midlands
Wales
North/North West
Scotland


Banded Herd Size
% respondents
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90%
80%
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50%
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2010
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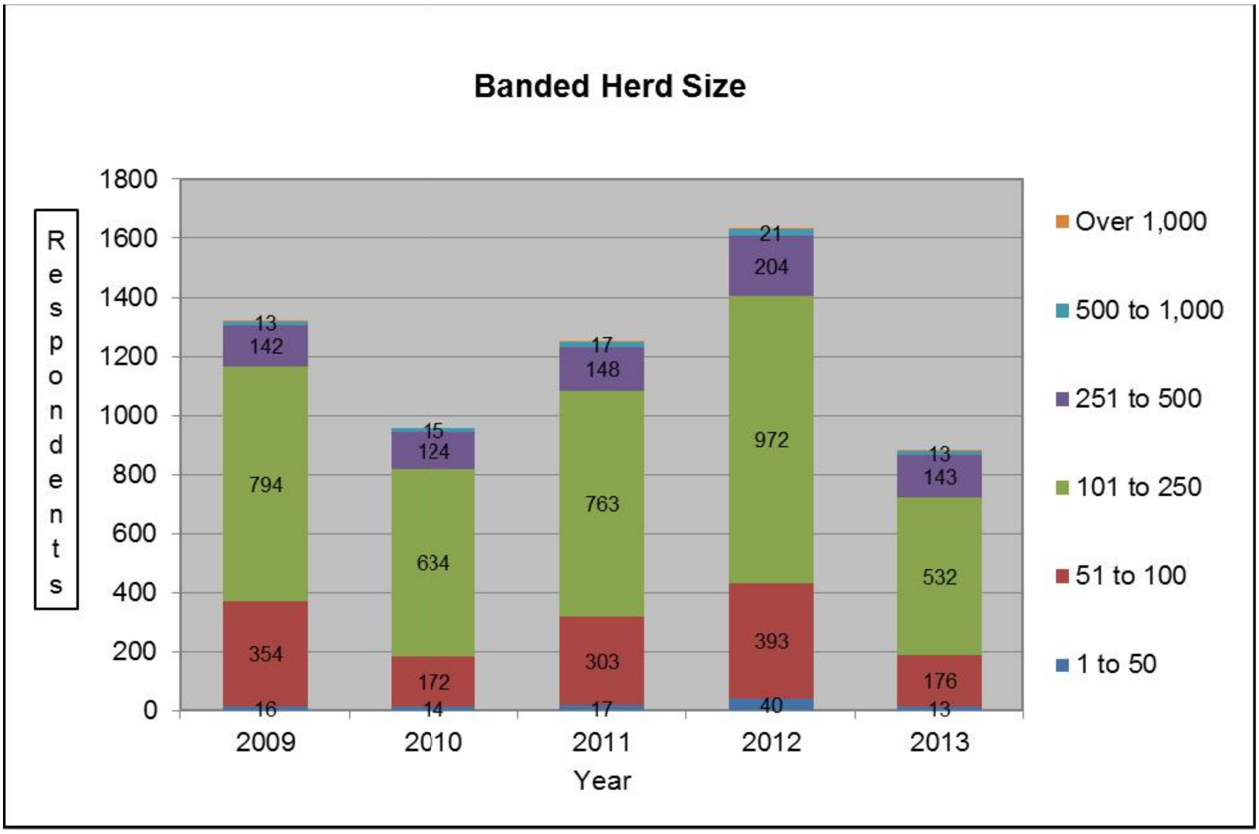
251 to 500
101 to 250
51 to 100
1 to 50


Banded Herd Size
Respondents
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1400
1200
1000
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13
142
794
354
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124
634
172
14
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148
763
303
17
21
204
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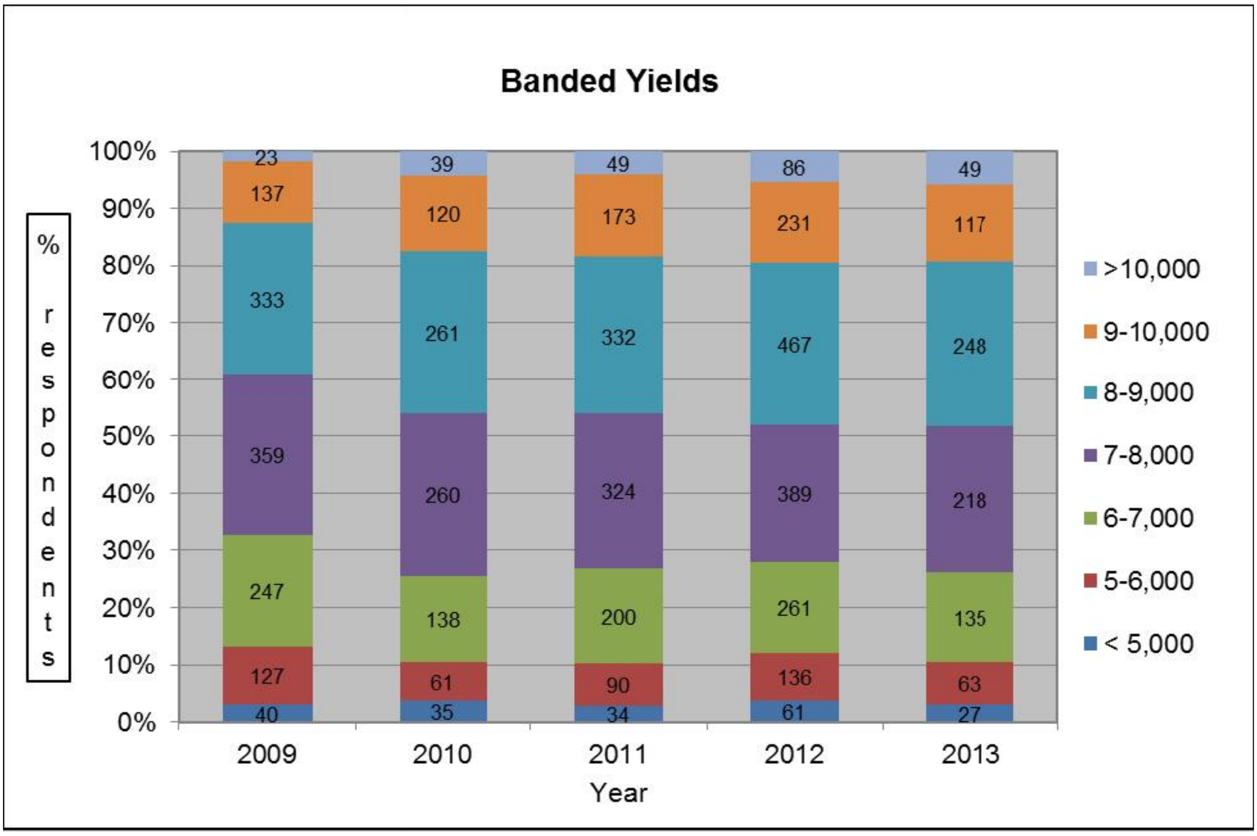
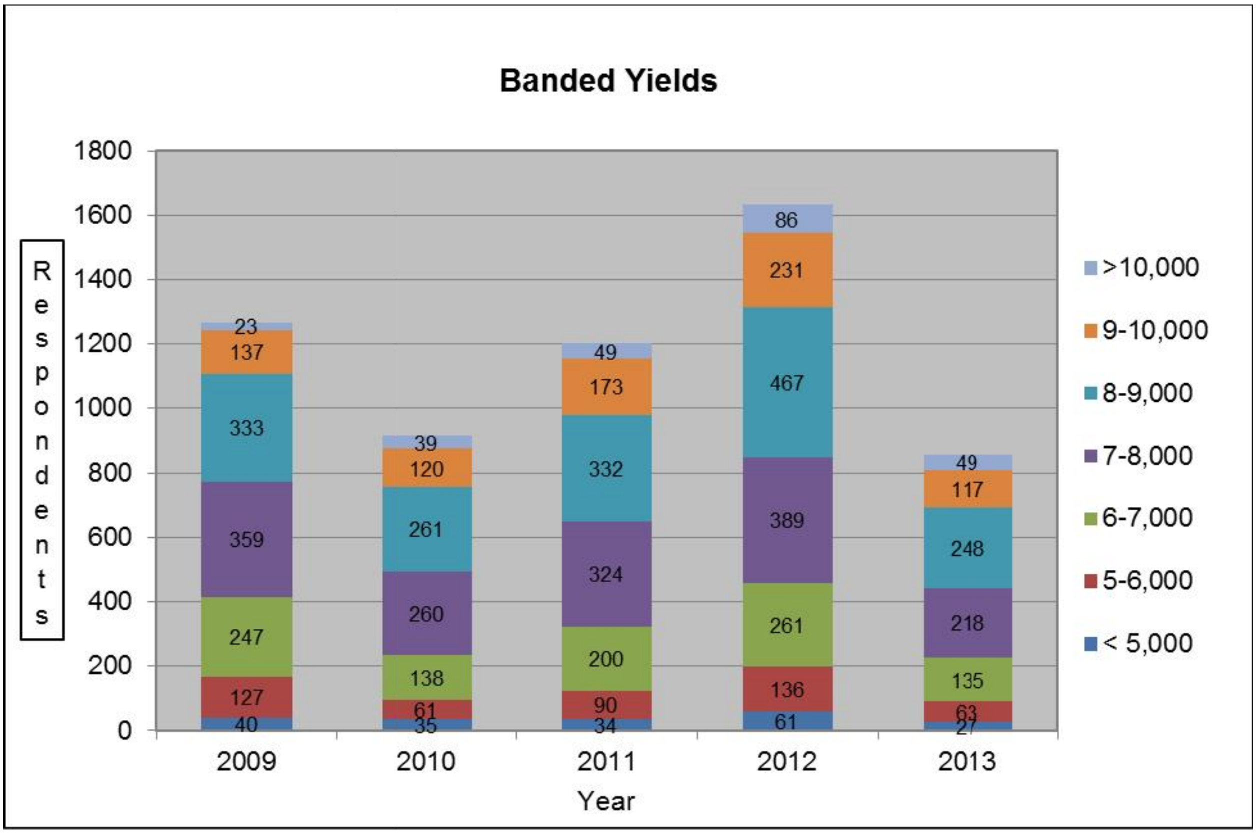
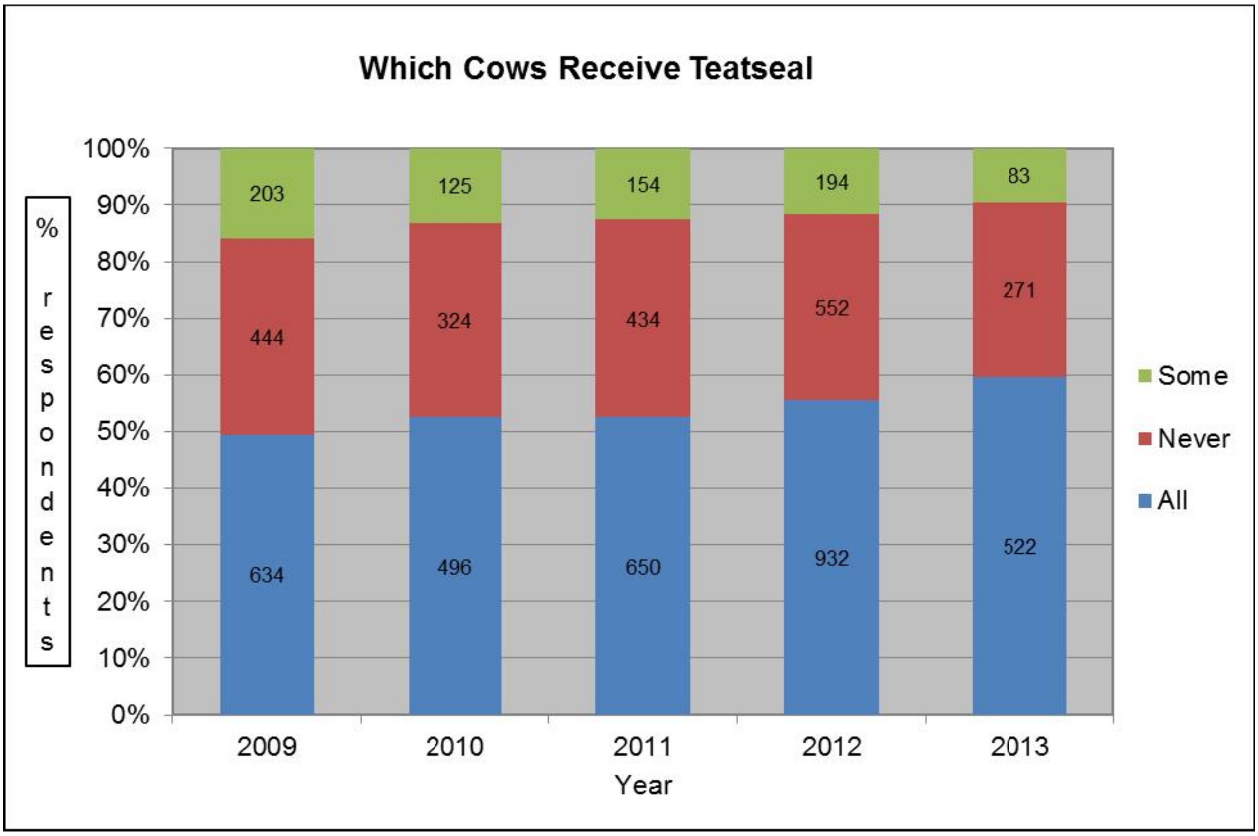
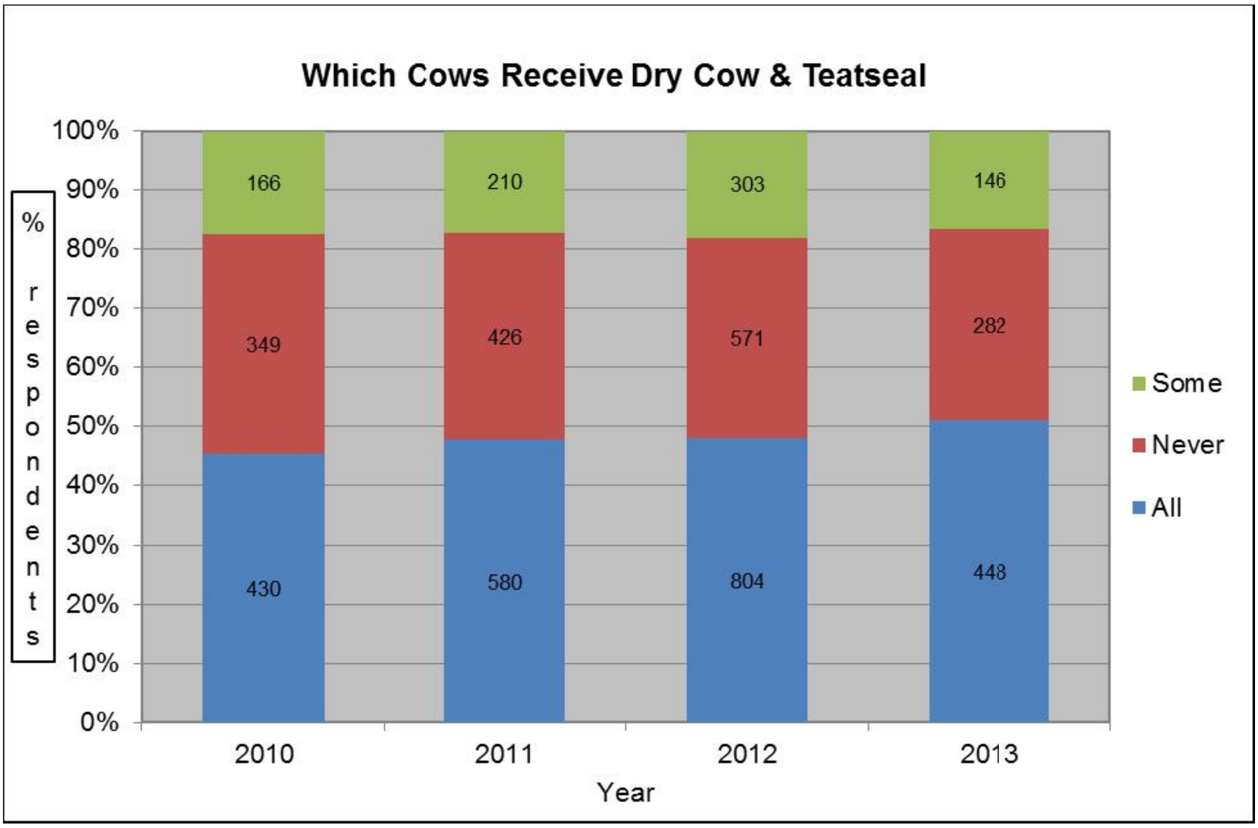
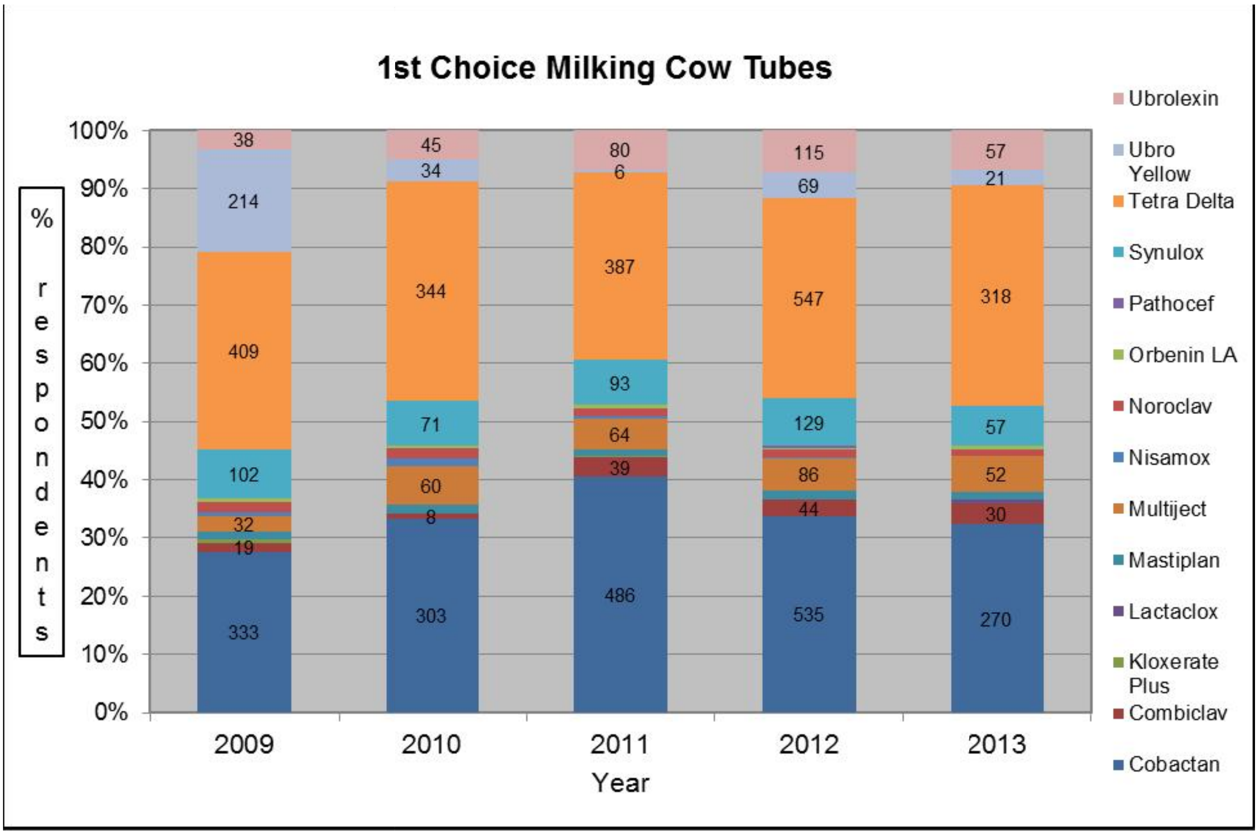
393
40
13
143
532
176
13
Over 1,000
500 to 1,000
251 to 500
101 to 250
51 to 100
1 to 50

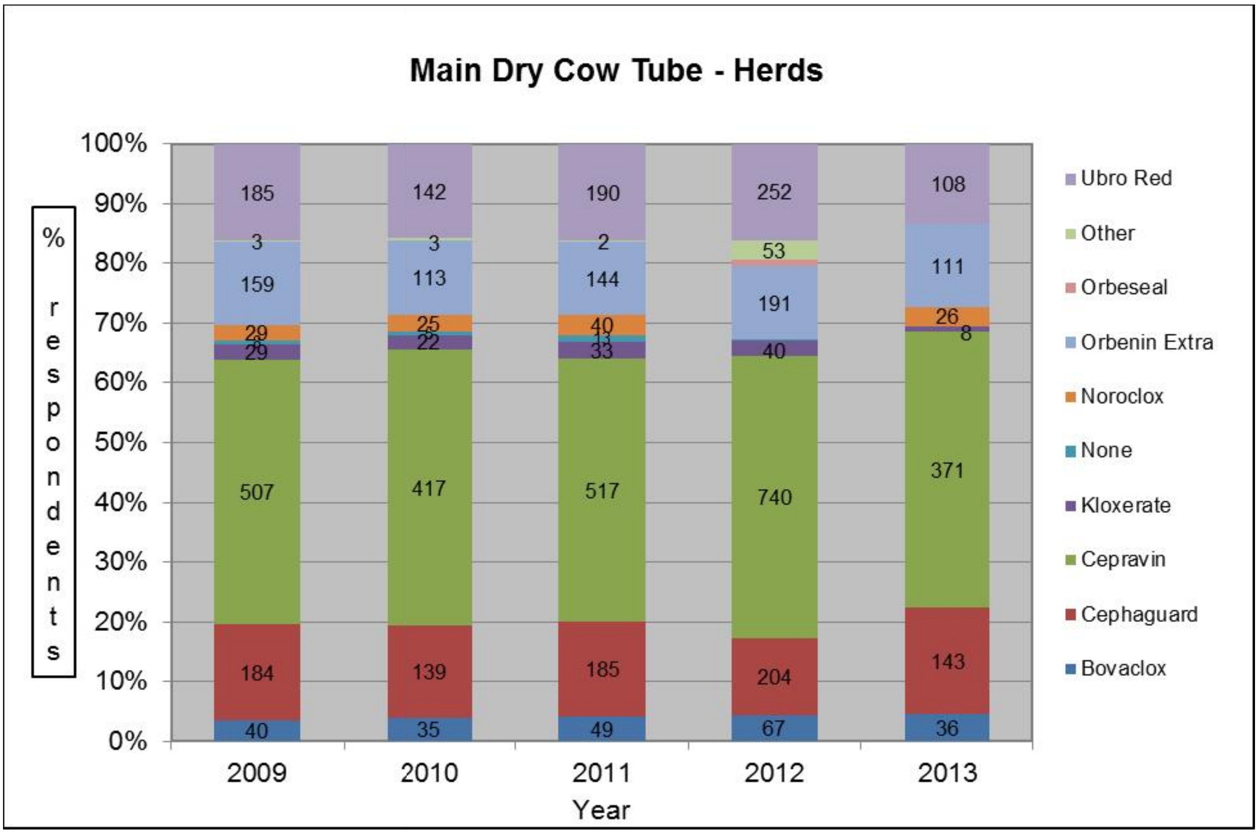

Banded Yields
% respondents
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2009
2010
2011
2012
2013
Year
>10,000
9-10,000
8-9,000
7-8,000
6-7,000
5-6,000
< 5,000
23
137
333
359
247
127
40
39
120
261
260
138
61
35
49
173
332
324
200
90
34
86
231
467
389
261
136
61
49
117
248
218
135
63
27

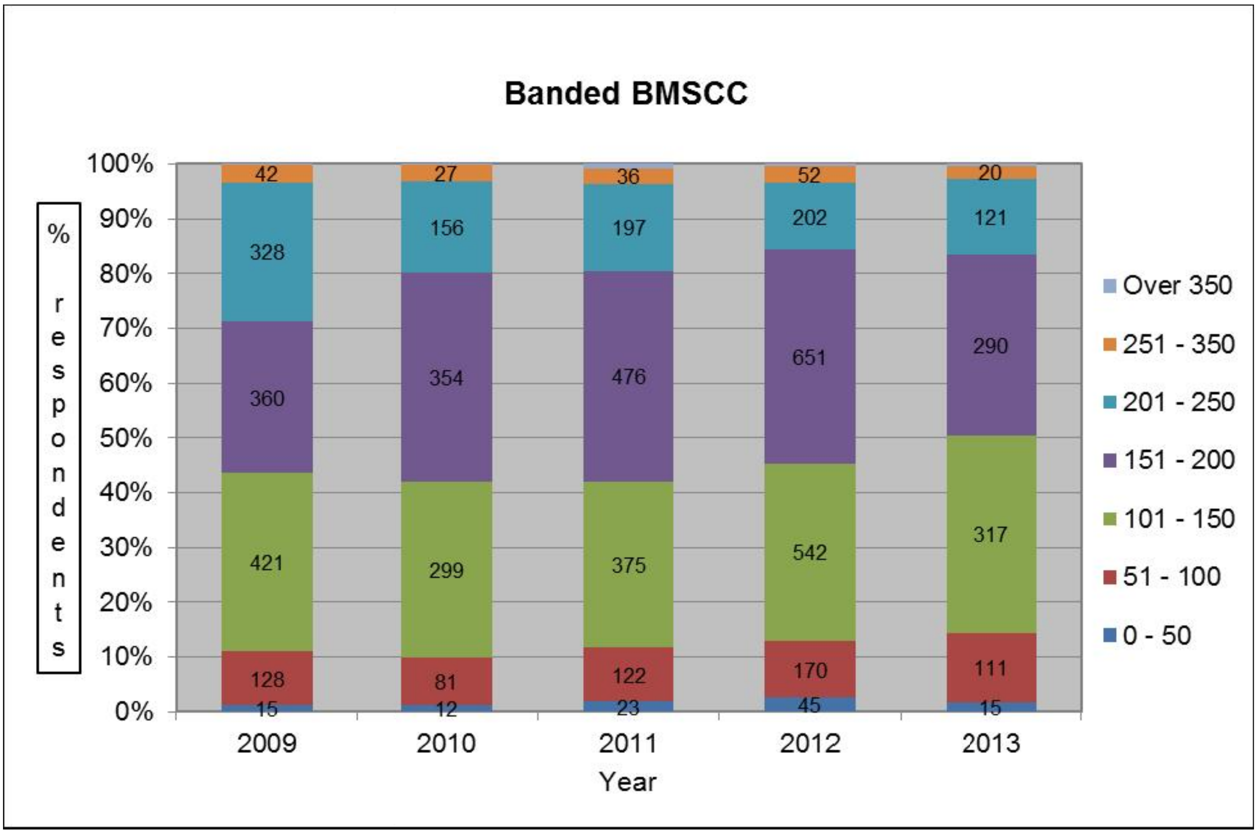

Banded Yields
Respondents
1800
1600
1400
1200
1000
800
600
400
200
0
2009
2010
2011
2012
2013
Year
>10,000
9-10,000
8-9,000
7-8,000
6-7,000
5-6,000
< 5,000
23
137
333
359
247
127
40
39
120
261
260
138
61
35
49
173
332
324
200
90
34
86
231
467
389
261
136
61
49
117
248
218
135
63
27

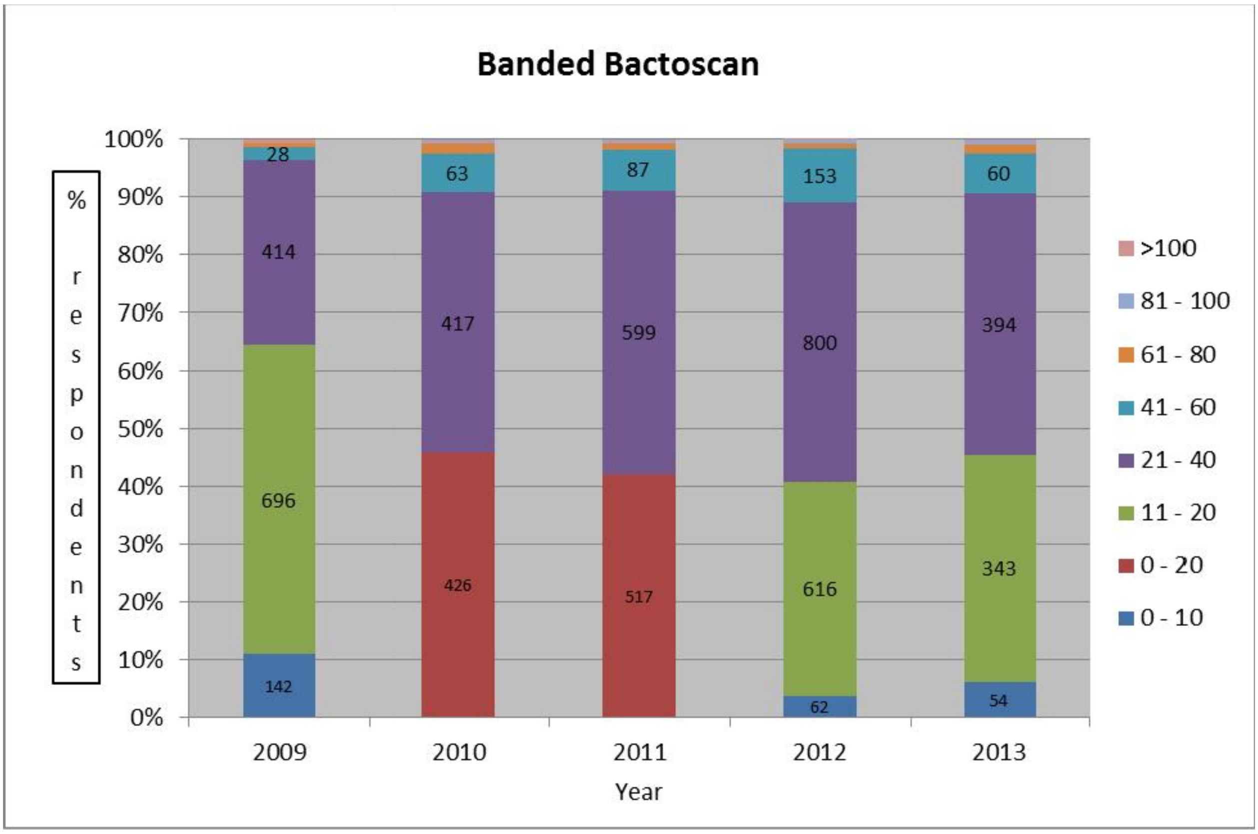

Which Cows Receive Teatseal
% respondents
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
203
125
154
194
83
444
324
434
552
271
634
496
650
932
522
2009
2010
2011
2012
2013
Year
Some
Never
All

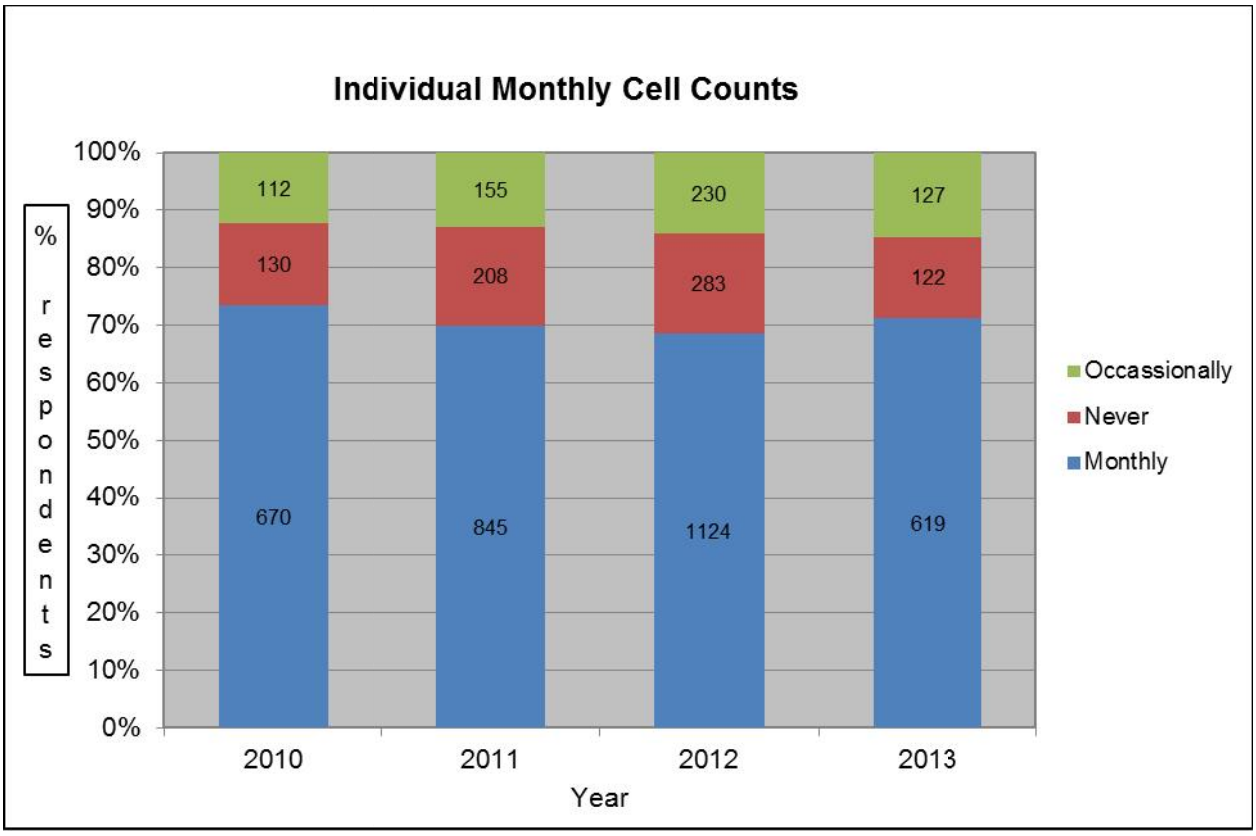

Which Cows Receive Dry Cow & Teatseal
% respondents
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
166
210
303
146
349
426
571
282
430
580
804
448
2010
2011
2012
2013
Year
Some
Never
All

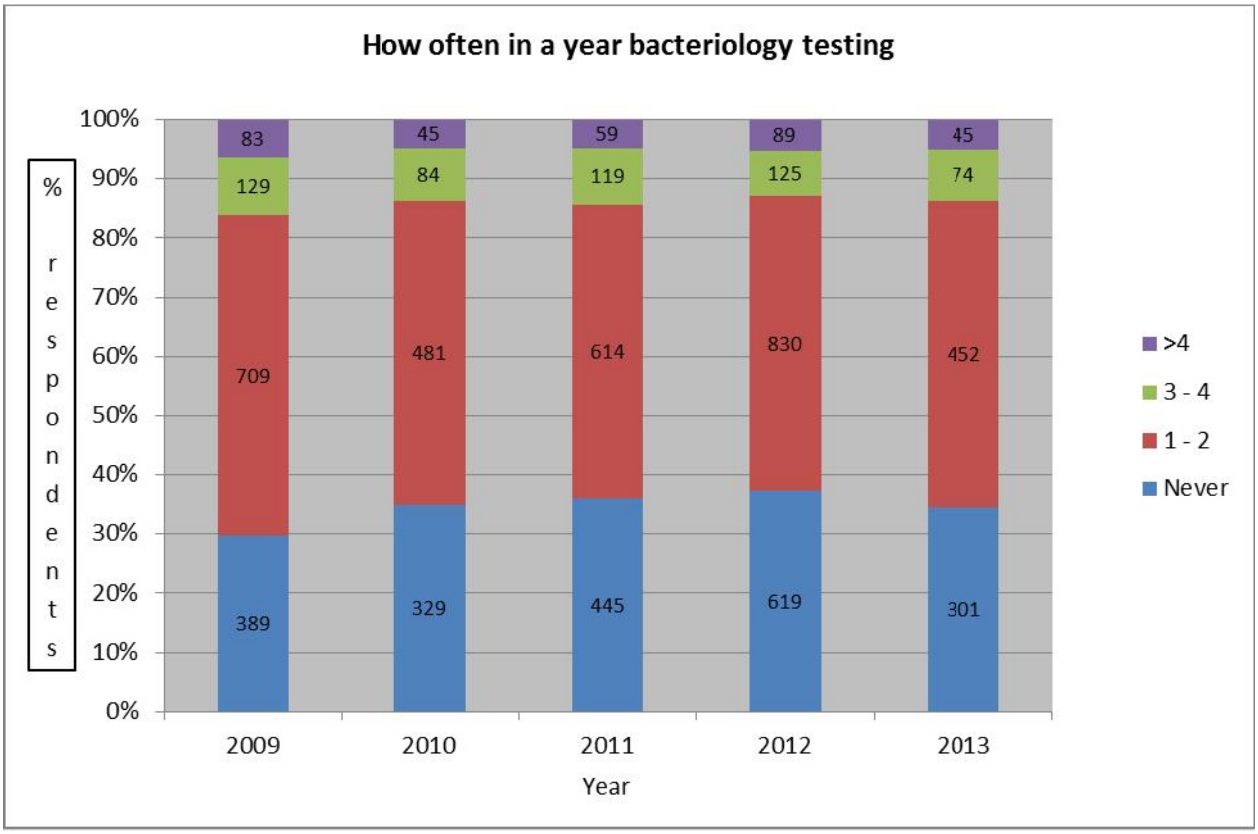

1st Choice Milking Cow Tubes
% respondents
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2009
2010
2011
2012
2013
Year
38
214
409
102
32
19
333
45
34
344
71
60
8
303
80
6
387
93
64
39
486
115
69
547
129
86
44
535
57
21
318
57
52
30
270
Ubrolexin
Ubro Yellow
Tetra Delta
Synulox
Pathocef
Orbenin LA
Noroclav
Nisamox
Multiject
Mastiplan
Lactaclox
Kloxerate Plus
Combiclav
Cobactan

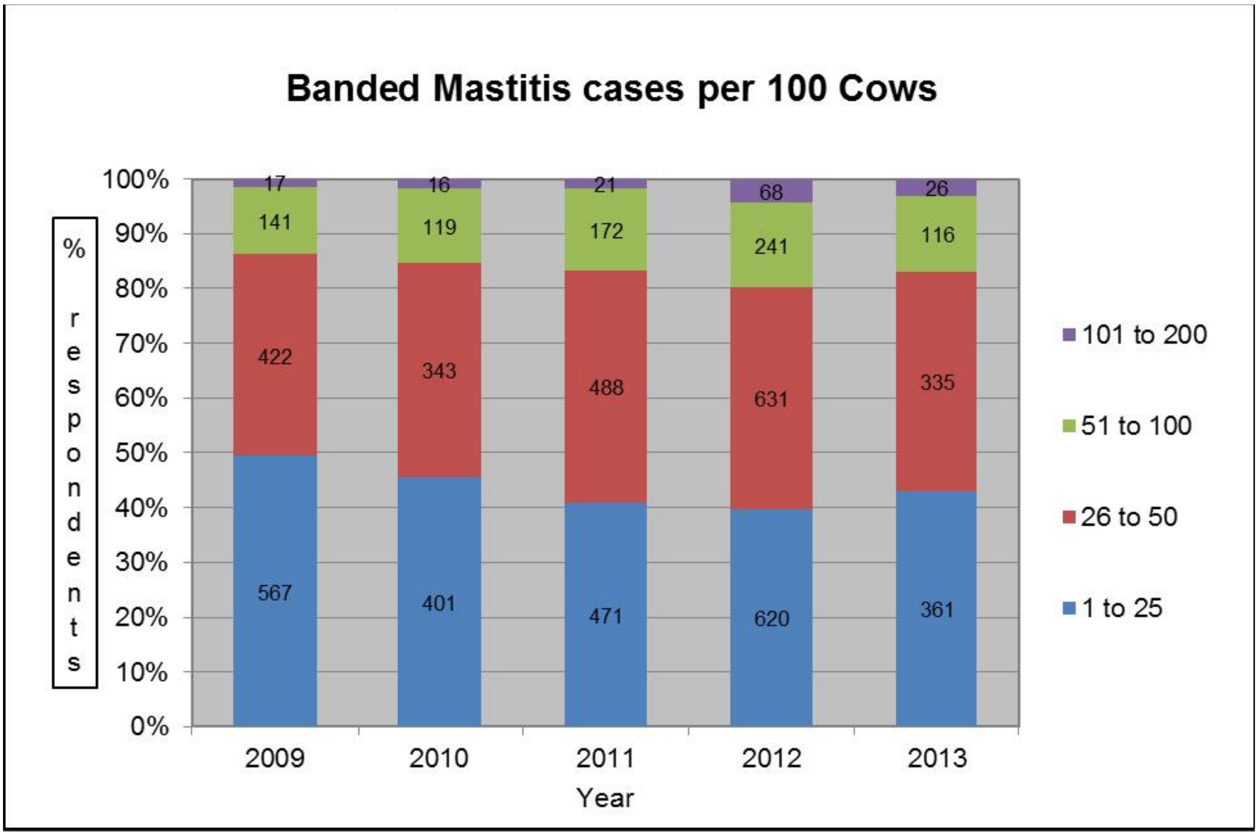

Main Dry Cow Tube - Herds
% respondents
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2009
2010
2011
2012
2013
Year
185
3
159
29
29
507
184
40
142
3
113
25
22
417
139
35
190
2
144
40
13
33
517
185
49
252
53
191
40
740
204
67
108
111
26
8
371
143
36
Ubro Red
Other
Orbeseal
Orbenin Extra
Noroclox
None
Kloxerate
Cepravin
Cephaguard
Bovaclox

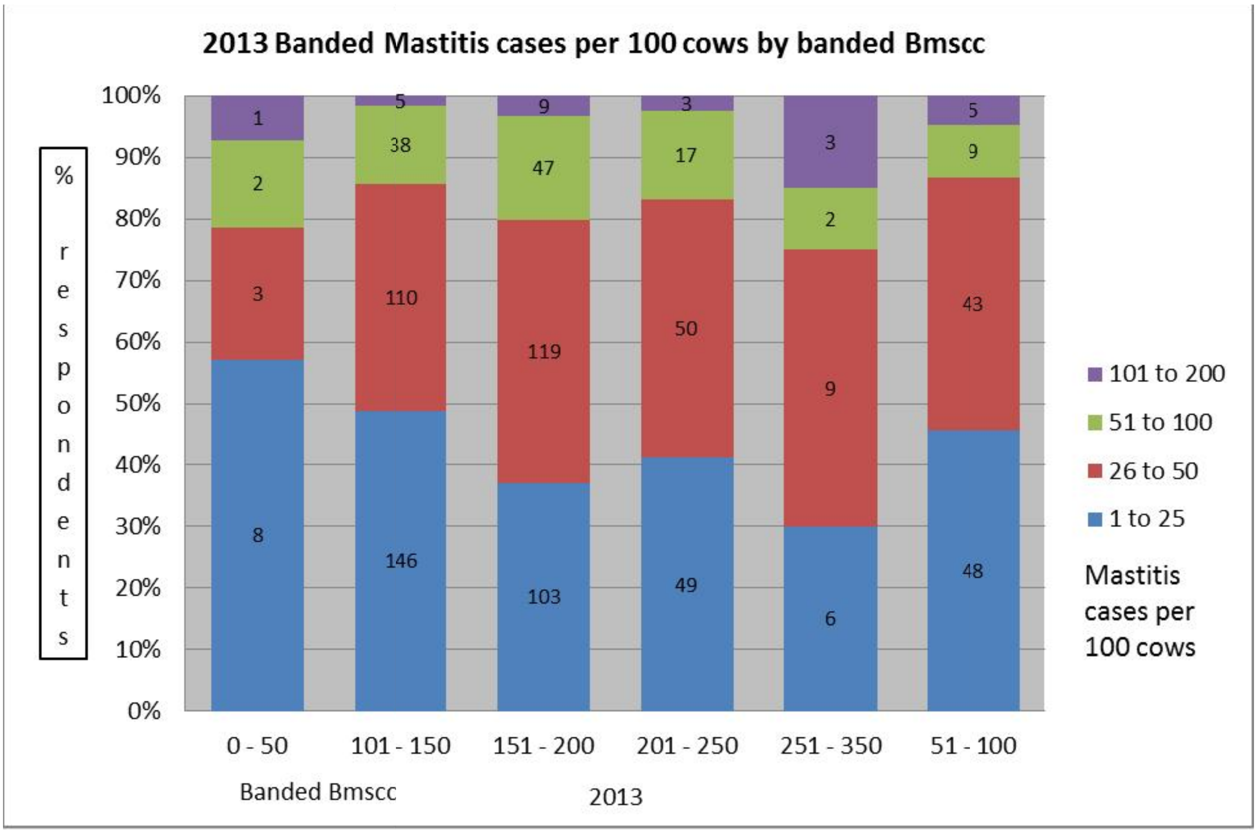

Banded BMSCC
% respondents
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
42
328
360
421
128
15
27
156
354
299
81
12
36
197
476
375
122
23
52
202
651
542
170
45
20
121
290
317
111
15
2009
2010
2011
2012
2013
Year
Over 350
251 - 350
201 - 250
151 - 200
101 - 150
51 - 100
0 - 50

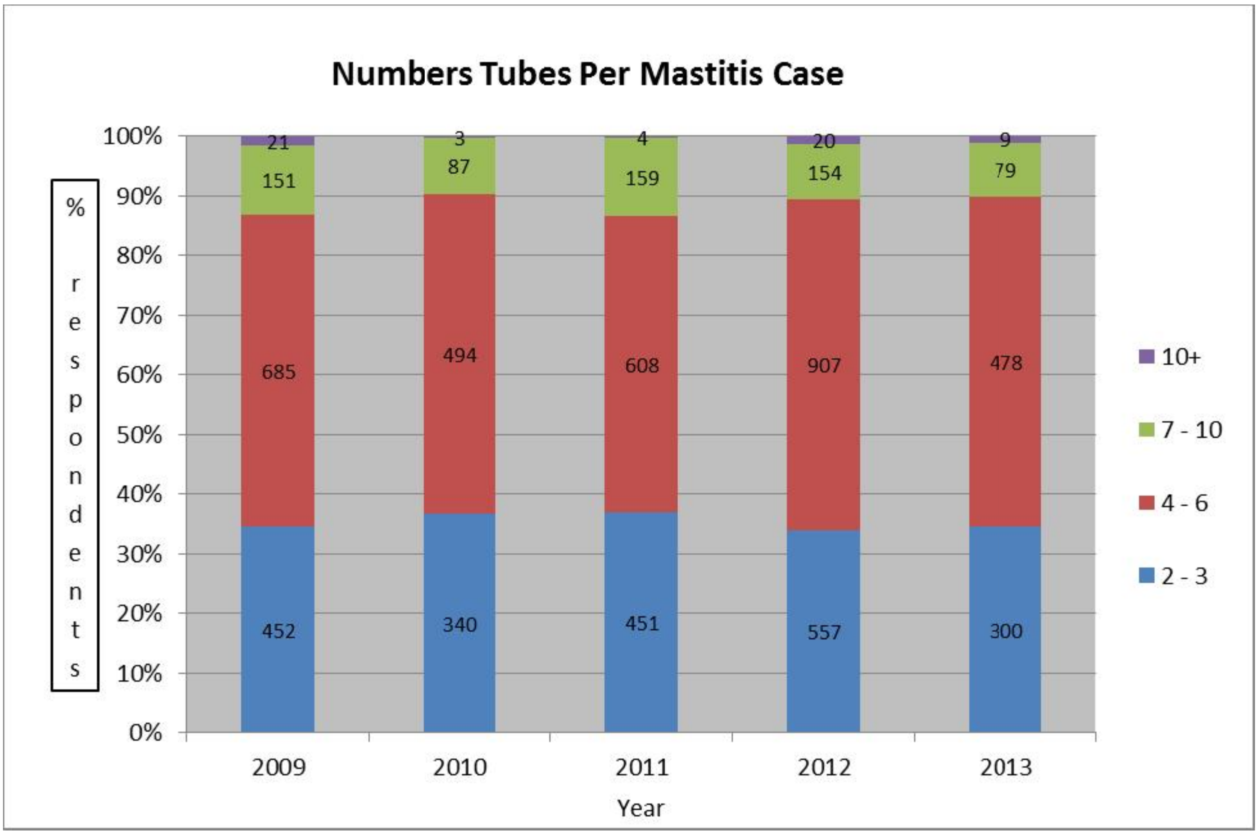

Banded Bactoscan
% respondents
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
28
414
696
142
63
417
426
87
599
517
153
800
616
62
60
394
343
54
2009
2010
2011
2012
2013
Year
>100
81 - 100
61 - 80
41 - 60
21 - 40
11 - 20
0 - 20
0 - 10

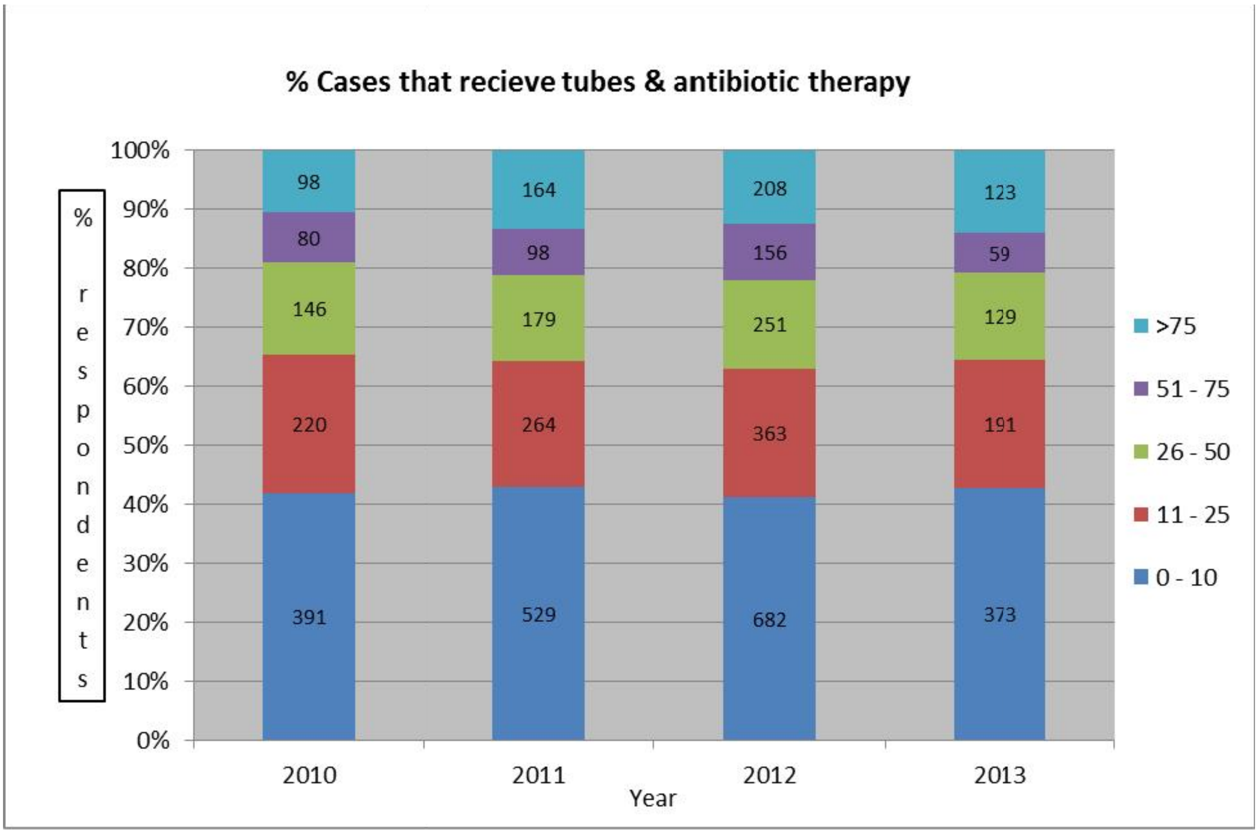

Individual Monthly Cell Counts
% respondents
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
112
130
670
155
208
845
230
283
1124
127
122
619
2010
2011
2012
2013
Year
Occassionally
Never
Monthly

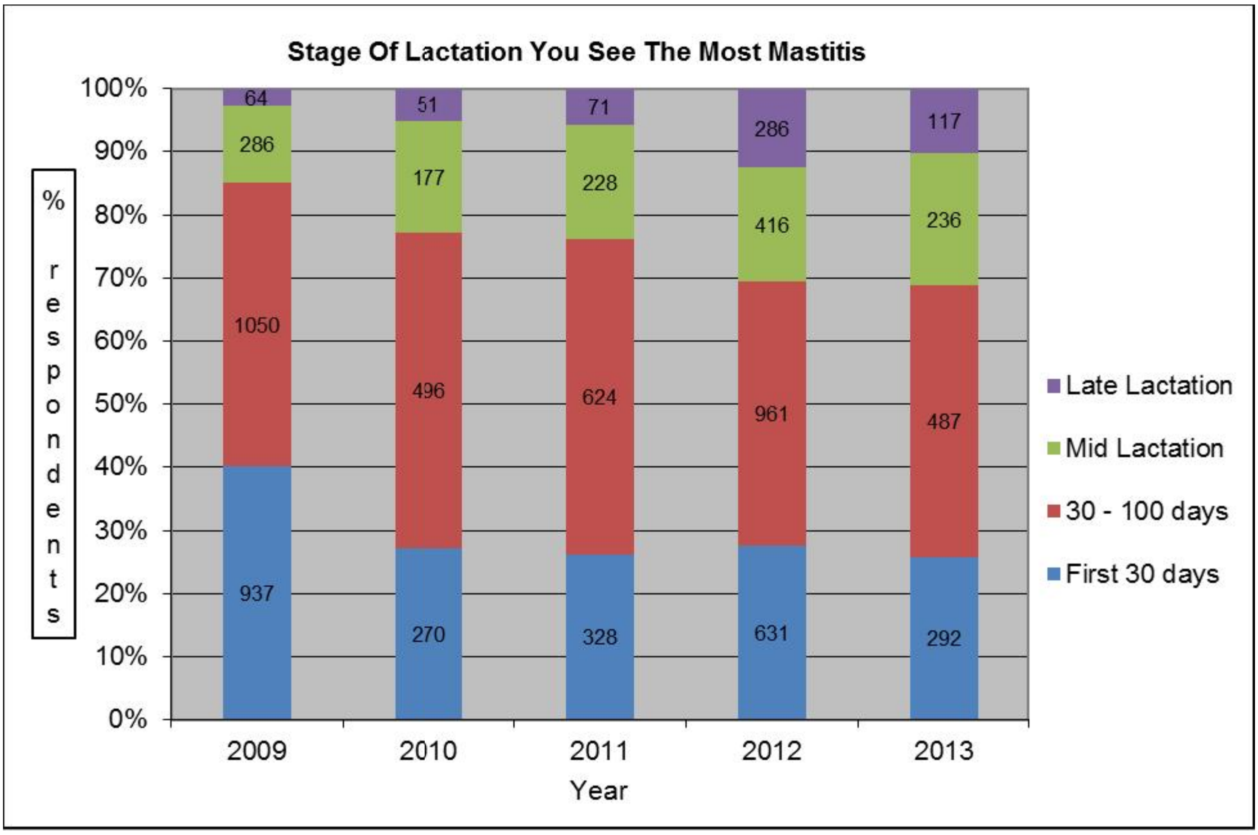

How often in a year bacteriology testing
% respondents
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
83
129
709
389
45
84
481
329
59
119
614
445
89
125
830
619
45
74
452
301
2009
2010
2011
2012
2013
Year
>4
3 - 4
1 - 2
Never

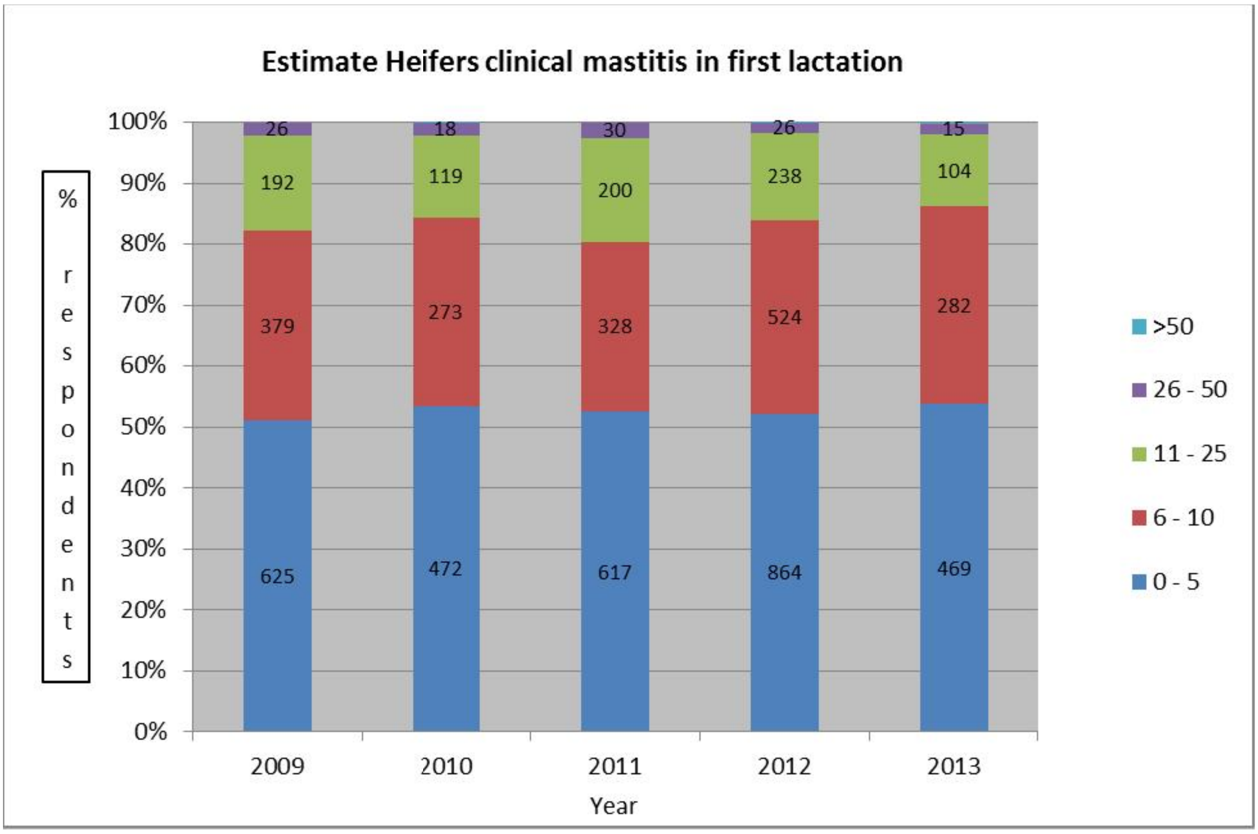

Banded Mastitis cases per 100 Cows
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
% respondents
17
141
422
567
16
119
343
401
21
172
488
471
68
241
631
620
26
116
335
361
2009
2010
2011
2012
2013
Year
101 to 200
51 to 100
26 to 50
1 to 25

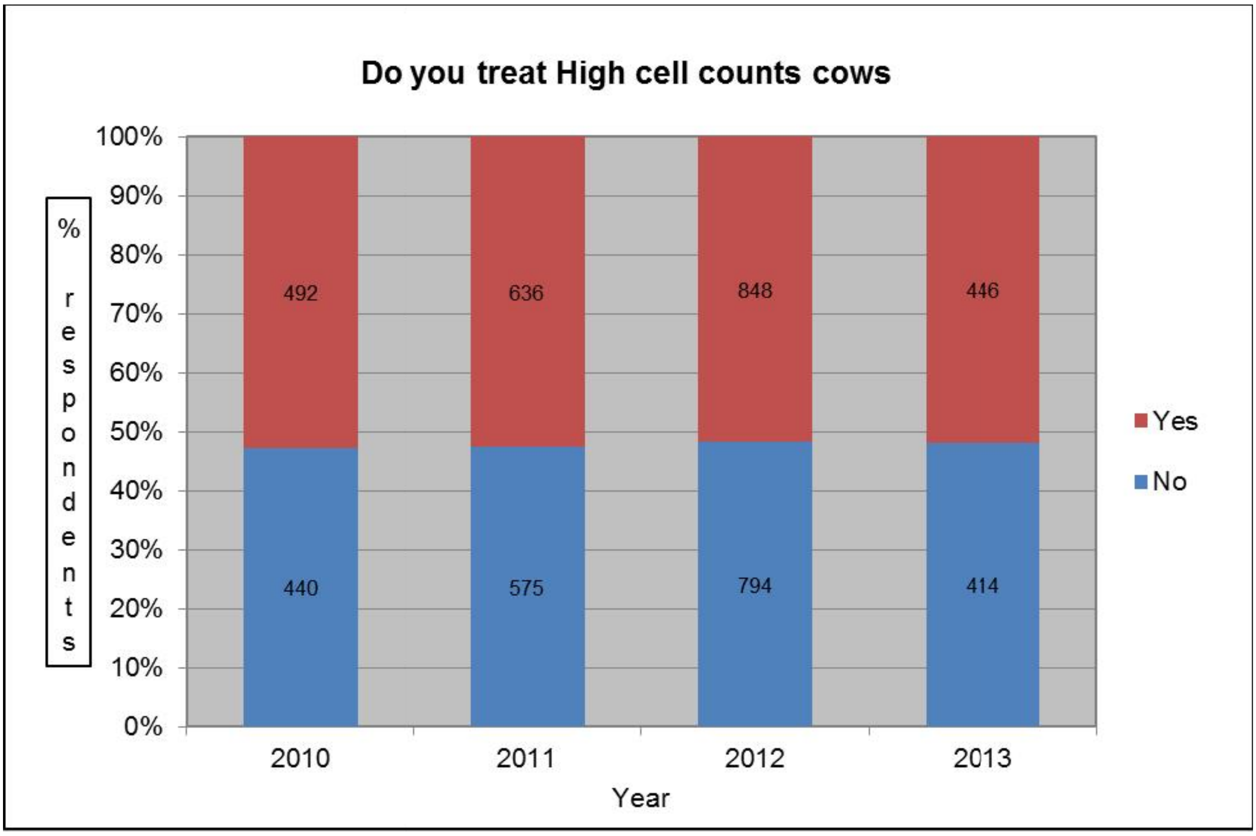

2013 Banded Mastitis cases per 100 cows by banded Bmscc
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
% respondents
1
2
3
8
5
38
110
146
9
47
119
103
3
17
50
49
3
2
9
6
5
9
43
48
0 - 50
101 - 150
151 - 200
201 - 250
251 - 350
51 - 100
Banded Bmscc
2013
101 to 200
51 to 100
26 to 50
1 to 25
Mastitis cases per 100 cows

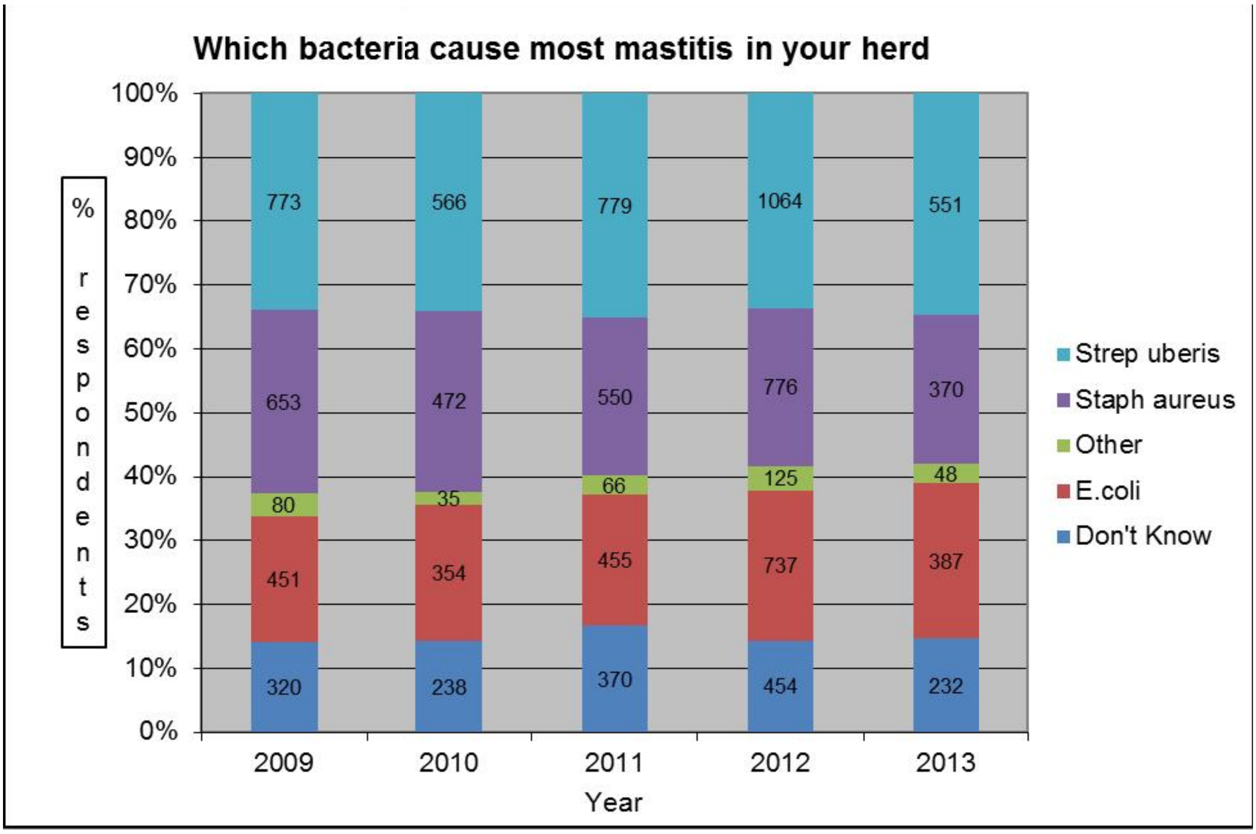

Numbers Tubes Per Mastitis Case
% respondents
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
21
151
685
452
3
87
494
340
4
159
608
451
20
154
907
557
9
79
478
300
2009
2010
2011
2012
2013
Year
10+
7 - 10
4 - 6
2 - 3

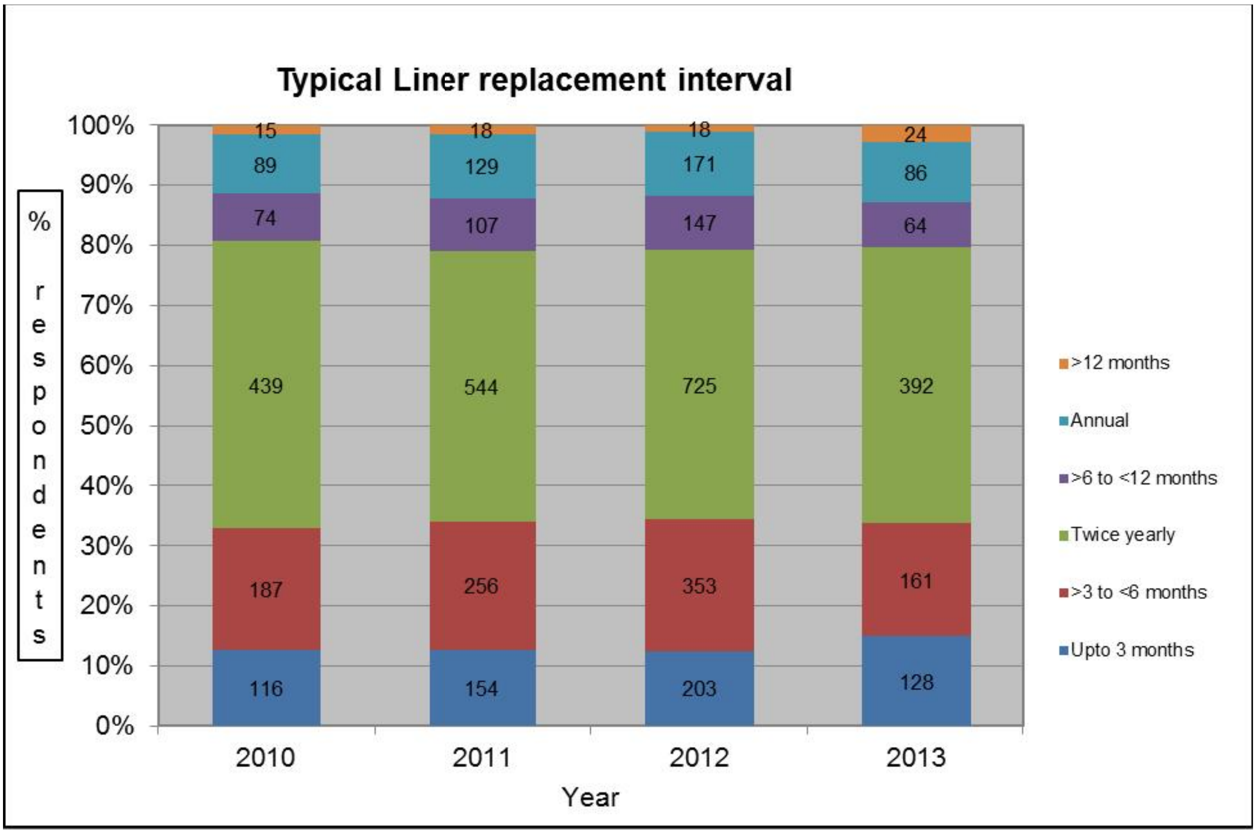

% Cases that recieve tubes & antibiotic therapy
% respondents
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
98
80
146
220
391
164
98
179
264
529
208
156
251
363
682
123
59
129
191
373
2010
2011
2012
2013
Year
>75
51 - 75
26 - 50
11 - 25
0 - 10

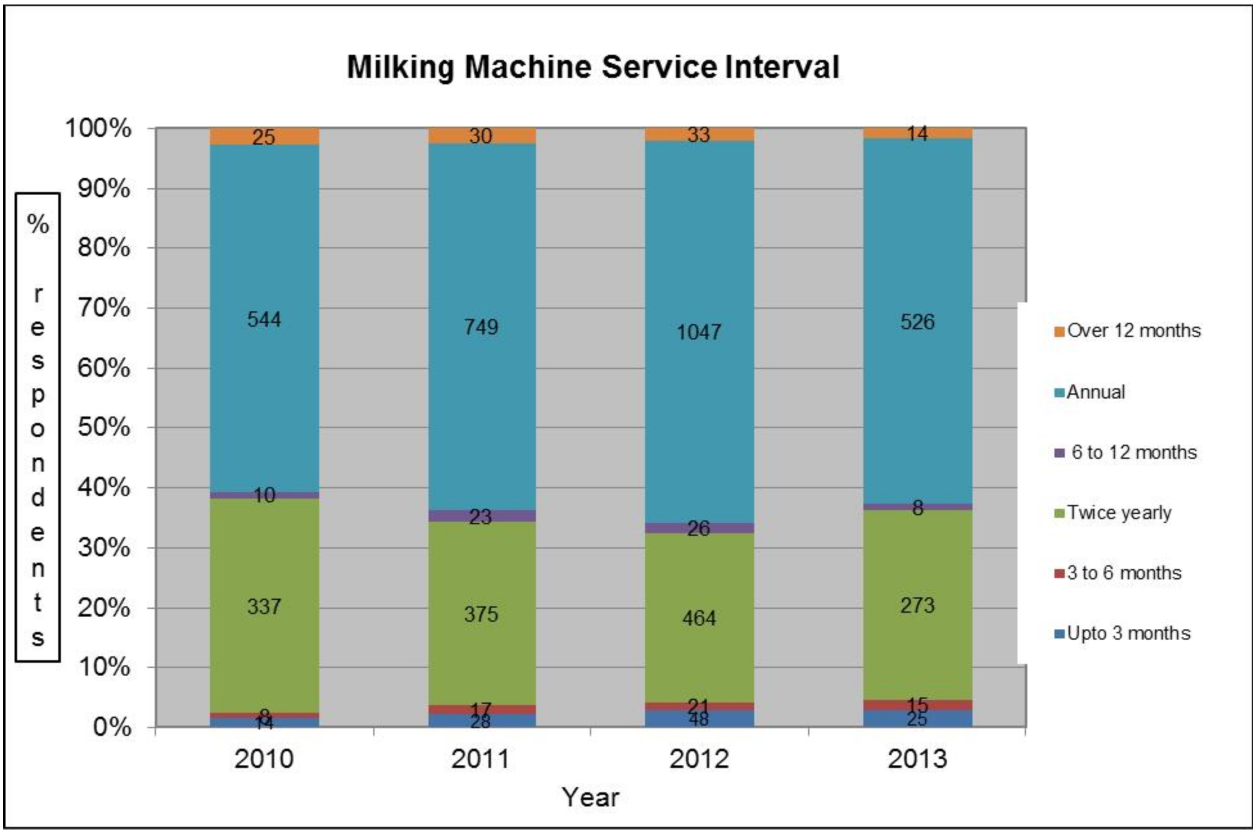

Stage Of Lactation You See The Most Mastitis
% respondents
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
64
286
1050
937
51
177
496
270
71
228
624
328
286
416
961
631
117
236
487
292
2009
2010
2011
2012
2013
Year
Late Lactation
Mid Lactation
30 - 100 days
First 30 days

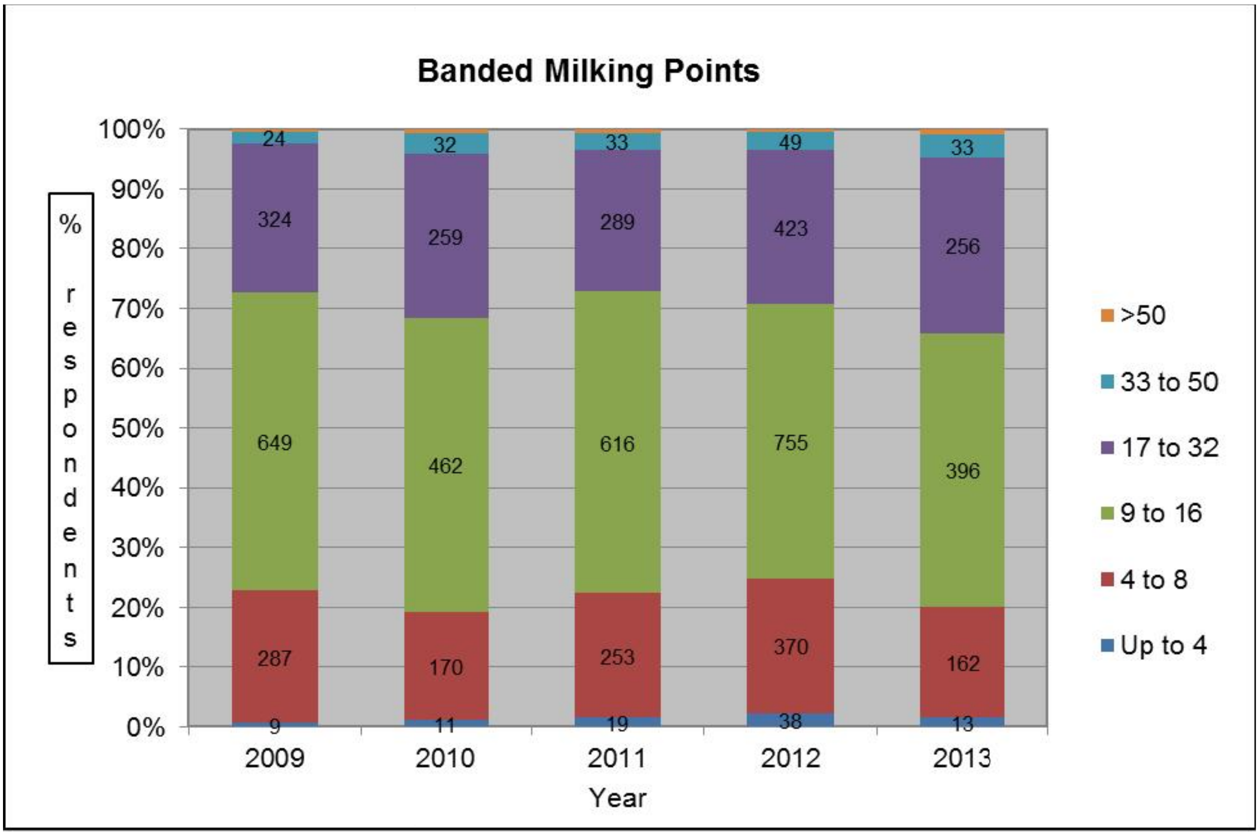

Estimate Heifers clinical mastitis in first lactation
% respondents
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
26
192
379
625
18
119
273
472
30
200
328
617
26
238
524
864
15
104
282
469
2009
2010
2011
2012
2013
Year
>50
26 - 50
11 - 25
6 - 10
0 - 5

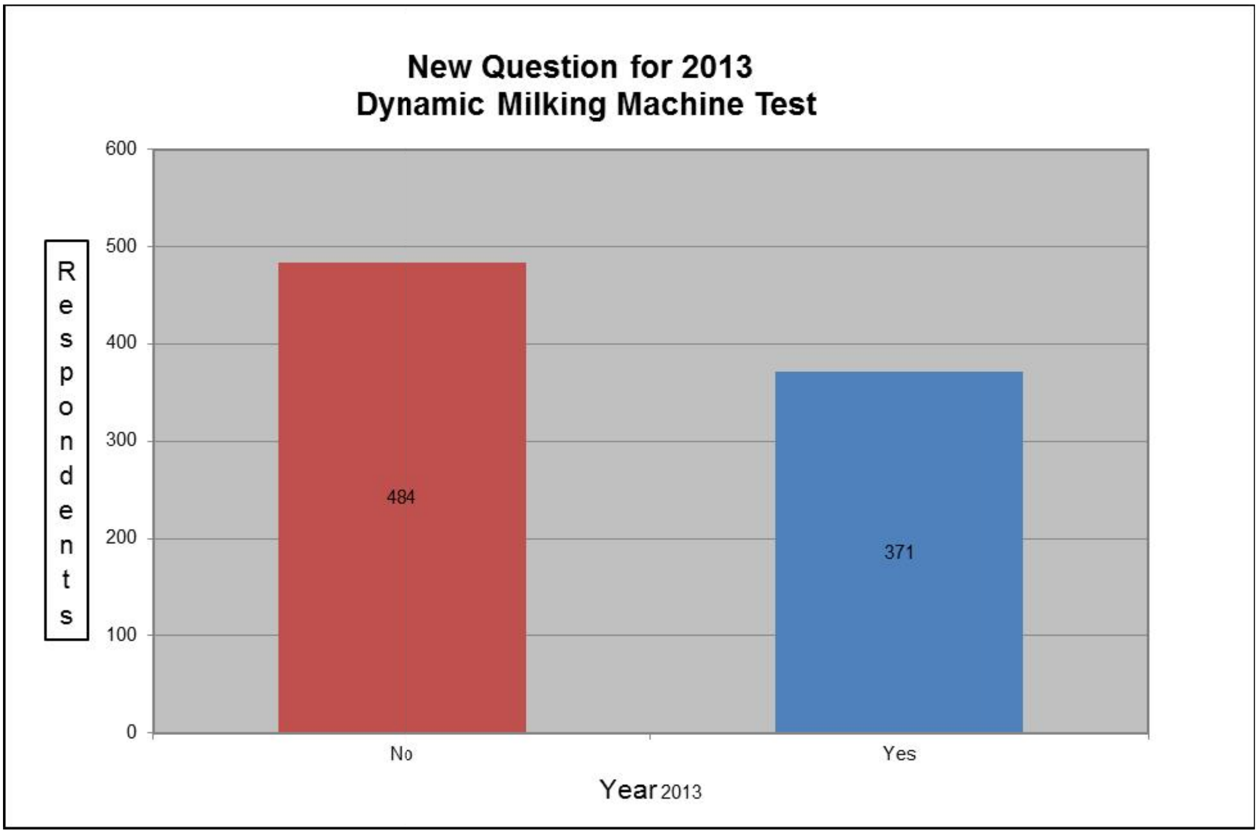

Do you treat High cell counts cows
% respondents
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
492
636
848
446
440
575
794
414
2010
2011
2012
2013
Year
Yes
No

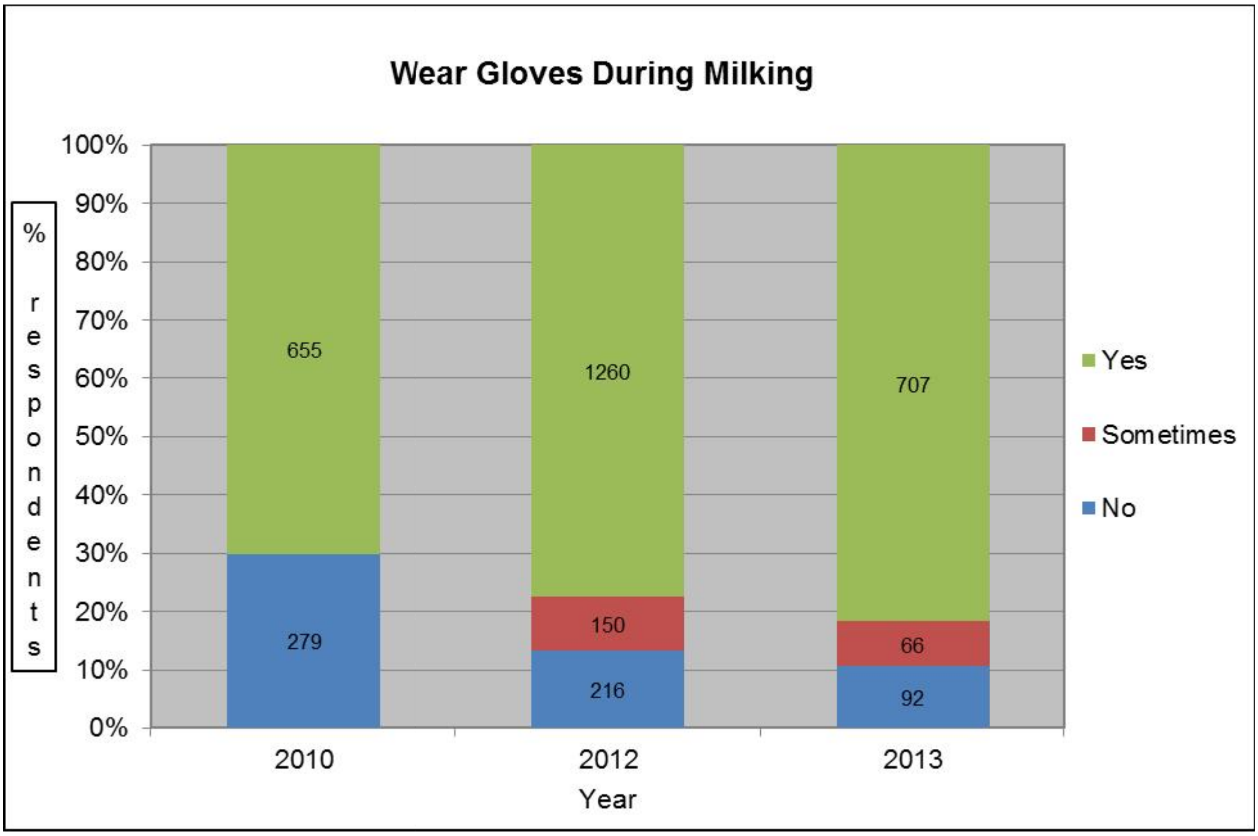

Which bacteria cause most mastitis in your herd
% respondents
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
773
566
779
1064
551
653
472
550
776
370
80
35
66
125
48
451
354
455
737
387
320
238
370
454
232
2009
2010
2011
2012
2013
Year
Strep uberis
Staph aureus
Other
E.coli
Don't Know

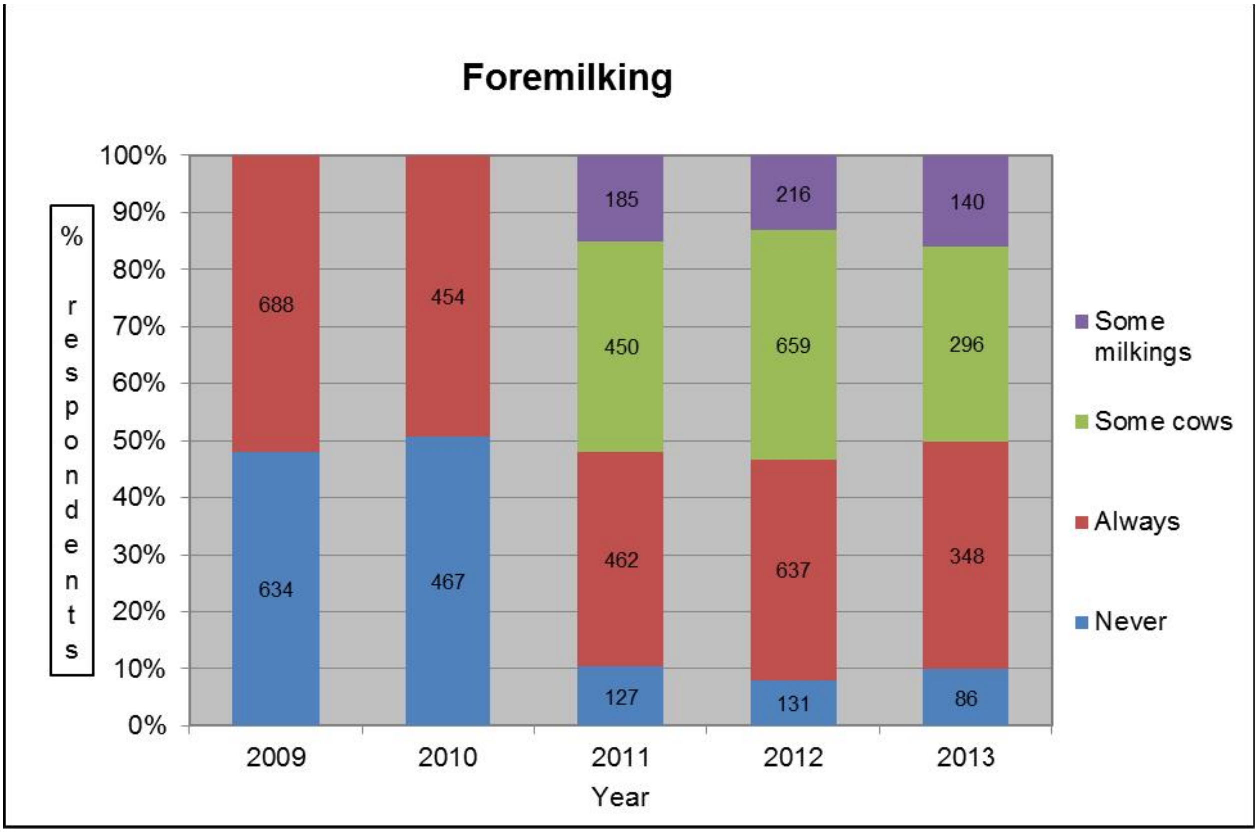

Typical Liner replacement interval
% respondents
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2010
2011
2012
2013
Year
>12 months
Annual
>6 to <12 months
Twice yearly
>3 to <6 months
Upto 3 months
15
89
74
439
187
116
18
129
107
544
256
154
18
171
147
725
353
203
24
86
64
392
161
128

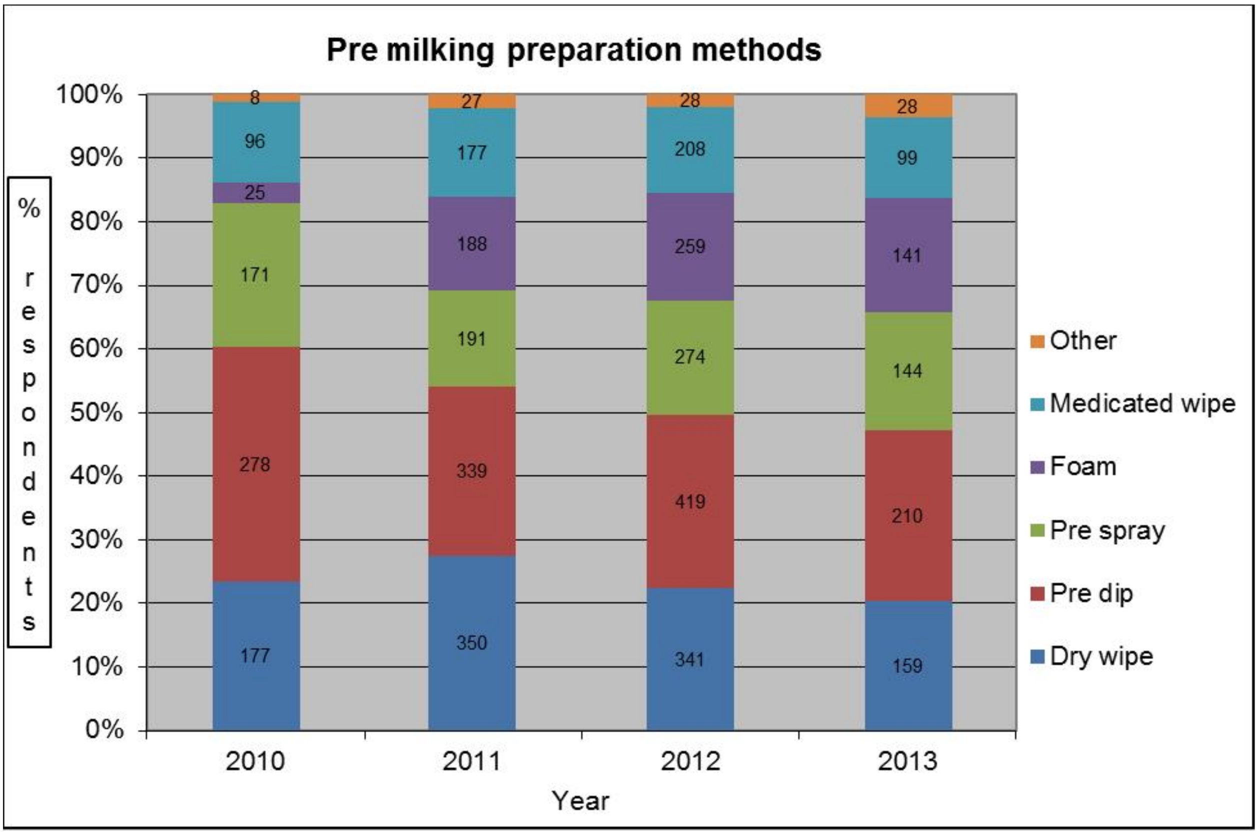

Milking Machine Service Interval
% respondents
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2010
2011
2012
2013
Year
Over 12 months
Annual
6 to 12 months
Twice yearly
3 to 6 months
Upto 3 months
25
544
10
337
8
14
30
749
23
375
17
28
33
1047
26
464
21
48
14
526
8
273
15
25

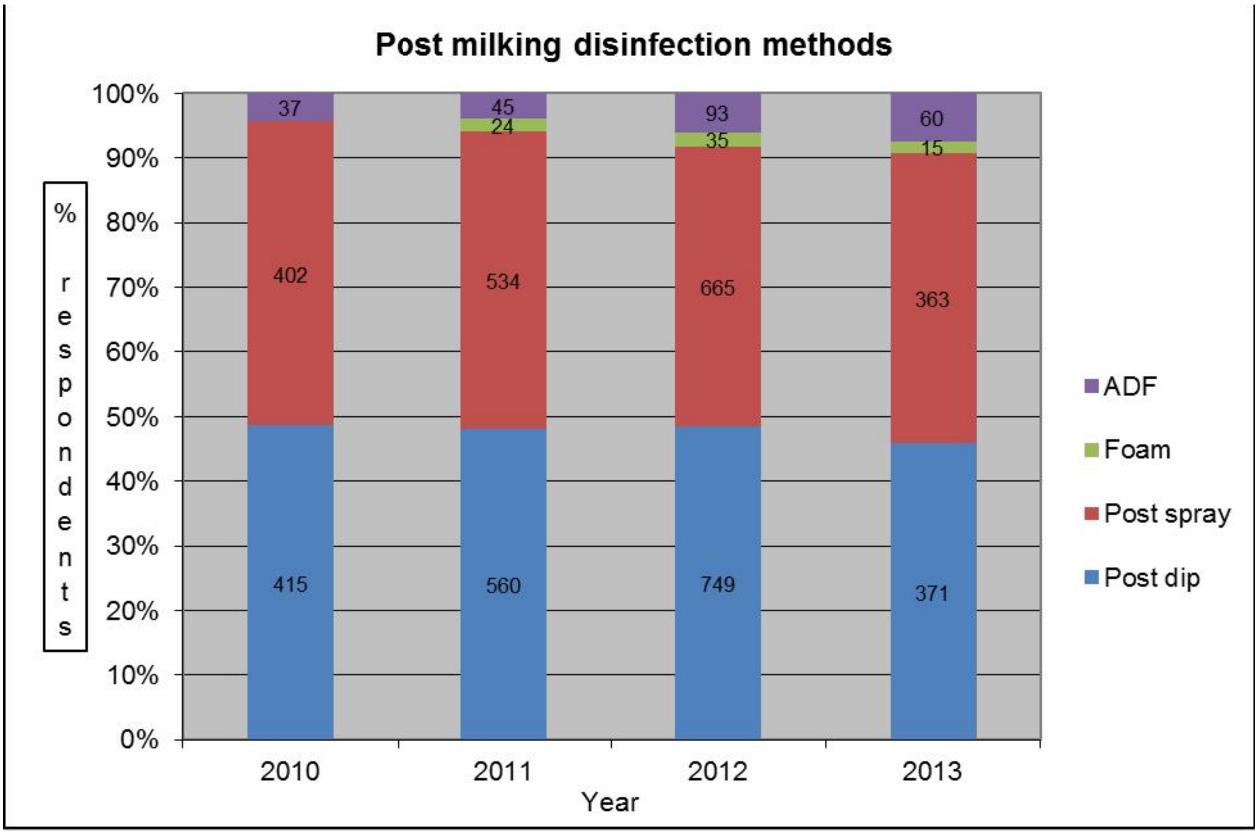

Banded Milking Points
% respondents
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2009
2010
2011
2012
2013
Year
>50
33 to 50
17 to 32
9 to 16
4 to 8
Up to 4
24
324
649
287
9
32
259
462
170
11
33
289
616
253
19
49
423
755
370
38
33
256
396
162
13

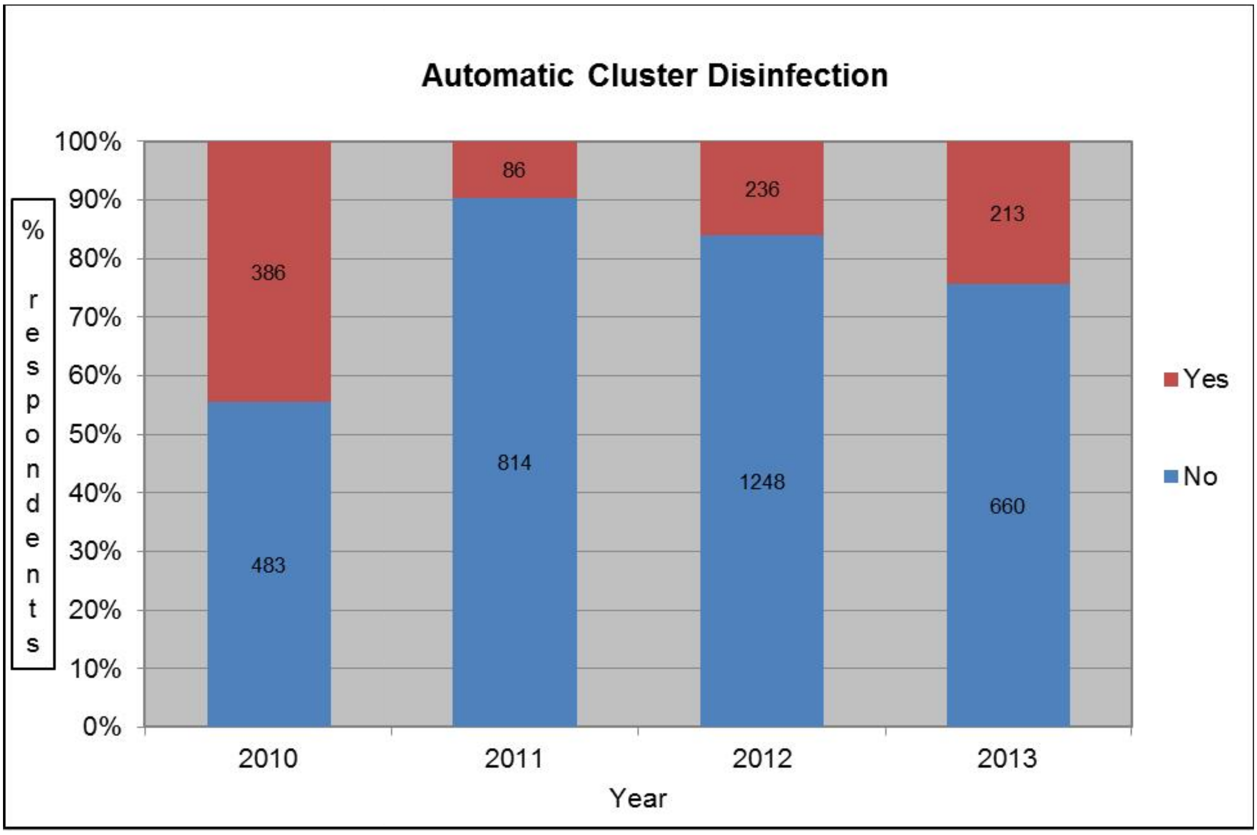

New Question for 2013
Dynamic Milking Machine Test
Respondents
600
500
400
300
200
100
0
484
371
No
Yes
Year 2013

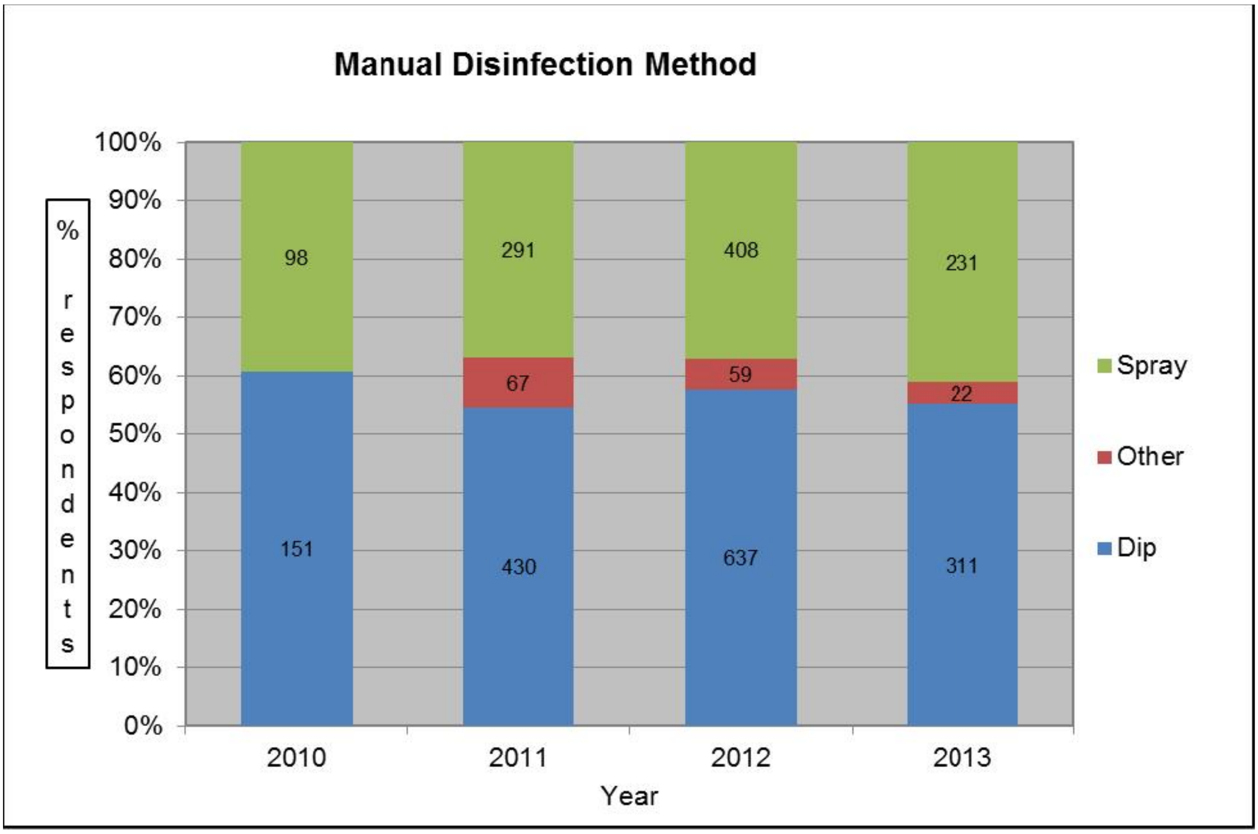

Wear Gloves During Milking
% respondents
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
655
279
1260
150
216
707
66
92
2010
2012
2013
Year
Yes
Sometimes
No

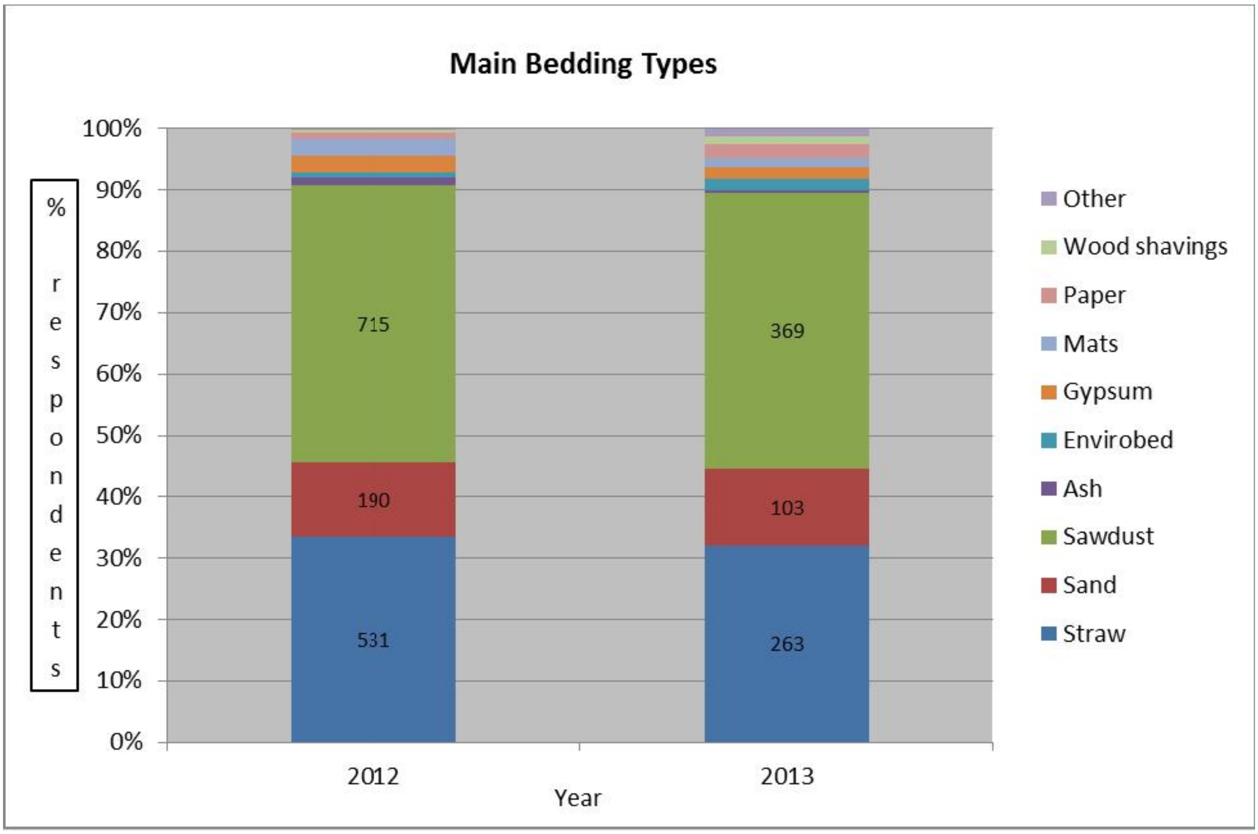

Foremilking
% respondents
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
688
634
454
467
185
450
462
127
216
659
637
131
140
296
348
86
2009
2010
2011
2012
2013
Year
Some milkings
Some cows
Always
Never

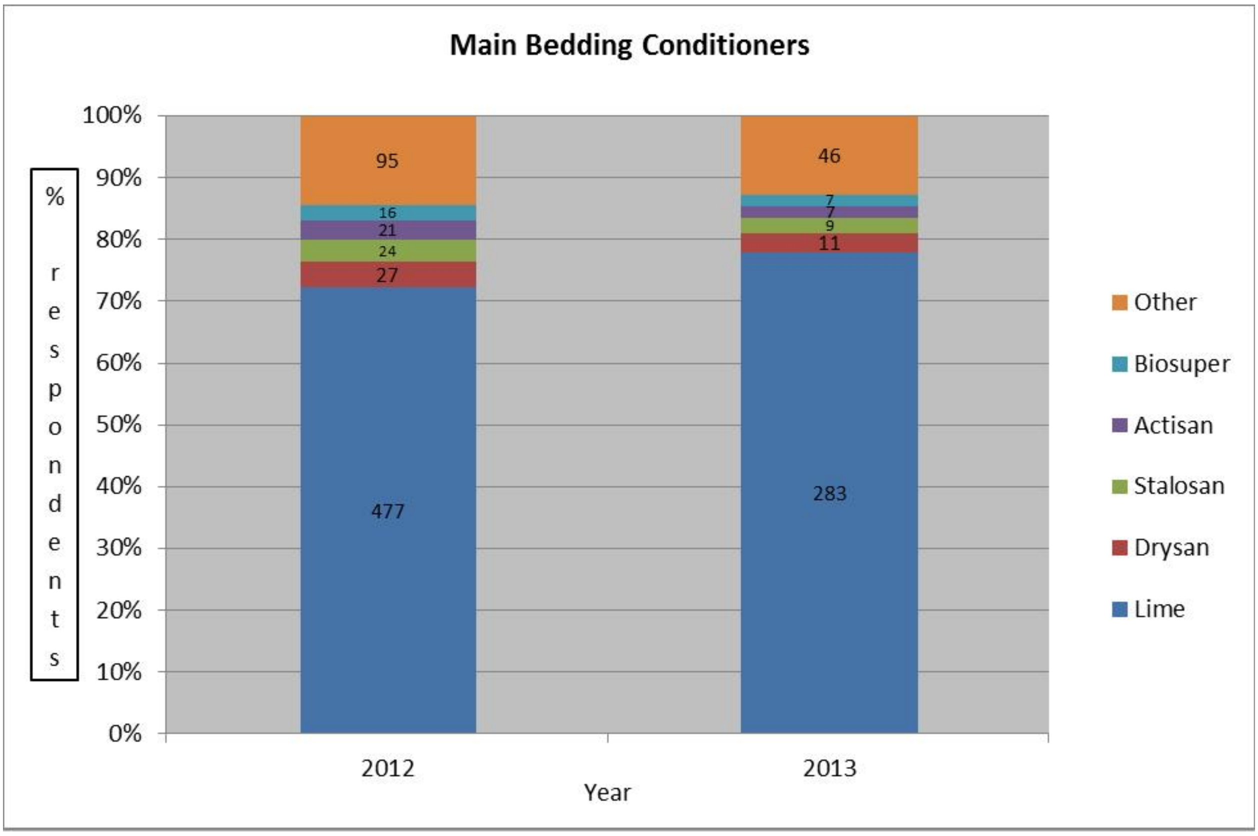

Pre milking preparation methods
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
% respondents
8
96
25
171
278
177
27
177
188
191
339
350
28
208
259
274
419
341
28
99
141
144
210
159
Other
Medicated wipe
Foam
Pre spray
Pre dip
Dry wipe
2010
2011
2012
2013
Year


Post milking disinfection methods
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
% respondents
37
402
415
45
24
534
560
93
35
665
749
60
15
363
371
ADF
Foam
Post spray
Post dip
2010
2011
2012
2013
Year


Automatic Cluster Disinfection
% respondents
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
386
483
86
814
236
1248
213
660
2010
2011
2012
2013
Year
Yes
No


Manual Disinfection Method
% respondents
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
98
151
291
67
430
408
59
637
231
22
311
2010
2011
2012
2013
Year
Spray
Other
Dip


Main Bedding Types
% respondents
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
715
190
531
369
103
263
2012
2013
Year
Other
Wood shavings
Paper
Mats
Gypsum
Envirobed
Ash
Sawdust
Sand
Straw


Main Bedding Conditioners
% respondents
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
95
16
21
24
27
477
46
7
7
9
11
283
2012
2013
Year
Other
Biosuper
Actisan
Stalosan
Drysan
Lime