

Mastitis in ewes: towards development of a prevention and treatment plan

Final Report

Selene Huntley and Laura Green

Background to Project

Mastitis is inflammation of the udder following bacterial infection. Financial costs arising from clinical mastitis in flocks rearing lambs for meat may be attributed to ewe treatment and mortality and lamb production losses from reduced milk production. This might result in neonatal lamb deaths and suboptimal weight gain.

Mastitis therefore has a considerable adverse economic effect on the UK sheep industry.

In order to understand how mastitis may be controlled, it is necessary to understand the levels of infection in a flock and its impact on productivity. In addition, improved knowledge of the disease process, including longitudinal patterns of infection, will contribute to our understanding of disease.

The current project comprised three longitudinal studies that were used

- to characterise the patterns of somatic cell count (SCC) in suckler ewes over the first 10 weeks of lactation
- to identify factors associated with intramammary infection (IMI) and the impact of IMI on lamb growth
- to investigate whether IMI may be reduced by the use of intramammary antibiotic treatment at dry off and the impact of dry-off treatment on productivity in the subsequent lactation.

Year1

Hypothesis;

Somatic cell count in meat ewes varies with time in lactation and can be used as a marker for intramammary infection.

Materials and Methods

A cohort of 48 ewes was followed for 8 weeks from lambing to weaning on one farm. Milk samples were collected weekly from each udder half of each ewe and analysed for somatic cell count (SCC) as a measure of inflammation in the udder. Corresponding samples were collected for bacteriological screening using a one plate culture technique.

The age of the ewe, the number of lambs reared and new teat lesions were also recorded. Somatic cell count was log transformed to normalise the outcome data. A multilevel model was constructed to analyse the data with examination as the first level and udder-half and ewe as the second and third levels respectively. Explanatory variables were included as fixed effects on the continuous outcome variable \log_{10} SCC, whilst the inclusion of examination number, udder-half and ewe as random effects accounted for the clustered nature of the data.

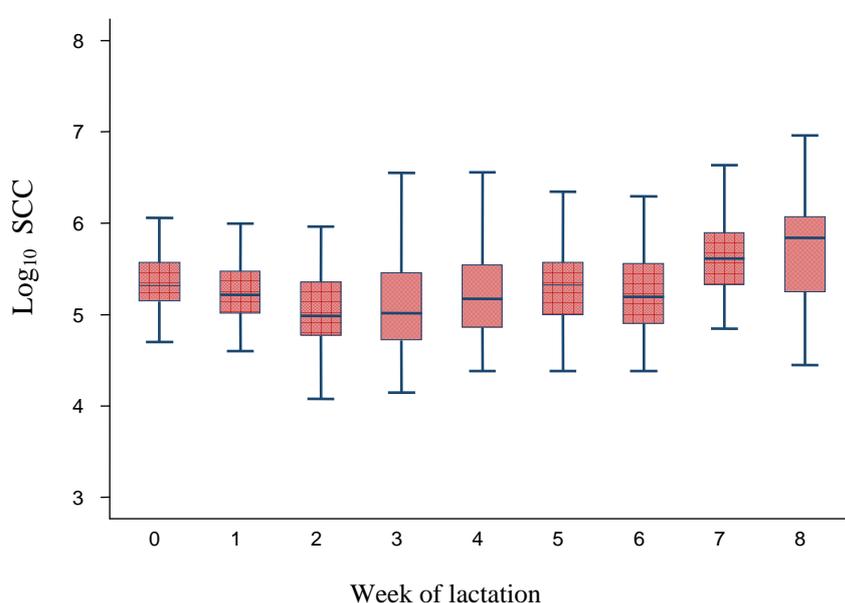
Key results:

The mean SCC through lactation was 724, 888 cells/ml.

Ewes older than five years of age had SCCs that were 13% higher than younger ewes ($P < 0.05$). The observation of *Mannheimia* or *Proteus* species from milk culture was associated with SCCs that were 28% higher and 3% higher than average respectively, whereas the observation of Gram negative bacteria was associated with SCCs that were 3% lower than average ($P < 0.05$).

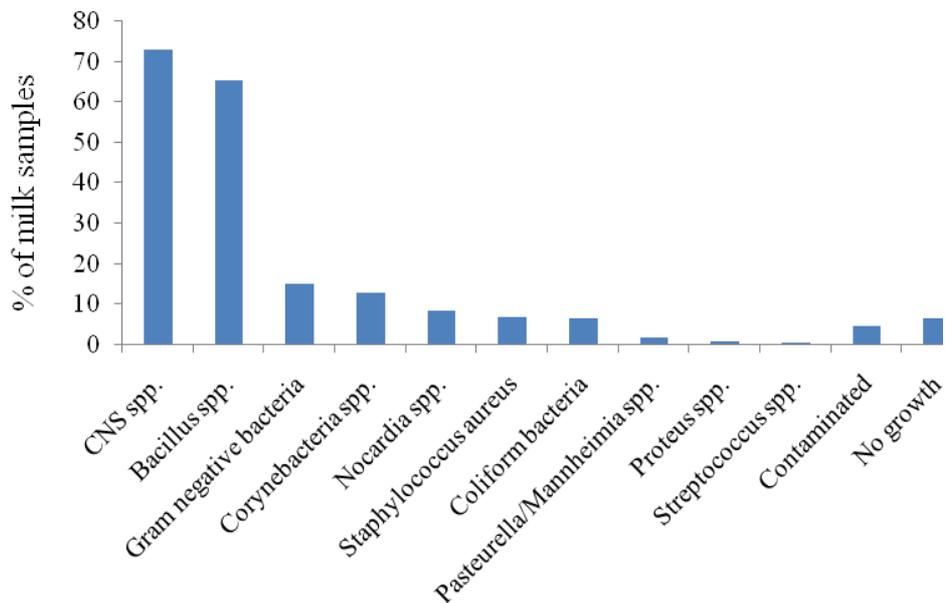
Somatic cell count was higher at lambing, decreased during lactation and then rose again towards the end of lactation (Figure 1).

Figure 1. Box and Whisker Plot of Log_{10} SCC by week of lactation



Bacteria were cultured from 93.7% ($n=627$) of milk samples, 4.3% ($n=29$) samples were contaminated and 6.3% ($n=42$) samples yielded no bacterial growth. The most common isolates were coagulase negative *staphylococcus* species ($n=488$, 72.9%) (Figure 2).

Figure 2. Percentage of positive bacterial isolates from milk samples



Discussion

An average SCC across lactation of ~725, 000 cells ml was observed. This value is high when compared to SCCs observed in dairy cows, where SCC > 200,000 cells/ ml is considered to be elevated and associated with udder infection. Although based on results from one farm, this high mean SCC, together with the high prevalence of bacteria cultured from milk throughout lactation, suggests that IMI of suckling ewes may be very common and that clinical cases of mastitis seen on commercial sheep farms may be the tip of an iceberg.

It was not possible to compare SCC of infected ewes with that of uninfected ewes in this study because of the low prevalence of uninfected udders. However, infection with some bacterial species, namely *Mannheimia spp* were associated with SCCs that were significantly higher than average, although the number of *Mannheimia* infections were low.

Conclusions

Somatic cell count of ewe milk exhibited a temporal trend over the first 8-10 weeks in lactation. Somatic cell counts were significantly higher in udder halves with *Mannheimia* infection, and in older ewes.

The proportion of milk samples that yielded bacterial growth was very high. Given the high values of SCC typically observed, we conclude that subclinical mastitis was very common in this flock.

Year 2

Introduction

From the study in year 1 we conclude that subclinical mastitis may be very common in suckling ewes. Thus a greater understanding of the impact on production and health of subclinical mastitis would be informative. In addition, the identification of potential risks for intramammary infection might assist in testing interventions to reduce IMI.

In dairy ruminants, subclinical mastitis is associated with lower milk yields. Thus in this study, where suckling ewes were the focus, the association of higher somatic cell counts with lower lamb weights over the first 8 weeks of age was investigated.

The association of other aspects of udder health (such as teat lesions) with lamb weight were also assessed.

Ewe level factors associated with higher somatic cell counts were further investigated, building on the findings from the Year 1 study.

Hypotheses:

Udder infections (as measured by SCC) in the first 8 -10 weeks of lactation are associated with low ewe body condition, poor udder conformation and the occurrence of teat lesions.

Lower lamb weight in the first 8 weeks of lactation is associated with udder infection (as measured by SCC), teat lesions and poor udder conformation.

Methodology

A cohort of 67 ewes was followed from January to May 2010 on one farm. Ewe body condition, udder conformation, teat placement and teat lesions were recorded within two days of lambing together with the number, sex and weight of lambs. Every 2 weeks each lamb was weighed and a milk sample was collected from each udder half for somatic cell counting. Detailed udder conformation scores (drop and teat position) and measurements (height and width) were recorded 2 weeks after lambing.

A multilevel model was constructed with weight of lamb as the outcome variable. There were three levels in the model: ewe, lamb and repeated measure of weight. A second multilevel model was constructed with \log_{10} SCC as the outcome variable and with ewe, udder half and repeated measures of SCC as random effects.

Key results

Significantly lower lamb weights were observed when the ewe had a mean $SCC > 400,000$ cells/ml (-1.70 kg), a non-traumatic teat lesion (wart, orf-like lesion or spot) (-0.65kg), or had had a traumatic teat lesion (bites, tears or chapping) 2 weeks previously (-1.1kg). Lambs also weighed significantly less when the lamb had diarrhoea (-1.15kg).

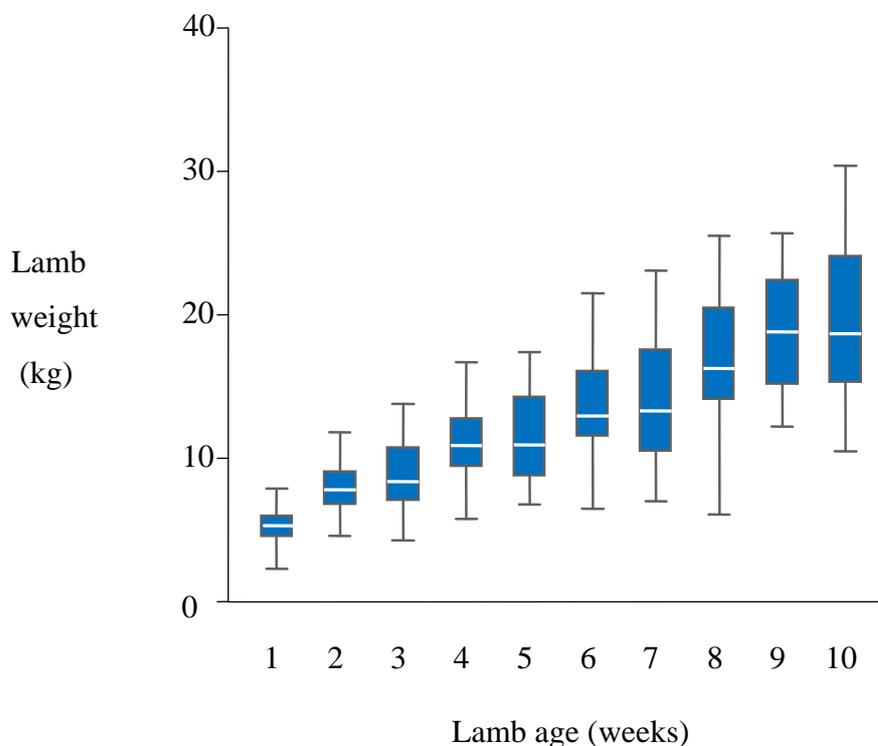
Lambs reared by a ewe that was in BCS of 2.5 or less before lambing weighed significantly less (-1.30 kg) than those reared by ewes in BCS of 3 or more. Lambs reared as a twins also weighed significantly less (-1.67kg) than those raised as singles.

Higher lamb weight was significantly associated with increasing lamb age in days (0.22kg / day) and a heavier birth weight (1.56 kg/kg).

The associations of the variables ewe age, teat position and supplementary feed before lambing with lamb weight could not be presented because of their high correlations with ewe BCS before lambing.

A plot of mean lamb weight over weeks of age is presented in Figure 3.

Figure 3. Box and whisker plot of mean lamb weight by weeks of age



Higher somatic cell counts were associated with pendulous udders (9.6% increase in SCC per cm increased drop) and larger total teat cross-sectional area (cm²) (7.2% increase of SCC per cm²). Somatic cell counts were also significantly higher in older (>5 years) that were thin (<BCS 2) during lactation.

Lower somatic cell counts were associated with higher average lamb litter weight (6.7% decrease in SCC per kg).

Discussion

High SCCs were present in older and thinner ewes, and in those with a greater drop of the suspended udder and larger teats, indicating that these ewes have higher levels of subclinical udder infection.

Lower lamb weights were observed in lambs reared by ewes with teat damage and those with a mean SCC greater than 400,000 cells/ml. Lambs reared by ewes in BCS of 2.5 or less before lambing weighed less than those reared in BCS of 3 or more. However, it was not possible to assess the association of ewe age, abnormal teat position or days supplementary feed with lamb weight as all were highly correlated with BCS. The effect of BCS on lamb weight was presented, as this was deemed to be of most useful and practical importance for farmers.

Future work focusing on improved udder and teat conformation could reduce intramammary infections and contribute to higher lamb growth rates. This study successfully demonstrated the importance of overall udder health and identified some potential practical approaches that farmers can make to maintain long term flock udder health and to maximise lamb production. Appropriate feeding of ewes through late gestation and lactation whilst monitoring ewe body condition may reduce the risk of subclinical mastitis and teat lesions and help maximise lamb weight growth.

Year 3

Hypothesis:

The Year 2 study demonstrated that high SCC was associated with lower lamb growth rates. Thus we wanted to test the hypothesis that treatment with a broad-spectrum intramammary antibiotic at weaning (dry off treatment) was associated with a decreased risk of subclinical mastitis (SCCs are lower, lambs weigh more through early lactation) or a decreased risk of clinical mastitis in the subsequent lactation.

Materials and Methods

Two farms were convenience selected to take part in the study. The first farm (Farm A) had a reported annual prevalence of clinical mastitis of <1% and thus the focus was on subclinical udder infection. The second farm (Farm B) had a reported annual prevalence of clinical mastitis of 5-10% and thus the focus was on clinical mastitis.

On both farms, ewes were enrolled into the study at weaning and randomly selected for treatment or control and for somatic cell counting. In ewes selected to receive treatment, a broad spectrum intramammary antibiotic treatment (Ubro Red, Boehringer Ingelheim) was aseptically administered into both udder halves at drying-off, using a fresh whole tube for each udder half. Before treatment, equal numbers of treated ewes and untreated ewes on each farm were sampled for somatic cell counting

On Farm A, the health of the udder was assessed by recording lamb weight from untreated and treated ewes at lambing and then at fortnightly intervals until they were 8 weeks of age. Ewes that had milk samples collected for somatic cell counting at weaning were re-sampled within 1-3 days of lambing, and at 4 weeks and 8 weeks in lactation.

On Farm B, all ewes on the farm were observed for clinical mastitis between September 2010 to September 2011, and cases were recorded by the farmer.

Key results

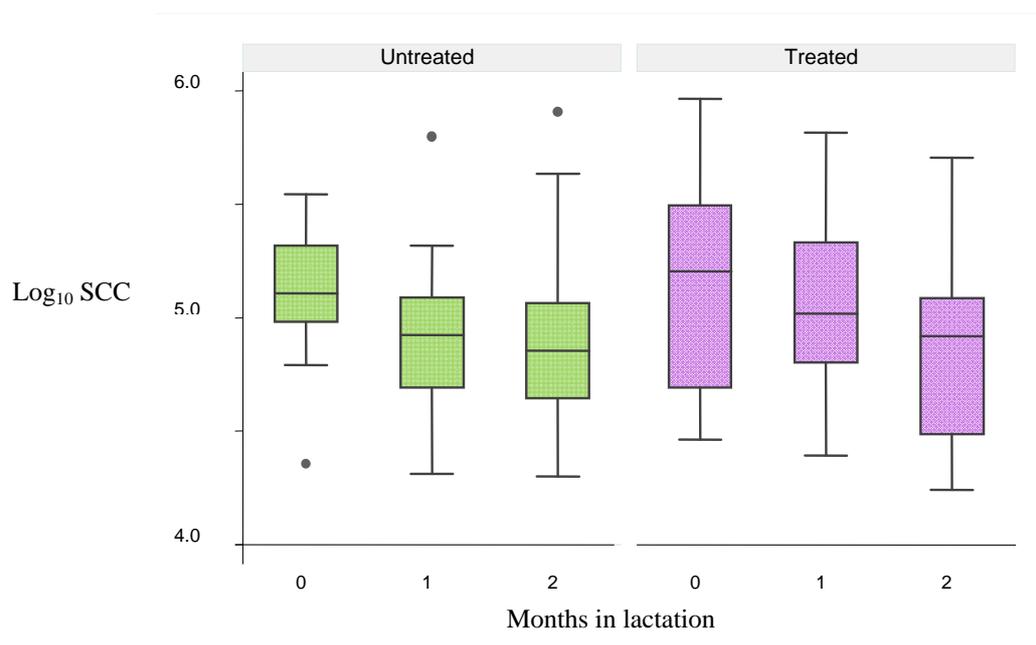
The incidence of clinical mastitis was significantly lower ($P < 0.05$) in treated ewes (3%) compared to untreated ewes (6%) on Farm B (Table 1).

Table 1. Number of mastitis cases observed in untreated and treated ewes

		Mastitis		
		No	Yes	Subtotal
Treated	No	598	38	636
	Yes	388	12	400
	Subtotal	986	50	1036

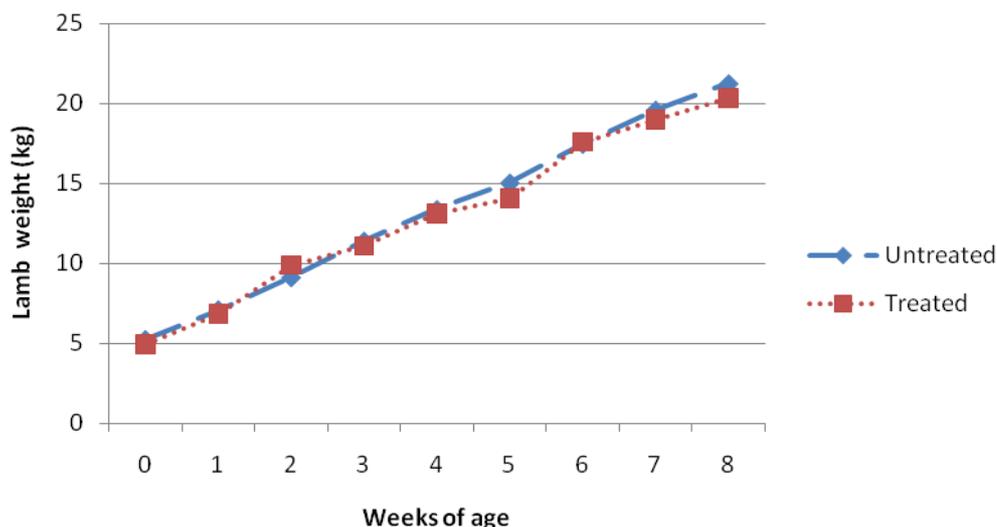
However, on Farm A, dry off treatment had no significant effect on somatic cell count levels of 16 untreated ewes and 17 treated ewes that were milk sampled (Figure 4). There was also no effect of dry-off treatment on lamb weight in the first 8 weeks of lactation of 194 lambs reared by 52 untreated ewes and 56 treated ewes (Figure 5).

Figure 4. $\text{Log}_{10}\text{SCC}$ in treated and untreated ewes by months in lactation



The pattern of SCC was higher at lambing than in the subsequent stages of lactation although not significantly so. This trend was seen in other years of the study although robust comparison between weekly SCC pattern in Years 1 and 2 compared to Year 3 was not possible because monthly rather than weekly observations of SCC were made, and relatively few ewes were followed for somatic cell counting in Year 3.

Figure 5. Mean lamb weight (kg) over the first 8 weeks of age of lambs reared by treated and untreated ewes



Discussion

The results of this study show that the use of dry off treatment was effective in preventing clinical mastitis, reducing the incidence by 50% on a study farm with high levels of clinical mastitis. This suggests that many of the ewes that developed clinical mastitis were already infected at weaning with the bacteria that caused clinical mastitis in the subsequent lactation.

In contrast, there was no significant effect of dry-off treatment on the levels of subclinical mastitis as measured by SCC of milk from ewes on a different study farm, with low-levels of clinical mastitis. This is surprising as one might expect a fall in SCC following removal of bacteria at the beginning of the dry period. It is possible that bacteria were able to enter the udder during the dry period after the antibiotic had decreased in efficacy but then one might expect this to have also occurred in the flock where there were high levels of clinical mastitis. Another explanation is that levels of IMI of ewes in this flock at weaning were not high enough for dry-off treatment to make a discernable difference to SCC in the subsequent lactation.

There was also no significant effect of dry-off treatment on lamb weight which is not surprising given that there was no difference in SCC of milk from treated and untreated ewes. It is unlikely that the lack of effect on the subclinical study farm was due to treatment failure due to incorrect administration of the preparation as the same technique was used on both study farms.

The use of dry-off treatment may be a useful approach for flocks with high levels of clinical mastitis, although decisions on whether to employ this strategy are likely to be influenced by the costs of treatment (see cost-benefit analysis below). However, dry off therapy is not an appropriate management tool to minimise intramammary infection in flocks with low levels of clinical mastitis.

Limitations of the study should be considered in extrapolating these results to the sheep industry. Only two farms were used in the study, one for each of the subclinical and clinical parts of the trial, thus robust conclusions on the efficacy of treatment on other farms cannot be drawn. The antibiotic preparation used in the trial that is not licensed for sheep and was selected for its broad spectrum antibiotic efficacy on IMI and clinical mastitis in cows. Although there was a significant clinical effect on the clinical trial farm, it should be noted that the flock was discovered to have a high flock seroprevalence (>80% estimated seroprevalence) of Maedi Visna which may have had an effect on the results.

Cost benefit analysis:

For a farm with 10% annual incidence of clinical mastitis, assuming that each case of clinical mastitis costs £13*, the price of intramammary dry-off antibiotic would need to be less than 65p per ewe to make dry-off treatment cost effective. However, such a low price of intramammary antibiotic preparation is unrealistic. The treatment cost of each ewe in the study was estimated at £4 per ewe, with one £2 antibiotic tube being administered per udder half ** (These were provided free of charge for the study by Boehringer Ingelheim)

At a price of £2 per tube, the annual incidence of clinical mastitis on farm at which such a prophylaxis would be cost effective is 62%. Such a high incidence is very unlikely, even on farms which are considered to have a mastitis problem.

This is an extremely rudimentary cost benefit analysis and is intended for guidance only. It does not include estimates of labour or time costs of treatment, or losses of production due to impaired lamb growth. As such the figures should be interpreted with caution.

*Clinical mastitis cost = replacement costs (£12.30***) + 1 injection of a commonly used long acting antibiotic such as Betamox LA (70p). This assumes that such a treatment is the minimum that may be expected for animal welfare but is generally ineffective in the long term with the udder half becoming non functional and subsequent replacement before the next lambing season.

**The estimated cost of treatment per ewe based on internet searches of purchase bulk buy costs of of Ubro Red (£2 per tube, £4 per ewe).

***Eblex, 2011, Eblex Business Pointers, Sheep and Beef enterprise tables 2010/2011 (http://www.eblex2.co.uk/documents/content/returns/brp_lambing_flocks_per_ewe_211011.pdf)

Conclusions

Treatment with dry off therapy may be of benefit in flocks with a high incidence of clinical mastitis to minimise livestock losses, although such a strategy would be highly constrained by the price of dry-off preparation. Based on a simple cost-benefit analysis, we cannot recommend the use of this treatment for the realistic cost effective reduction of clinical mastitis on farms. Such therapy is also highly unlikely to be of benefit in the reduction of levels of subclinical disease on farms with a low incidence of clinical mastitis. These conclusions are based on results on one study farm for each of the two parts of the trial and therefore we cannot robustly make claims for all sheep farms.

Overall conclusions from project

This project demonstrated that subclinical mastitis is very common in suckling ewes and that the majority of udder infections are manifest as subclinical mastitis rather than clinical disease.

Subclinical mastitis does have an impact on production thus farmers should be aware of the importance of maintaining udder health in order to maximise production. We demonstrated that older ewes, those in poor body condition and those with poor udder conformation were at greater risk high SCC.

Meanwhile subclinical mastitis was associated with suboptimal weight gain in lambs over the first 8 weeks of life. Teat lesions (which may be an indicator of suboptimal nutrition), poor udder conformation and old ewes were also associated with lower than expected lamb weights over the first 8 weeks of age.

Optimisation of udder health is best achieved through appropriate management decisions which include appropriate feeding of ewes through gestation and early lactation, vigilance in observation for udder problems, (for example by tipping the ewe to observe for teat lesion in early to mid lactation) and not retaining ewes with poor udder conformation or very old ewes for tugging. Farms with high levels of clinical mastitis may benefit from the adoption of use of dry off treatment as part of their disease risk mitigation strategy although the financial costs of involved would need to be carefully considered.

Impact of project

This project has identified the importance of udder health on production and identified hypotheses for routes to improve udder health. Two clear areas for further investigation are the role of good udder and teat conformation on intramammary infection and the persistence of bacteria in the udder over lactations.

Acknowledgements

We are grateful to EBLEX for funding this project and to Boehringer Ingelheim for providing Ubro Red intramammary antibiotic treatment free of charge. We thank the farmers who kindly permitted us to carry out the studies on their farms.