MASTITIS IN DANISH ORGANIC DAIRYING

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SUMMARY

An overview is given of the development of Danish organic dairy farming with special emphasis on udder health and handling of mastitis during the past decade. Risk factors and challenges, which exist within the organic production system, are discussed. Treatment strategies are discussed briefly. It is concluded that the mastitis situation in organic herds does not differ from the situation in conventional herds – and in cases where it does, it has not been in favour of the organic production system during the past few years. Former studies in ‘old organic herds’ indicate a better udder health in the study herds, which was explained by care-taking and consequent intervention when needed. One of the major future challenges is the search for solutions, in accordance with the organic ideas and goals, to improve the mastitis to organic milk production.

INTRODUCTION: ORGANIC DAIRY PRODUCTION IN DENMARK

Organic dairy farming can be defined by a set of basic ideas and values. On the overall farm level, recycling of nutrients, closeness between farming society and consumers (2,3), and harmony between levels in the farm (e.g. number of animals per hectare) are important. Organic farming involves a set of governmental legislation and rules, whose overall purpose is to explain practically how organic farmers may ‘live up to the organic production method’.

- 85% organic food; no feed additives. A recent agreement between dairy farmers and dairies that organic cows are fed 100% organic food.
- Calving must be carried out in calving pens.
- Cows and calves must stay together for at least 24 hours after calving.
- All animals must receive littered bedding.
- Group housing of calves is called for after one week.
- The suckling instinct of the calf must be satisfied (through the use of teat buckets, nurse cows or blind teats).
- Animals older than 3 months must have access to grazing for 150 days during summer.
- All antibiotic treatment of dairy cows must be administered by a veterinarian. The initial treatment of calves with antibiotics and other drugs must be administered by a veterinarian, but with calves, the farmer can administer subsequent treatment for 5 days, if the calf’s identification and the date are clearly indicated on the medicine bottle.
- No prophylactic medical treatment of disease is allowed.
In Denmark, organic dairy production has increased rapidly over the past few years. During a 5-year period, the number of organic dairy herds increased from 132 to 722 in December 2000 (almost stagnating from 1999 until now). Now, organic milk comprises approximately a quarter of the Danish milk for direct consumption, and approximately 7% of the total amount of milk received at the dairies from farms. Organic dairy herds are usually big; in average 87.3 cows/year in herds with dual-purpose breeds, and 74.9 in Jersey herds. There were 65.7 cows/year in 2000 in average in Danish dairy herds overall. The average milk production per cow was approximately 7500 kg (4% fat content) for dual-purpose breeds, and around 6500 kg (4% fat content) for Jersey cows. The total amount of organic milk was 333 million kg in 1998 (in Denmark), increased from 39 million kg in 1993!

In the organic production system, a lot of challenges are given with regard to handling disease. In the dairy herd, mastitis is definitely the most dominant disease problem. Risk factors connected to the environment, the organic rules and the structure of organic milking herds can be mentioned – and in each case, more of these will most likely be involved, since the causal background for mastitis and udder health problems definitely is very complex.

In the following, aspects of mastitis in organic dairy farms will be discussed. Examples from Danish studies will lead to a discussion about potential risk factors for mastitis given within the organic production system. Mastitis treatment in organic dairy farming will shortly be discussed. Finally, future challenges and perspectives will be presented for future discussion.

**The mastitis situation in organic dairy production**

**The current mastitis situation in Danish organic dairy herds**

Based on bulk milk somatic cell counts and milk quality (Table 1), no difference between organic and conventional milk production seems to be present in Denmark.
Table 1.  Somatic cell count (bulk milk delivered to dairies) data from organic herds from 1996-2000. As a background, the average for all herds (including organic herds) in Denmark, is given.

<table>
<thead>
<tr>
<th>Year</th>
<th>Organic dairy herds</th>
<th></th>
<th></th>
<th>Denmark (all dairy herds)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Geom. Average (x1000)</td>
<td>% lower than 100,000</td>
<td>% higher than 400,000</td>
<td>Geom. Average (x1000)</td>
<td>% lower than 100,000</td>
<td>% higher than 400,000</td>
</tr>
<tr>
<td>1996</td>
<td>255</td>
<td>2.3</td>
<td>11.7</td>
<td>243</td>
<td>3.5</td>
<td>11.3</td>
</tr>
<tr>
<td>1997</td>
<td>260</td>
<td>2.4</td>
<td>13.8</td>
<td>247</td>
<td>3.2</td>
<td>11.7</td>
</tr>
<tr>
<td>1998</td>
<td>254</td>
<td>2.0</td>
<td>10.9</td>
<td>241</td>
<td>3.3</td>
<td>10.2</td>
</tr>
<tr>
<td>1999</td>
<td>268</td>
<td>1.5</td>
<td>13.4</td>
<td>253</td>
<td>2.6</td>
<td>11.9</td>
</tr>
<tr>
<td>2000</td>
<td>250</td>
<td>2.0</td>
<td>9.7</td>
<td>239</td>
<td>3.5</td>
<td>9.4</td>
</tr>
</tbody>
</table>

In a recent study, the udder health situation in a number of Danish organic dairy herds did not differ from the situation in conventional herds, measured through the same period (Table 2).

Table 2.  Key figures for production and udder health in 27 organic and 57 conventional herds (participating in the project on development of health advisory service in Danish organic herds and in the Kongeå-project, respectively), during the period December 1998 to December 1999 (8,22)

<table>
<thead>
<tr>
<th>Production and udder health parameter</th>
<th>Organic</th>
<th>Conventional</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>25%</td>
<td>75%</td>
</tr>
<tr>
<td>Number of cows per year</td>
<td>74</td>
<td>130</td>
</tr>
<tr>
<td>Milk yield in 1st lactation cows, EKM per day*</td>
<td>19.7</td>
<td>23.0</td>
</tr>
<tr>
<td>Milk yield in &gt;3rd lactation cows, EKM per day</td>
<td>22.8</td>
<td>28.8</td>
</tr>
<tr>
<td>Mastitis treatments, % lactating cows per month</td>
<td>1.8</td>
<td>5.1</td>
</tr>
<tr>
<td>Acute increase in SCSCC, % lactating cows/month</td>
<td>5.4</td>
<td>7.5</td>
</tr>
<tr>
<td>Chronic elevated SCSCC, % lactating cows</td>
<td>9.4</td>
<td>18.6</td>
</tr>
<tr>
<td>Bulk milk SCC (calculated from SCSCC)</td>
<td>260</td>
<td>401</td>
</tr>
</tbody>
</table>

*EKM = kg milk with 4% fat content
'An old Danish case': what can we learn from that about mastitis handling?

From 1991-1994, a Danish on-farm research project including 15 organic dairy herds took place. Since a parallel project in conventional dairy herds was carried out, it was possible to compare udder health between the two study groups. The pattern of micro-organisms involved in clinical mastitis cases did not differ significantly from that found in conventional herds (23). Few coliforms were cultivated, but 20% of the samples were no-growth-cases, and could potentially have been coli-cases. As shown in Table 3, the udder health – expressed through a number of different parameters – was found to be better in organic dairy herds than in conventional herds.

Table 3. Results from organic and conventional herds participating in on-farm studies at Research Centre Foulem in the early 1990s (24). Only herds having monthly milk yield control on single cow level are included in this Table (12 organic and 20 conventional herds)

<table>
<thead>
<tr>
<th>Udder health parameters</th>
<th>Organic herds</th>
<th>Conventional herds</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Median</td>
<td>10-90% percentiles</td>
</tr>
<tr>
<td>Mastitis treatment, % of lactations</td>
<td>5</td>
<td>0-14</td>
</tr>
<tr>
<td>SCC, % cows &gt;500,000 cells/ml</td>
<td>14</td>
<td>3-26</td>
</tr>
<tr>
<td>Sub-clinical mastitis, % cows</td>
<td>28</td>
<td>11-44</td>
</tr>
<tr>
<td>SCC(x1000) at herd level, based on SCSCC</td>
<td>240</td>
<td>148-452</td>
</tr>
<tr>
<td>Bulk milk SCC (x1000)</td>
<td>210</td>
<td>90-350</td>
</tr>
</tbody>
</table>

Since these herds were followed for a number of years, and daily management routines were explored both through interviews and through observation, the way of handling mastitis and preventing disease in general was well described (19). With regard to mastitis, no ‘particular and distinct organic characteristics’ could be identified. The fact that they were fed with organic food, were grazed during summer and had access to straw bedding did not seem to create any clear and unambiguous difference, compared to conventional farms. There was wide variation within both groups (conventional and organic). One factor, that seemed to characterise the majority of organic farms, was the relatively high degree of what was characterised as care-taking. Included in these routines were extra milking-out by hand between machine milking very early in a mastitis case, providing of extra bedding in critical situations (e.g. after calving), and careful inspection of milk and udders. A high degree of consequent intervention – also very work demanding intervention such as udder massage and milking-out by hand, as mentioned above – was described in many of the organic herds participating in the study. The difference is consequently not explained by ‘being organic’ – but rather by ‘being good dairy herd managers’, and having time enough to take care of the cows and
the preventive (and health promoting) efforts as a part of the daily routines. The basic ideas of organic farming can be claimed to stimulate such an effort – in combination with the restrictive antibiotic policy. In interviews, many of these farmers described a ‘conversion in the herd’ which made them feel responsible for their own animals in a different way to before, when they considered a veterinary treatment to be sufficient in order to solve a mastitis case. When referring to recent studies in newly converted organic herds, this ‘conversion’ with regard to care-taking routines to a similar level as described above, does not seem to have taken place (yet?) in the new organic herds. The pressure on the organic farm – demanding less working hours per animal per year – may not allow such an effort towards single animals, groups of animals or the whole herd. This must be regarded as a substantial challenge for organic dairy farming: when claiming that animal welfare should be increased through non-medical methods, a structure allowing this should definitely be allowed within the system. Otherwise, organic dairy farming will be characterised by an unacceptable level of disease problems.

Conversion to organic farming: a situation of chaos and changes

In a recent study, involving interviews of veterinarians, cattle advisors (agricultural scientists giving advice to cattle herds) and newly converted farmers, it became clear that the conversion period was very often related to changes in the farm. Herd size very often increased and housing system was changed in connection to the conversion. This led to a further demand of changes in daily management (21,25). During the conversion process, there was generally much focus on the crop production (without fertiliser and pesticides), and the interaction between the herd and fields (grazing management and roughage production). In contrast, there seemed to be very little focus on health issues specifically related to the dairy cows, calves and heifers. The knowledge about and understanding of organic animal husbandry was relatively limited among many animal health professionals (veterinarians), and since organic herds apparently ‘look like’ conventional herds, very little search for solutions fitting to an organic context and the goals for organic farming was carried out. In many cases, the farmer had to explain to the veterinarian about the restrictions and organic production conditions. This is unacceptable for a farmer seeking and paying for advice from a professional advisor, who is supposed to be the one basing his/her advice on knowledge – not only about disease and health, but knowledge about factors which can influence the solutions. The fact that the conversion of the herd is very little in focus, and that health professionals have so little knowledge about organic farming – and in particular the goals for organic farming – points at some future challenges, and ways of improvement.
Mastitis in organic dairy herds in other European studies

In other European studies, the level of mastitis in organic dairy herds appears to be the same as in conventional herds (13,14,28,5,17,18). Ebbesvik and Loes (9) found a lower mastitis incidence in organic compared to conventional dairy herds. The results in these studies are often based on mastitis treatments, which definitely is not the same as the occurrence of mastitis! The farmer’s decision to treat mastitis is as complex as the nature of mastitis itself (27), and more information should be included in order to support the conclusion about overall mastitis levels in dairy herds in general. There is – however – basis for concluding that mastitis is a dominating problem in organic dairy farming, and that much more effort and attention seem to be needed to solve the problems.

Potential risk factors for mastitis, related to organic farming production conditions

The risk of mastitis may be related to some production conditions, which are present in organic herds. Not all of these conditions are present ONLY in organic dairy herds; e.g., summer grazing is practised in many dairy herds – not only organic herds! In the following some of these risk factors, which were found to be of potential importance for the occurrence of mastitis in Danish studies in organic herds, will be listed:

Summer grazing

- In general, there is a better hygiene during the grazing period. Cows (including udders and teats) are cleaner.
- Bulk tank milk somatic cell counts are often higher in late summer (may be influenced by intensive clover feeding, climatic factors and a disproportion between energy supply and milk yield).
- Sun burns on teats and udder (some breeds – e.g. Holstein-Friesians with ‘white udder skin’ - are particularly disposed).
- Access to grass *ad libitum* may complicate the drying off process and lead to increased weight gain in dry cows (fat cows) and consequently metabolic disease and reduced udder health.

Feeding strategies

- Organic feeding is very much based on roughage. This has to be of good quality in order to ensure enough uptake. Stimulation of rumen function should lead to a good health situation, including udder health.
- High yielding cows (genetically stimulated to high milk yield) can get into negative energy balance during the high yielding period of their lactation. This may cause increased risk of metabolic diseases and imbalance, also increasing the risk of mastitis. Organic dairy cows in Denmark are genetically of the same origin as conventional cows – which means bred
for high milk yield. If fed sufficiently and with a good energy input-output balance, high yield does not necessarily lead to increased disease levels!

Access to bedding area for all animals

- Straw yards or deep litter very often lead to an increased risk of mastitis involving *S. uberis* and *E. coli*. In practice, it can be shown that the housing systems built for deep litter systems, do not provide enough fresh air, which leads to a very poor quality of the immediate environment – followed by severe problems of environmentally based udder infections.
- Deep straw bedding might improve the hygiene and decrease the risk of teat injuries, hock lesions etc., but increases the demand for claw trimming.
- Sand is also accepted for bedding – in Denmark, this is relatively new, but the preliminary results from herds using sand bedding seem promising.

Drying off

- Prohibiting antibiotics for preventive use when drying off may increase the risk of clinical mastitis during the dry period and the following lactation. In practice, dry cow mastitis is relatively often seen in organic herds.
- (Drying off can be difficult during summer, see above)

Access to daily exercise

- Less risk of teat injuries in loose housing systems.
- Well exercised animals: better condition, better locomotory system (also leading to reduced risk of traumas and teat injuries).
- In tied-housing systems, outdoor exercise should be provided daily during winter. In some cases - depending on weather conditions – this would lead to reduced teat skin quality. In practice, this is an ‘historical problem’, since the amount of organic tied housing systems is very low now.

Access to suckling – and cow-calf relationship during the first 24 hours of the calf’s life

- In Denmark, suckling in dairy herds is mostly practised by having some cows (e.g. cows with high somatic cell counts) with 3-4 calves each, either in single boxes or common ‘suckler areas’. The introduction of calves to suckler cows (called ‘suckler aunts’, since it is not the biological mother of the calves) is shown to be most successful if the calf was allowed to suckle its own mother before introduction to an ‘unknown cow’ (26).
- Some studies and practical experiences indicate that suckling can reduce somatic cell count in cows with sub-clinical mastitis, and prevent clinical mastitis.
- For several reasons – including udder health – keeping the cow and calf together (after calving and as suckler cows) should not lead to omission of post partum udder control. Practical experience indicates that cross suckling (in systems allowing this) may lead to avoidance of milking of single glands (maybe mastitic glands, from where the milk tastes more salty and less attractive to the calf). This increases the need for daily inspection.

Other and more specific problems related to udder health may occur in organic dairy herds. In practice, very many heifers in Danish organic herds are kept in deep litter areas in herds, whilst the dairy cows are kept on slatted and concrete floors with beds. This may lead to a need for a gradual introduction, claw trimming before first calving and a recommendation to make an area of concrete or slatted floor in the heifer area – e.g. in the feeding place.

**Treatment strategies in organic herds**

The restrictions on antibiotics may positively lead to a more intensive health promotion and disease prevention effort, and to consequent and early intervention in case of disease, as discussed above. It may – also positively - lead to reduction in antibiotic resistant mastitis pathogens, and to a culling strategy, where e.g. cows infected with *S. aureus* are culled instead of treated with antibiotics in spite of a bad prognosis. In this way, antibiotics are administered in a more sensible and responsible way.

On the other hand, the restrictions on antibiotic use may negatively lead to a non-treatment policy, where animals requiring treatment will not be treated. This may lead to experimenting with non-antibiotic treatment strategies without any documented effect, and/or carried out by persons with little education and experience with such disease treatment methods. In case of farmers ‘suffering’ from the idea that conversion to organic farming automatically will lead to a better health situation, it is hazarded to stimulate a ‘non-treatment strategy’ in their herds, without simultaneously introduction of a profound surveillance and care-taking effort.

With regard to mastitis, an outbreak of dry cow mastitis is a particular concern. This is not only the case for organic herds in Denmark, since preventive medical dry cow therapy has been prohibited in all Danish dairy herds since 1995. Dry cow mastitis or mastitis at calving (indicating the presence of mastitis in the dry period) is a problem in some herds. The practical solution is very often selective treatment at drying off, when verifying the presence of bacteriological udder infection through cultivating of milk. There is without doubt need for more knowledge about robust and non-medical drying off routines and dry cow management.

A critical antibiotic policy has been stimulated during recent years from increasing concern about antibiotic resistance. A large proportion of antibiotics used for treatment of production animals is estimated to be
unnecessary (29,1), and/or based on vague and non-documentated ground (see Baadsgaard (6) for statistical analyses and discussions of this with regard to antibiotic use in non organic pig herds).

Homoeopathic and other ‘alternative treatment methods’

The EC-Regulation (No. 1804/1999) – explicitly favours homeopathic treatment to allopathic treatment (defined more or less as bio-medical treatment). The interest for homoeopathy is wide-spread among organic farmers also in Denmark (20), and homoeopathy is used as a part of the treatment regime in organic herds in more European countries (11,4). Hovi and Roderick (12) reported that 627 of 1259 clinical mastitis cases were treated with homoeopathy in a survey of organic herds.

Homoeopathy is based on holistic ideas of health and disease, and the treatment aims to stimulate the whole organism (physically, emotionally and mentally) to cure, rather than to attack specific micro-organisms. These ideas seem to be well in accordance with the basic ideas of organic farming (7,30,16), besides the fact that the homoeopathic medicines is ‘non-chemical’. Homoeopathy – as well as many other ‘alternatives’ to bio-medical disease treatment – is not immediately in accordance with the bio-medical model of health and disease, and therefore not accepted. Descriptions and research, which can be communicated across these borders of common understanding, are definitely needed, and very few of such studies do exist (10,15). The homoeopathic treatment method demands specific education in order to be used correctly. Treating homoeopathically also demands knowledge about the animals in the herd, and a good dialogue between the persons involved in the treatment (e.g. farmer and veterinarian).

CONCLUSION AND FUTURE CHALLENGES: DEVELOPMENT OF ‘ORGANIC SOLUTIONS’

A number of studies indicate that the level of mastitis in organic herds does not differ significantly from the level in conventional herds – and where it does, it is not in favour of the organic dairy farming. The way of producing organic milk in Northern-Western Europe seems also to be basically similar to the production of conventional milk. Since many farmers have converted to organic production during the past few years, some of the mastitis problems may be due to a chaotic situation (e.g. in Denmark, conversion is often related to new housing system and increase in number of cows). When focusing on health promotion in organic farming, it is clearly not satisfactory to face substantial disease problems.

Organic livestock farming provide many challenges for good herd management. Good animal health and welfare is definitely shown not to come as a ‘natural consequence of conversion to organic farming’, but rather through an increased effort to build up a good and robust system and implement good care-taking routines into the daily management. A major
future challenge is to develop health promotion routines, which are based on – and aim to develop – the basic ideas of organic farming. It is a challenge for animal health professionals to develop a good dialogue with organic farmers, and it is a challenge for organic farmers to direct and include the health professionals in the development of the herd in a way, which stimulates the herd individual development.

ACKNOWLEDGEMENTS

Organic farmers are gratefully acknowledged for collaboration, access to data, their herds and daily life, and participation in interviews and discussions. My colleagues – especially DVM, Ph.D. student Torben W. Bennedsgaard, DVM, Research professor Stig Milan Thamsborg, and DVM, Ph.D. Carsten Enevoldsen - are gratefully acknowledged for stimulating discussions about mastitis in Danish organic herds. Laust Jepsen, DVM, from the Danish Dairy Board is gratefully acknowledged for providing data on milk quality in organic dairy herds. My colleagues from the NAHWOA-network (EU-funded Network for Animal Health and Welfare in Organic Agriculture) are gratefully acknowledged for bringing all these animals health, welfare and disease issues into a larger perspective through inspiring meetings.

REFERENCES


USE OF HOMOEOPATHY AND NON-ANTIBIOTIC TREATMENT FOR MASTITIS IN SOMERSET

Steve J. Turner
Old Burford Farm, Pilton, Shepton Mallet, Somerset, BA4 4PA

SUMMARY

Results arising from the non-antibiotic and homoeopathic treatment of mastitis on two organic dairy farms in Somerset are presented.

One farm has a Guernsey herd, the other Holstein-Friesian cattle. Both farms finished their conversion to organic production in the summer of 1999. Each herd maintained between sixty-five and seventy cows over the period of study. The use of dry cow therapy ceased in the spring 1998 for the Guernseys and in the summer for the black and white herd.

In the Guernsey herd results were assessed on the basis of clinical signs, palpable udder health, milk appearance and non-recurrence of clinical cases, plus reference to the bulk milk somatic cell count. The herd is not NMR-recorded. Over the three-year period of study so far, the homoeopathic and non-antibiotic therapy resulted in a clinical cure rate of 70% from October 1999 to September 2000 and 55% from then until the end of August 2001.

In the Holstein-Friesian herd, National Milk Records data allowed the assessment of individual cow somatic cell count (ICSCC) following treatment. On the basis of the clinical signs and the consistent fall of ICSCC to below 250,000 cells/ml for more than two months after treatment, lower success rates of 55% and 53% were achieved over the two years of study since October 1999.

Results are also presented for treatment of high milk somatic cell count cows without antibiotics.

Reasons for the reduction in clinical cases over the period of study are discussed.

INTRODUCTION

The two dairies are adjoining units run under separate management, one with seventy Guernsey dairy cows plus followers, and the other with seventy Holstein-Friesian dairy cows plus followers. There is a substantial beef enterprise arising from the Channel Island herd, and a smaller one from the black and white herd. An organic cereal enterprise supplements both farms.
The farms commenced conversion to organic production early in 1997 and have been supplying the Organic Milk Cooperative with milk since the summer of 1999. Over the last two years both farms have been gradually converting their cows to spring calving. Approximately a quarter of each herd calved in the autumn of the year 2000, these have been served to calve in the spring of 2002 with the main portion of the herd. The use of whole-herd, dry cow antibiotic therapy ceased on both farms in the spring of 1998 although some individual cows have been treated in the Friesian-Holstein herd prior to their last lactation when their monthly somatic cell counts were consistently above 400,000 cells/ml.

This is an on-going study that has been undertaken because there is a need to assess whether alternatives to antibiotics and other chemotherapeutics have a role to play in the treatment of mastitis and other conditions affecting food-producing animals. The treatment of mastitis lends itself to assessment because as well as clinical judgement the measurement of somatic cell count provides a readily available parameter in measuring response to therapy.

The pan European Standards for organic agricultural production were revised and updated in August 2000 after a long consultation process, and provide a base for adoption by the United Kingdom Register of Organic Food Standards, and the certifying bodies such as the Soil Association and Organic Farmers and Growers. The Livestock Standards stipulate that:

‘Phytotherapeutic and homoeopathic products ....... shall be used in preference to chemically synthesised allopathic veterinary medicinal products and antibiotics provided that their therapeutic effect is effective for the species of animal and the condition for which the treatment is intended.’

There is a requirement for the responsible use of antibiotics in food producing animals in order to protect their efficacy in human medicine. One has to question whether the widespread practice in the United Kingdom and some other countries of dispensing intramammary and dry cow therapy without total veterinary control over their use constitutes responsible use. In Scandinavian countries all mastitis treatment is undertaken by veterinarians (5). This is all the more pertinent given the fact that intramammary therapy alone, when used in licensed courses, is largely ineffective in the cure of mastitis in the lactating animal, certainly when the more pathogenic organisms are concerned. When used off-licence, over prolonged courses, surveys have shown that milk is often only discarded for the licensed period rather than the seven days legal requirement (2,3), and antibiotic residues are of great concern to the milk processing industry (4,1).

When using antibiotics to treat mastitis on these two farms I always use systemic therapy in combination with intramammary products, and always test the milk for antibiotic residues before offering waste milk to calves. Milk is not
Homoeopathic medicines are being sold by pharmacies and farms are attending courses on how to use them, but there is very little actual assessment of claim validity. The Homoeopathic Medicines Directive for internal or intramuscular use in animals, which stipulates a withdrawal period of two days, is not always followed. This is a major problem that needs to be addressed.

The difficulty in assessing homoeopathic medicines is that the products are often advertised as having a high potency, which makes it difficult to determine their efficacy. However, studies have shown that homoeopathic medicines can be effective in treating certain conditions. For example, a study published in the Journal of Homoeopathic Medicine found that homoeopathic medicines were effective in treating ear infections in dogs.

Organic Standards when using homoeopathics products is that none are licensed by the Veterinary Medicines Directorate for internal or intramuscular use in animals. There are only a few remedies, such as Aloe vera, that are being widely used. Products derived from Aloe vera are being widely used in the UK. The Veterinary Medicines Directive for internal or intramuscular use in animals, which stipulates a withdrawal period of two days, is not always followed. This is a major problem that needs to be addressed.

The prolonged withdrawal periods stipulated by Organic Standards when using homoeopathic medicines make it difficult to determine their efficacy. For example, a study published in the Journal of Homoeopathic Medicine found that homoeopathic medicines were effective in treating ear infections in dogs.

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Discard of antibiotic-contaminated milk into the environment usually via the slurry pit, results in contamination of the environment and risks the possible transfer of resistance to other types of bacteria through genetic transfer. Use of antibiotic combination therapy or parental therapy alone in preference to using antibiotics is not recommended. Use of antibiotics should be restricted to situations where they are essential for animal health or welfare, and to diseases or conditions where the risk of antibiotic resistance is low.

All antibiotic use is recorded and reported to the Veterinary Medicine Directorate. The use of antibiotics for growth promotion is currently being phased out. The use of antibiotics for growth promotion is currently being phased out. The use of antibiotics for growth promotion is currently being phased out.

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the pathological condition being treated. It therefore requires particular knowledge of the individual to be able to use this type of therapy successfully.

**TREATMENT METHOD**

In addition to the relevant homoeopathic medicine for the signs being shown by the animal, plus her constitutional medicine, all mastitis cases were treated by regular stripping, usually a minimum of four-times daily until a clinical cure was achieved. In the Guernsey herd many infected quarters were stripped out every two hours until a major improvement was observed. Cold water hosing of the affected quarter was done concurrently if there was painful swelling and if the animal had a pyrexia (a temperature of 106°F was not uncommon with *Streptococcus uberis* mastitis). The medication was changed as signs changed and stopped when significant improvement had occurred. If a marked improvement was not achieved within 48 to 72 hours treatment was supplemented by parenteral and intra-mammary antibiotic therapy, usually for four days. Although a number of cows were systemically ill with marked pyrexia at the outset only one worsened significantly enough to require supportive therapy in terms of non-steroidal drugs or fluid therapy.

Milk samples were taken from most of the quarters affected and bacterial culture was conducted by the Langford Veterinary Investigation Centre. The California Milk Test (CMT) was used to assess when milk could be returned for sale, with organic withdrawal periods being observed where allopathic therapy proved necessary. The Delvotest SP antibiotic test (Gist Brocades, Delft, The Netherlands) was used to ensure that calves did not receive milk containing detectable antibiotic residues. Individual cow somatic cell counts (ICSCC) were recorded monthly using the National Milk Records service on the Holstein-Friesian herd. A successful treatment was recorded only if an ICSCC of less than 250,000 cells/ml was achieved for more than two consecutive months following the case in addition to a normal milk appearance and a normal palpation of the quarter.

**RESULTS**

**Guernsey herd**

Whatever the final outcome it was remarkable how well almost every case responded symptomatically to the combination of homoeopathy, the stripping and the cold water bathing. Almost without exception body temperature dropped to normal or near normal within 24 hours, and in some cases from as high as 106°F. The severe pain in a swollen quarter would reduce rapidly and be resolved within a similar period. The acute swelling also resolved fairly rapidly. Over the whole period of this study, that is three years in the Guernsey herd and two in the Holstein-Friesian herd, non-steroidal anti-inflammatory and anti-toxic therapy was required in only one case, even though some of the
animals would most definitely have required it on their initial clinical signs had they not responded so well to the alternative therapy. No fluid therapy was required. I use both non-steroidal drugs and intravenous hypertonic saline for mastitis therapy without much hesitation in my conventional practice.

However, when residual swelling and clotting of the milk was still present after three days, many of the cases could not be resolved without antibiotics. Most of these cases were caused by *Str. uberis*.

All mastitis cases arising in the Guernsey herd have been treated using the regimen given above from October 1998 to the present. In the twelve months to the end of September 1999 twenty cows suffered mastitis and fourteen (70%) responded to homoeopathy and stripping out without further treatment or recurrence. Of the fourteen cows that responded with only a single case occurring, *Staphylococcus aureus* was isolated from four, *Str. uberis* from three, *Staphylococcus pyogenes* from one and Serratia spp. from one. Milks from five cases were either not cultured or gave no growth. Recurrent cases were caused by *S. aureus* (three), *Str. uberis* (one), and *Escherichia coli* (one), with no bacteria recovered from one case.

The next twelve months saw seventeen cows affected of which twelve (70%) responded without recurrence. Of the twelve, *S. aureus* was isolated from one, *Str. uberis* from one, no bacteria were found in one sample and nine were not cultured. Of the five cows suffering recurrence, *S. aureus* was responsible for one, *Str. uberis* for one, with no bacteria recovered or no milk examined for the other three.

From October 2000 until the end of August 2001 fifteen cows were affected of which eight showed a good response (53%). Of the eight, *S. aureus* was isolated from three, *Str. uberis* from two, *E. coli* from one and no bacteria found from another, with one not sampled. Of those which did not respond without resorting to antibiotics *S. aureus* was grown from one, *Str. uberis* from two, *E. coli* from two (these last two were cull cows in which the mammary suspensory ligament had stretched and the udders had collapsed), one yielded no recoverable bacteria and one was not cultured.
Table 1. Outcome of clinical mastitis cases treated initially with homoeopathy in the Guernsey herd

<table>
<thead>
<tr>
<th>Time period</th>
<th>CLINICAL CASES</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CASE</td>
<td>S. aureus</td>
</tr>
<tr>
<td>Oct 98-Sept 99</td>
<td>Primary ‘cure’</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>No response or recurring</td>
<td>3</td>
</tr>
<tr>
<td>Oct 99-Sept 00</td>
<td>Primary ‘cure’</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>No response or recurring</td>
<td>1</td>
</tr>
<tr>
<td>Oct 00-Aug 01</td>
<td>Primary ‘cure’</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>No response or recurring</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>Primary ‘cure’</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>No response or recurring</td>
<td>5</td>
</tr>
<tr>
<td>% cases</td>
<td>59</td>
<td>34</td>
</tr>
<tr>
<td>% ‘cure’</td>
<td>62</td>
<td>60</td>
</tr>
</tbody>
</table>

Non-responding cases were treated with systemic and intramammary antibiotics. Recurring cases were either treated homoeopathically or, if severe, with antibiotics as above, usually with good results. No cows were culled for mastitis apart from the two with collapsed udders. One other cow lost milk production from the affected quarter but regained it the next lactation. Whilst no individual cow somatic cell counting is undertaken on this herd the monthly bulk milk counts have been consistently below 250,000 cells/ml throughout this period.
Holstein-Friesian herd

Up until September 1999 most cases of mastitis in the Holstein-Friesian herd were treated with a combination of systemic and intramammary therapy. Since then all have been treated initially homoeopathically as above, resorting to antibiotics if the case did not start responding well within two to three days or if a relapse occurred.

During the initial twelve months twenty seven cows were treated homoeopathically for mastitis of which fifteen (55%) responded clinically and with the required reductions in the somatic cell count requirement for a 'cure' to be recorded. Twelve cows remained with a high individual SCC and six had one or more repeated clinical episodes. Of the responding cases Str. uberis was recovered from two, Bacillus spp from one, Proteus spp. from one and Serratia spp. from one. Nine cases did not have milk cultures undertaken (unfortunately if a rapid clinical response occurred no bacteriology was deemed necessary at this time although from the point of view of this paper it would have been highly relevant). Of the twelve cases that failed to respond without antibiotics six were caused by Str. uberis, one by Streptococcus dysgalactiae, two by S. aureus, one by a non-haemolytic staphylococcus and two by Corynebacterium spp. Non-responding cases, including six which recurred after homoeopathic treatment, and some cows with a persistently high cell count, were treated with antibiotics as previously described.

Since October 2000 fifteen cows have had clinical mastitis of which eight cases (53%) responded to homoeopathic therapy without recurrence or requiring antibiotics. Of the eight, Str. uberis was isolated from one case, E. coli from six, and a coagulase ve staphylococcus from another. Of the seven non-responding cases that required antibiotic treatment three were caused by Str. uberis, one by Str. dysgalactiae, two by Serratia spp. and one sample was not cultured before antibiotic treatment ensued. Of these seven non-responding cases two recurred after homoeopathic treatment and were treated with antibiotics.
Table 2. Outcome of clinical mastitis cases treated initially with homoeopathy in the Holstein-Friesian herd

<table>
<thead>
<tr>
<th>Time period</th>
<th>CLINICAL CASES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CASE</td>
</tr>
<tr>
<td>Oct 99-Sept 00</td>
<td></td>
</tr>
<tr>
<td>Primary SCC ‘cure’</td>
<td>0</td>
</tr>
<tr>
<td>No response</td>
<td>2</td>
</tr>
<tr>
<td>Oct 00-Aug 01</td>
<td></td>
</tr>
<tr>
<td>Primary SCC ‘cure’</td>
<td>0</td>
</tr>
<tr>
<td>No response</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td></td>
</tr>
<tr>
<td>Primary SCC ‘cure’</td>
<td>0</td>
</tr>
<tr>
<td>No response</td>
<td>2</td>
</tr>
<tr>
<td>% cases</td>
<td>5</td>
</tr>
<tr>
<td>% ‘cure’</td>
<td>0</td>
</tr>
</tbody>
</table>

Cows with a high ICSCC

In April 2000 eight cows showing a high ICSCC post-calving had milk from individual quarters selected by a CMT examined bacteriologically. The cows were then treated with the relevant constitutional homoeopathic medicine twice daily for three days using a vulval spray.

Two of these cows had had previous mastitis, one when she was dry. Str. uberis was isolated from six cows, Proteus spp. from one and E. coli from one. Five of the cows showed a significant improvement. Two cows showed a persistent reduction in cell count over the ensuing months from 200,000 cells/ml to 300, milk from one cow (the Proteus spp. case) declined from 2000 to 200 cells/ml and the E. coli case showed a decline from 3000 to 20 cells/ml. Three of the Str. uberis infected quarters sustained a high cell count but without clinical mastitis.

In January and February 2001 six cows were selected in the same way for a similar treatment. Two quarters contained Str. dysgalactiae, one Serratia spp., one Bacillus spp. and two non-haemolytic staphylococci. None showed a significant response and were eventually treated with antibiotics.
DISCUSSION

The high level of mastitis suffered by the Holstein-Friesian herd in particular following the conversion to an organic system proved deeply concerning in view of the sustained measures used routinely on this farm to control the condition.

The parlours are tested twice yearly, once with a dynamic test. Teat liners are changed according to manufacturer’s recommendations, and milking is into large-volume claw bowls. Twice-daily hot water circulation cleaning is in use. Cows’ teats are washed if visibly dirty, and all teats are wiped with an individual disinfectant wipe or pre-dipped and wiped. Post-milking all teats are dipped with a high quality iodine disinfectant containing, glycerine and lanolin as emollients. High cell count cows and any mastitis cases are milked with a separate cluster to those used for the main herd and these ‘mastitis’ clusters are kept constantly flushed with a cold water hose when not in use during the milking period. Mastitic and antibiotic contaminated milk is passed into dump churns.

Cubicle conditions are excellent with concrete beds covered with a high-density foam mattress and a thick rubber mat. The comfort of these beds was instrumental in completely preventing lameness during the housing periods of the last two winters. Beds are brushed off, dry straw added and passages scraped, all twice daily. A thin dusting of lime was used every two days on the beds until February 2000 when this was replaced by a powder disinfectant (Zal Drysan, Deosan, Diversey Lever) that releases chlorine on contact with moisture. The effect of this change on teat condition and mastitis was dramatic. Although the skin of the teats had no lesions before the change it was very dry compared with that of cattle kept in the dry cow loose yards that were not limed. Within two weeks of changing from lime to Drysan teat condition had improved significantly and the number of mastitis cases in cows that had calved in the previous months fell equally dramatically. I postulate that this was due to the teat ends regaining their normal suppleness and the teat duct closing more efficiently and quickly.

The second change that has made a marked difference in the Holstein-Friesian herd was the removal of loose-straw bedded yards for housing dry cows. These loose yards were well drained, cleaned out fortnightly and space allowances exceeded Soil Association requirements, with large amounts of fresh, dry straw added daily. An iodine barrier teat dip (Ioshield, Henkel Ecolab) or an external teat sealant (Dryflex, De Laval) was applied every four to five days. In spite of these measures dry cow mastitis became a problem and far too many cows calved down in the winter and spring of 1998/1999 and 1999/2000 with a high cell count, with or without clinical mastitis in the succeeding weeks. *Staph. uberis* was isolated in most of the mastitis cases and from the high cell count quarters. This problem was accentuated by the change over the last three years from a summer/autumn calving pattern to spring calving, requiring the cows
to be dried off during the housing period. The loose yards were replaced for the winter of 2000/2001 with portable cubicles using the same type of matting system and management as used for the milking animals.

The third management change was to alter the method of drying off cows for the winter of 2000/2001. Previously, cows were separated from the main herd at the end of lactation when giving less than eight litres of milk, stopped milking abruptly, put into a straw yard and fed straw for four to five days or until dry, with supplementary hay or big bale silage being added when their milk production had stopped. This proved distressing for all concerned, with constipated cows, some leaking milk, and no less than seven dry cow mastitis cases during the winter of 1999/2000. The procedure now being followed successfully is to milk the cows at the end of lactation once daily for a week, separate them off into the dry cow cubicles and milk them three or four times every two days, discarding this milk, then stop milking and use the Iosfield dip as before. Milk from the every-other-day milking of these cows is discarded to avoid raising the bulk milk somatic cell count.

These measures have stopped the dry cow mastitis and the stress of drying off completely, as well as leading to many fewer cows showing a high cell count at the start of lactation, without unfortunately eliminating them entirely. The number of clinical cases of mastitis overall has been halved, to the equivalent of twenty-one affected cows per hundred cows and twenty-five cases per hundred cows per year, levels which compare well with most conventional herds. The rolling three-monthly herd cell count is approximately 200,000 cells/ml on this NMR recorded herd with an average annual yield of 7000 litres/cow.

Results of treatment with the non-antibiotic and homoeopathic regime showed response rates of more than 50% in the Holstein-Friesian herd and 70% in two out of three years in the Guernsey herd, with an effective response in virtually all *E. coli* cases. The improvement in the systemic signs was a revelation, even if the mastitis required antibiotic assistance to clear. Most failures were in cases caused by *Str. uberis* and the impending licensing of an internal teat sealant may well be helpful in preventing this environmental organism invading the udder during the dry period.

The conclusions drawn so far with non-antibiotic treatment of mastitis are that it can have a role to play in the treatment of clinical mastitis, particularly on organic farms. However, because homoeopathic therapy as used here relies on relating the medicines used to the signs and the constitution of the animal, it is not easy to apply without a degree of knowledge and experience. Nevertheless, there are enthusiastic farmers and stock-persons using homoeopathy and claiming success against mastitis. Where the type of infection can be recognised clinically as being caused by Gram-positive bacteria, particularly *Str. uberis*, it may be better to treat with a combination of injectable and intra-
mammary antibiotics immediately rather than create potentially chronically infected cows, although the systemic signs are likely to be helped with homoeopathic medicines, in addition to the conventional therapy. This means accepting the costs of the prolonged milk discard. There is always a place for the repeated stripping out and cold-water bathing of the affected quarter no matter what treatment is used. I advise this on my conventional clients herds, although it is a time consuming business and requires easy, convenient access to the patient and good handling facilities.

There is no doubt that prevention of mastitis is far better than cure, whatever the therapeutic route chosen. The measures taken above illustrate what can be done to reduce the incidence. The standard of management and housing of the dry cows needs to be very high on organic farms in order to prevent infections picked up during the dry period becoming a problem during lactation. I am convinced that deep-littered straw yards are not suitable housing for dry or lactating dairy cows, especially for potentially high genetic merit animals genetically programmed to give high yields in fast milking times through poorly closing teat canals. Large and comfortable cubicles are needed for dry cows. Calving areas need special attention and with my own herd these are cleaned out after each calving, with sand being put down under fresh bedding. Wet straw following calving is removed and replaced. The calf is removed after twenty-four hours to reduce stress on the mother and calf. Great emphasis is placed on reducing stress on the cows as a means of disease prevention and mastitis is no exception. Presently available external teat sealants seem minimally effective in preventing infection, and the impending UK licensing of the internal teat sealant that is presently used in New Zealand is eagerly awaited.

REFERENCES

THE USE OF A BISMUTH-BASED TEAT SEAL AND THE BACTERIOCIN LACTICIN 3147 TO PREVENT DRY PERIOD MASTITIS IN DAIRY COWS

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SUMMARY

Mastitis in dry cows has traditionally been controlled with long-acting intramammary antibiotic formulations. However, the widespread use of antibiotics, particularly for prophylactic application, is likely to be restricted in the future. As a consequence, there is now a growing requirement for effective alternatives to prevent mastitis. A bismuth-based, intramammary teat seal has recently been shown to be as effective as “dry cow” antibiotic therapy for the prevention of new dry period infections. A new prototype formulation containing the bacteriocin, lacticin 3147 and teat seal has also been shown to be effective in controlling Streptococcus dysgalactiae and Staphylococcus aureus using experimental infection models both in non-lactating and lactating dairy cows.

INTRODUCTION

Dairy cows are particularly susceptible to mastitis during the dry period and Staphylococcus aureus, Streptococcus dysgalactiae and Streptococcus uberis are still the dominant pathogens associated with dry period infections in Irish herds. During the last three decades long-acting intramammary antibiotics have been used routinely as a means of curing existing infections in mastitic cows and also for preventing new infections in previously uninfected cows (2). While dry cow antibiotic therapy has helped to reduce the incidence of mastitis in the past, there will be a greater emphasis on reducing antibiotic inputs in the future due to the perceived connection between the over-use of antibiotics and the emergence of antibiotic resistant organisms. The debate on “to treat or not to treat” uninfected cows at drying-off has been ongoing for many years and some researchers have recommended that dry cow antibiotic therapy should be reserved for infected cows and not applied as a routine prophylactic measure (4,5). On the other hand, it has been shown that the incidence of new intramammary infections increases when uninfected cows are left untreated, particularly in the early part of the dry period. Studies in New Zealand (20) showed that 16% of a sample of 528 untreated quarters, uninfected at drying off, developed a new infection during the dry period. Berry (1) also showed that between 30% and 50% of untreated cows at drying off developed new infections during the dry period compared to a new infection rate of between 0% and 15% in cows treated with antibiotics.
The continued use of antibiotics in the dry period for either therapeutic or prophylactic purposes has some disadvantages, including the perceived connection to the emergence of antibiotic-resistant human pathogens particularly with the increased incidence of organisms such as methicillin-resistant \textit{S. aureus}, which is prevalent in nosocomial infections in humans (6). Such concerns have prompted the World Health Organisation to issue recommendations on global programmes to try to reduce the use of antibiotic therapies for both human and animal applications in the future (19).

Sealing the teats of uninfected cows at the end of lactation may provide an acceptable alternative to blanket treatment with antibiotics. External applications of sealers reported by Oliver \textit{et al.}, (10) failed to achieve satisfactory control 48 hours after administration. Farnsworth \textit{et al.}, (7) also reported on the use of an acrylic teat seal applied externally by dipping teats after milking. This formulation was effective in reducing the incidence of sub-clinical mastitis. The authors also recommended its use particularly for the control of coliform infections. The use of an internal sealer comprising of bismuth subnitrate and acriflavine was also considered as an alternative to antibiotic therapy in uninfected cows at the end of lactation (9). This product was successful in preventing new dry period infection in studies using artificial bacterial challenge, but further work was required to improve the persistence of the seal for more extended dry periods.

Recent developments in non-antibiotic internal teat sealing technology have proved to be very effective in preventing new cases of mastitis during the dry period when infused into the teats of uninfected cows at drying-off. The teat seal formulation contains a heavy inorganic bismuth salt in a mineral oil base and is infused from a plastic syringe which is of a similar type to those used for infusion of intramammary antibiotic. In the New Zealand study reported by Woolford \textit{et al.}, (20), Teatseal™ [Bimeda (NZ) Ltd, Auckland, New Zealand] was as effective as a long-acting antibiotic containing 250 mg of cephalonium in preventing naturally occurring infections in cows which were classified as uninfected at drying-off. In that study \textit{Str. uberis} was the principal pathogen causing mastitis in the dry period.

Bismuth-based teat seals are biologically inert and do not have an associated anti-microbial activity. Attractive non-antibiotic additives to enhance teat sealing formulations might include bacteriocins such as nisin (3, 12) or lactacin 3147 (13). Bacteriocins are proteins produced by some bacteria that have the ability to kill other organisms. Both nisin and lactacin 3147 are natural foodgrade anti-microbials with a broad-spectrum of inhibition against Gram-positive bacteria. Taylor \textit{et al.} (17) showed that a single intramammary infusion of nisin was effective in treating both streptococcal and staphylococcal infections in bovines. In these experiments, however, the nisin preparation produced an adverse cellular response in the udder. More recent interest in nisin was reported by Sears \textit{et al.} (16) who showed that nisin in combination with lysostaphin cured 66% of
S. aureus, 95% of Streptococcus agalactiae and 100% of Str. uberis infections. Nisin has since found application in two commercial teat hygiene products that are currently used for the prevention of mastitis.

In recent years a number of new bacteriocins have been isolated and characterised in a collaborative study between Moorepark Research Centre and University College Cork. One of these bacteriocins, designated lacticin 3147, is produced by Lactococcus lactis ssp. lactis DPC3147 and was first isolated from Irish kefir-like grains used for bread-making (11). Lacticin 3147 has been shown to be effective against all Gram-positive bacteria tested to date including mastitis-causing pathogens (14).

This paper describes a series of experiments in the development of a teat seal and lacticin 3147 formulation for the prevention of mastitis in non-lactating cows.

**EXPERIMENTAL STUDIES**

**Teat seal/lacticin 3147 formulation**

The teat seal formulation used in the studies was similar to the seal used in the New Zealand study (20). However, the surfactant Tween 80 was also added to facilitate the release of lacticin 3147 from the sealing material. A liquid preparation of lacticin 3147 was prepared as described previously (15, 18) and blended with teat seal. The blended formulation was filled into plastic syringes (4 g per fill). The efficacy of the teat seal containing lacticin 3147 was assessed in vivo by artificial challenge using both non-lactating and lactating cow models. The impact of the bacterial challenge was manipulated by increasing the number of colony forming units inoculated or by increasing the depth to which the bacteria were introduced into the teats.

**Streptococcus dysgalactiae efficacy study in non-lactating cows**

A study in non-lactating cows was designed to ensure that the Str. dysgalactiae challenge loading was sufficient to ensure the partial failure of the teat seal alone. The expected impact of this technique was to increase the infection level and provide a high level of challenge against the seal plus lacticin 3147 combination. Sixty-eight uninfected udder quarters were selected in 18 dairy cows. After the last milking of the lactation, thirty-three teats were infused with teat seal and 35 with teat seal combined with 20,000 AU (arbitrary units) of lacticin 3147. Within cow treatment comparisons were made using treatment pairs selected at random to either right front and right hind quarters or left front and left hind quarters. Three days after infusion, 68 treated teats were inoculated via the streak canal to a depth of 17 mm with 100 µl of antibiotic-free skim milk containing 1.5 x 10⁴ cfu/ml of Str. dysgalactiae. The challenge organism was classified as Str. dysgalactiae ssp. dysgalactiae by SDS-PAGE total protein profiling (BCCM™ Culture Collection; Laboratorium voor Microbiologie, Universiteit Ghent, Belgium) and was previously isolated from a case of clinical mastitis in the research herd attached to Moorepark Research Centre.
Following challenge, the cows were observed twice daily for signs of clinical mastitis. Udder quarters were allowed to develop definite clinical signs of mastitis before a sample of secretion was taken for bacteriological analysis. The trial was ended 8 days after inoculation when samples of secretion were collected from all remaining non-clinical quarters.

*Str. dysgalactiae* isolates were typed by RAPD fingerprinting using a random primer. Genomic DNA was isolated from the challenge strain, *Str. dysgalactiae* and from teat isolates (after challenge) by a modification of the method by Hoffman and Winston described by Gardiner et al., (8). This procedure was used to ensure that the bacteria recovered from clinically affected quarters and from the quarters harbouring *Str. dysgalactiae* could be confirmed as the challenge strain.

Results of *Streptococcus dysgalactiae* challenge study

Fourteen (42%) clinical *Str. dysgalactiae* infections developed in the sealed teats and 2 (6%) in the teats treated with teat seal and lacticin 3147. On the last day of the trial, 6 additional quarters in the sealed group were shedding the challenge strain while there were no recoveries from the other teats infused with seal plus lacticin 3147 (Table 1). All of the clinical infections caused by the challenge strain in the sealed teats developed in the first four days after challenge compared with one in the teats infused with seal plus lacticin 3147 (Figure 1). The difference in incidence of new infections caused by the challenge strain was significant (p<0.001). Time to survival distribution analysis between the rate of occurrence of each clinical event also showed that the difference between the treatments was significant (p<0.001).

Table 1. **Clinical mastitis and bacterial recoveries after challenge with *Streptococcus dysgalactiae* in quarters treated with teat seal and teat seal plus lacticin 3147**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Quarters (n)</th>
<th>Clinical infections</th>
<th>Non-clinical recoveries</th>
<th>Clinical infections and non-clinical recoveries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seal</td>
<td>33</td>
<td>14 (42.0%)</td>
<td>6</td>
<td>20 (61.0%)</td>
</tr>
<tr>
<td>Seal / lacticin</td>
<td>35</td>
<td>2 (6.0%)</td>
<td>0</td>
<td>2 (6.0%)</td>
</tr>
</tbody>
</table>
Figure 1. Daily incidence rate of new clinical infections caused by the challenge strain of *Streptococcus dysgalactiae* in quarters treated with teat seal and teat seal + lacticin 3147

![Graph showing daily incidence rate of new clinical infections](image)

**Staphylococcus aureus** survival study

Sixteen uninoculated lactating cows were selected and within those, 58 quarters were used for the experiment. After the morning milking, 29 quarters were infused with teat seal combined with 32,768 AU of lacticin 3147 and 29 served as untreated controls. One hour after infusion, both treated and untreated teats were inoculated *via* the streak canal to a depth of 17 mm with 100 μl of antibiotic-free skim milk containing 1.7 x 10³ cfu of *S. aureus* DPC5246.

The evening milking was omitted. At the next morning milking, 18 hours later, teat seals were removed from the treated teats and milk samples were collected from all quarters for bacteriological analysis. *S. aureus* isolates were identified and enumerated in the foremilk samples to assess differences in recoveries between treatments.

**Results of Staphylococcus aureus** survival study

*S. aureus* survived in 19 of the 29 control quarters (66%) and in 4 (14%) of the quarters treated with teat seal and lactacin 3147. This difference was significant (P<0.001), (Table 2). Recovery bacterial counts were also made on the milks containing surviving *S. aureus* to assess differences between treatment and control. Overall, the presence of teat seal plus lactacin 3147 reduced the *S. aureus* recovery counts (Figure 2) and the difference in log-transformed recovery data was significant (P<0.001). These data indicated that, in addition to reducing the number of teats shedding viable *S. aureus*,
the teat seal plus lacticin 3147 also reduced the number of challenge organisms in those teats from which *S. aureus* were recovered.

**Table 2.** The effectiveness of teat seal plus lacticin 3147 in eliminating *Staphylococcus aureus* in artificially infected teats of lactating cows compared with untreated controls.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Teats (n)</th>
<th>Teats shedding <em>S. aureus</em> (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Untreated control</td>
<td>29</td>
<td>19 (66%)&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Seal + lacticin 3147</td>
<td>29</td>
<td>4 (14%)&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>a,b</sup>Values with different superscripts are significant P<0.001

**Figure 2.** Staphylococcal recoveries from untreated teats and from teats infused with teat seal plus lacticin 3147 after they had been inoculated with ~1.7 x 10<sup>3</sup> cfu per teat of *Staphylococcus aureus* DPC5246

**DISCUSSION**

The development of non-antibiotic formulations for the prevention of mastitis in cows has the potential to reduce the dependence on antibiotics for prophylactic therapies in the future. The trials reported here form part of a more comprehensive data set on a non-antibiotic approach to mastitis prevention.

These trials have shown that the teat seal and lacticin 3147 combination in the absence of conventional antibiotic therapy was effective in controlling *Str. dysgalactiae* infections in the dry period under conditions of experimental challenge. Moreover, the challenge strain of *Str. dysgalactiae*
could not be isolated from the remaining non-clinical udder quarters after eight days of exposure to the challenge strain. The presence of lacticin 3147 was also associated with a delayed onset of mastitis in the two quarters in which infection occurred. For example, the first clinical case of mastitis in an udder quarter treated with teat seal plus lacticin 3147 occurred 4 days after inoculation, at a point where 13 quarters containing teat seal alone had already become clinically infected.

In the lactating cow model using *S. aureus* as the challenge pathogen, teat seal and lacticin 3147 significantly reduced the numbers of teats shedding the challenge organism. In addition, the population of viable bacteria in teats shedding *S. aureus* was significantly reduced relative to the control udder quarters. This decrease in bacteria numbers occurred during a relatively short exposure period of 18 hours. The survival of some of the *S. aureus* may have been due to an insufficient concentration of lacticin 3147, or a lack of physical contact between the bacteria and the teat seal formulation. Insufficient release of lacticin 3147 from the teat seals or too short an exposure period may have also contributed to the survival of some *S. aureus* in this lactating cow model.

A significant outcome of our trials was the *in vivo* evidence of the ability of lacticin 3147 to retain activity against *Str. dysgalactiae* in the teat and prevent the onset of clinical mastitis during the 8-day trial period. This trial provided convincing evidence that the bismuth-based teat seal and lacticin 3147 combination offered very effective protection against a significant challenge with an important mastitis-causing pathogen.

While all *S. aureus* were not eliminated in the lactating cow model, there was a significant reduction in staphylococcal recoveries from the teats infused with the teat seal plus lacticin 3147 combination. Since the results of this trial demonstrate that teat seal plus lacticin 3147 reduces the number of teats shedding *S. aureus* in a lactating cow, then it may be speculated that the risk of infection should be considerably reduced also in a dry cow model with a similar product.

The choice of teat seal as a delivery vehicle for lacticin 3147 has a number of advantages. The teat seal alone has already been shown to provide an effective barrier against new infection in a large animal trial in New Zealand (20). That study showed that teat seal was as effective as a long-acting antibiotic containing the cephalonium (250 mg) in preventing naturally occurring infections in 528 dairy cows which had been selected as non-infected at drying-off. In the New Zealand study, however, the principal pathogen causing new infections was *Str. uberis* and the incidence of other mastitis-causing pathogens was too low to make valid comparisons. One of the main advantages in combining the seal with a broad-spectrum bacteriocin, therefore, is that in addition to the physical barrier effect of the teat seal, the seal also localises the anti-microbial inhibitor in the teat sinus. Since anti-microbial activity is not required throughout the complete mammary gland for mastitis prevention using the teat sealing system, then
the amount of bacteriocin required per seal treatment will be small relative to antibiotic usage with conventional dry cow therapy. However, the optimum concentration of lacticin 3147 to be incorporated into teat seal to increase the efficacy still remains to be established.

Currently in New Zealand, the teat seal product without the addition of lacticin 3147 is recommended for use in cows with a milk cell count of <150,000 cells/ml at drying off. The seal is applied routinely and without associated antibiotic treatment. The incorporation of a non-antibiotic antimicrobial such as lacticin 3147 should provide an additional barrier against Gram-positive pathogens, which may be introduced inadvertently into the teat by the herdsman at the time of infusion or may enter naturally during the dry period. The principal advantage is that neither of the components contain antibiotics and, therefore, should not compromise current biomedical applications.

REFERENCES

PLANNING A NEW DAIRY UNIT

Graeme Lochhead
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INTRODUCTION

The fundamental purpose of a dairy unit is to house and manage the business’s productive unit – the dairy cow. It is essential to concentrate on cow-centred design while also considering ease of management and the wishes of the business’s owners. The design of a dairy unit is a complex equation, bringing together the needs of cow and work force to attain efficiency and output.

GENERAL DESIGN CRITERIA

It is essential to develop a team approach to design ensuring that the wishes of the farmer are translated into the built farm. Keeping it simple will ensure that all those who work in the facility will, for the next 30 years, be able to maximise the facility. The wish list of the farmer (client) must be taken on board and fully researched and qualified if varied from the norm. The farmer must be made aware of the full potential and limitation of choices they make.

Setting out a brief from which to work will ensure that sight is kept upon the purpose of the project. The brief would be an interpretation of the wish list and would contain all the elements to be designed for, i.e. number of cows, calving pattern, number of bulls, feeding system, waste handling system, parlour choice, cow handling system (AI stalls, crush, calving boxes, isolation pen), etc.

Having set out these basic parameters that the unit must satisfy, including cow throughput and compliance to assurance schemes, then the design centres around two elements: the parlour and the waste handling system.

Existing health check

A green-field site is not always the best sites and a full survey and health check of the existing arrangements should be made. Although not always obvious, the integration of new into old can often satisfy the brief. Attention should focus on ‘general purpose’ type buildings that can accommodate the larger design dimensions now common.

A financial feasibility study, based on budget figures, should be carried out to identify the sensitivity of the project and to set a ceiling. Always remember that the building is a tool for management to use not a cure; concentration on elements away from that may affect production.
Having analysed the existing buildings and the budget (based on sketch designs) progression to the next stage can be made on the basis of limits set – be they cost or existing buildings.

**Parlour choice**
The role of the designer should be to facilitate the decision process in choosing a parlour, not to make the choice on the client’s behalf. A clear and detailed brief of what is expected of the parlour should be prepared, based on throughput, routine, cow position, ID system, level of automation.

The designer should clearly advise upon experiences and likely parlours that could satisfy the parameters laid down. Increasingly there is interest in rotary, rapid exit and swing over parlours for attaining high throughput. High throughput should be gauged upon litres per hour as it is margin on litres that will make profits based on attention to reducing cost per litre.

The parlour brief should be tendered formally or informally to give all an opportunity to satisfy the brief and to add fair competition to the process. Part of the tender process will be formal or informal interviews and identification of service provision.

**Waste handling system**
In deciding which waste handling system to opt for, one must choose the housing and bedding system. The vogue is for cubicle systems for a number of reasons:

(i) stocking densities are higher so building cost per cow is less
(ii) management of bedding is more efficient and cheaper (even in areas with an abundance of straw)
(iii) management of mucking out is easier
(iv) research is mixed on the advantages of cows on straw and the benefits to welfare and health

The majority of new housing systems are based on cubicles, using Dutch cantilever dividers with dimensions of 1.2 cm by 2.7 m for black and white genetics. The existing standards set by BS5502 (Table 1) do not reflect the current advice for 1.15m x 2.7m cubicles.

The selection of cubicle bedding is a choice from chopped straw, sawdust (on mats or mattresses) chopped paper or sand. Recent developments have seen an increased interest in the use of deep sand beds. The choice dictates the slurry handling system generally using above ground storage outside the building and a high level of automation e.g. passageway scrapers.
Table 1  Dimensions of cow cubicles (BS5502: Part 40: 1990)

<table>
<thead>
<tr>
<th>Mass of cow (kg)</th>
<th>Length of cubicle (m)</th>
<th>Clear width of cubicle between partitions (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>350 to 500</td>
<td>2.00</td>
<td>1.0 to 1.10</td>
</tr>
<tr>
<td>500 to 600</td>
<td>2.15</td>
<td>1.10 to 1.15</td>
</tr>
<tr>
<td>600 to 700</td>
<td>2.3</td>
<td>1.15 to 1.20</td>
</tr>
<tr>
<td>700 to 800</td>
<td>2.4</td>
<td>1.20 to 1.30</td>
</tr>
</tbody>
</table>

SPECIFIC DESIGN CRITERIA

Stress and discomfort will lead to a reduction in the productivity of the cow and adversely affect the potential return. Advances in breeding are all too often over-ridden by poor housing and therefore full potential is rarely achieved. The design should ensure maximum comfort and welfare in all aspects of the unit to ensure that no injury is inflicted on the cows. The 1990s saw an increase in the use of cow cubicle mats and mattresses and detailed results on efficiency and durability are still awaited, but there can be no dispute that cubicle comfort has improved.

Cow centred design

Research has indicated that simulating natural cow behaviour in the building as close to that outside in the field will maximise production. Cows often ruminate while lying down and lie for 12-13 hours per day (Table 2). Thus, it is essential to encourage the cow to lie down and this can only be achieved if the cow is comfortable.

Space-sharing cubicle design prevents damage to the cow and allows her to lie clean and undisturbed in comfort. Forward- and side-lunging space must be provided to assist the cow to rise naturally and the Dutch cantilever, Dutch comfort and mushroom divisions achieve this. The majority of cubicle problems and cow injuries stem from inadequate size and the current view on dimensions (1.2m wide x 2.7m long) does, however, depend on cow size and specific dimensions. Refurbishment of existing systems often poses a real problem due to the limited space available for extending cubicle length. This can be overcome e.g. by the use of space-sharing cubicles, extension of the bed into the passage or placing the cubicle herringbone etc. Cantilevered cubicles offer more scope than other designs to incorporate continuous mattresses without cutting around division legs.

Table 2  Time spent at grass over a 24-hour period

<table>
<thead>
<tr>
<th></th>
<th>Lying (h)</th>
<th>Ruminating (h)</th>
<th>Lying ruminating (h)</th>
<th>Standing ruminating (h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pasture</td>
<td>12</td>
<td>7</td>
<td>5.5</td>
<td>1.5</td>
</tr>
</tbody>
</table>
Stress-free movement and handling
Research into cow behaviour has aided in the design of minimal stress solutions in housing systems. Cow movement through the system should be efficient, stress- and injury-free, and unexpected changes in level, sharp bends or protrusions, dark and narrow passages must be designed out. The design of a simple, straight-run layout with wide passages, sensible gating and ease of grouping is essential for the cow to fulfil her potential.

Parlour choice has to be made in relation to the size and output of the herd, but should be exclusively for the milking of the cow and other management of the cow. Access should be visually direct so that the cow can ‘see the noise’, and should also be easily-cleaned and conform to the latest regulations. The system should be capable of being operated by one person and can be achieved with good quality backing gates in the collecting yard.

Access from the parlour to well-designed handling facilities will ensure the herdsperson is in control of the daily care needed by the herd. The system should incorporate AI facilities, foot care and crush, holding pen and access to dry cow/calving yards. In order to facilitate the current philosophy of pre- and post-calving housing on straw yards, careful attention must be paid to the ease of movement between the yard and parlour in order to alleviate this naturally stressful period. Good design in and around the parlour is an essential feature of a modern dairy unit. Full use should be made of ID systems incorporating auto-segregation.

Feeding
The feed barrier should be constructed to allow free and easy access to the food and prevent cow aggression and injury. Individual feeding space of 700 mm per cow should be provided to aid grouping and management. The complexity of the barrier is influenced by the farmer’s aims and objectives, but it is essential to avoid nape and brisket damage. The cow should be capable of demonstrating a natural grazing stance, which may be improved by raising the feed passage 150 mm above the feed stance. A simple offset (100 mm) top rail can be effective. A simple cambered feed passage, without a trough, will allow the passage to be cleaned with ease and fresh food to be presented to the cow. Wastage is less of a problem with precision-cut, total mixed ration. The ability to clean away any uneaten food is required and should be considered.

A natural environment
It is important to simulate a natural climate without the adverse effects of the outside environment in order to achieve the maximum comfort for the cow. The building should be light and airy but draught-free, which is achieved by 25% roof light area, a protected open ridge, and breathing roof (stepped sheets or continuous gap between sheets). Care should be taken to prevent draughts from the ends of the building by careful use of gates, doors and ventilated screens in order to avoid the creation of a wind tunnel.
Concentration on achieving a stress-free environment and high levels of comfort will have a greater effect on production.

Waste
Ant-pollution legislation prescribes set storage periods for waste and, in order to minimise the amount of waste stored, all rainwater must be diverted. All accommodation should be contained under an umbrella structure to aid waste control and management. Close attention should be paid to waste control. The waste should be viewed as an asset which can aid crop production, thus storage, handling, spreading must be managed in order to utilise this nutrient fully. Current waste systems can be designed to handle liquid, semi-solid and solid waste so it is important not to lose sight of the cow-centred objective and ‘allow the tail to wag the dog’ and have the system designed around the cow.

Legislation

The implications of these, and the need to get the design right, result in a time lag between initial concept, through design and construction to completion and use. This time lag means that forward planning is essential, and thought and action should be taken now. As an example, the process from concept, Local Authority Planning approval, detailed design and tendering for prices can take 5 - 8 months, and sometimes longer. The message here is to think ahead in good time.

THE HUMAN INFLUENCE

The Stockperson
In the past concentration on cow-centred design approaches were considered the correct way, and this is still correct, but often at the expense of the workforce. The aspiration of those working on farms has changed, even to the point of ‘having a day off’ and so the design process should take account of this. The stockperson is a critical part of achieving efficient production and can make the difference between profit and loss.

The dairy unit should provide an environment easy to manage and give facilities to aid the management. Attention should also be given to others in this process, such as vet and nutritionist. Facilities provided should include office, vet and AI room, WC and shower as a minimum.

The customer and the consumer
In complying with the assurance schemes in design, we aim to satisfy the milk buyer (customer) and, hopefully by this, the consumer. The perception
of quality cannot be underestimated and should be designed into the system.

By starting with a clean-to-dirty philosophy, aiming to have a clean human end and a dirty animal end opposite we can go part way to meeting this perception. The clean end starts with access to the tank room with attention to tanker access, staff access and visitors (both regular e.g the vet, and invited). Each step in the progression from tank room to waste storage will get increasingly dirty, i.e. tank room to milk reception, milk reception to parlour pit, pit to cow standing, cow standing to collecting yard, yard to housing and housing to waste storage.

This clean-to-dirty flow should be considered as much as the cow flow of the building and also feed and waste management flow.

THE DESIGNED APPROACH

Dairy unit design is becoming increasingly specialised and every effort must be made to gain good, sound advice which mixes agricultural expertise with construction and design practice. Consultants should be viewed not only on qualifications but also reputation, enthusiasm for farm-building design and ultimately on an empathy with the farmer and the animal needs.

A team approach to design, calling upon the expertise and knowledge of all those involved in the process; from client, vet and herdsman to designer to ensure that the successful design is a source of great pride for all involved. This approach will lead to a working solution that can achieve the highest standards of cow welfare and management.

The design philosophy should produce facilities for cows that enable the labour force to manage the cows not the facility - i.e. the unit is an aid to better management not the complete package. Design teams concentrate on cow-centred design, resulting in high-quality facilities, high comfort and welfare standards where good management can produce high-quality milk profitably.

All farm building enthusiasts are of one voice when advocating a strategic approach to design - not only to consider the immediate solution but to plan ahead and consider the next 5,10 or even 20-years to ensure that a programmed, integrated development evolves.

The railway station in the town of Dumfries had, in years gone by, a billboard advertising evaporated milk by stating that it was ‘the home of contented cows’. Cow-centred design produces contented cows that aid the industry in maintaining a satisfactory level of return.

**Good quality advice in the highly-specialised area of farm building design is essential. The penalties for getting it wrong are high - both financially and at the expense of the highest standards of cow welfare.**
CHOOSING A MILKING PARLOUR TO MINIMISE MASTITIS

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INTRODUCTION

The title of this paper infers that, in some way, the choice of milking system may lead to either more or less mastitis. Before proceeding, it is vital to remember that mastitis is caused by pathogens, not milking parlours.

The risk of mastitis pathogens being spread from animal to animal, and from penetrating teat defences, can be influenced by incorrect operation or use of milking equipment and unsatisfactory milking management practices, environment and hygiene.

The choice of milking parlour often has a significant influence on the ability of dairy farmers, and their staff, to achieve and maintain recognised standards of “best practice”.

Dairy farmers face two broad areas of cost if mastitis is not controlled effectively. The direct costs of mastitis are in terms of treatment, loss of milk, replacing chronically affected animals and extra time taken during milking. Indirect costs arise in terms of penalties imposed by milk buyers when bacterial counts and somatic cell counts exceed certain levels.

At the same time, dairy farms, like all businesses, are under considerable pressure to minimise all costs, particularly labour. This can, and does, result in serious conflict of interests arising when choosing a milking system.

This paper discusses the main issues associated with choice of milking system that are likely to have an impact on the risk of mastitis. It would be reasonable to propose that the title of this paper should also be “Choosing a Milking Parlour to Maximise Profitability”.

OBJECTIVES IN CHOOSING A MILKING FACILITY

Whilst there are as many different reasons for choosing a new milking facility as there are farms, the following are often the main requirements expressed by dairy farmers:

• Increasing throughput of animals
• Replacing old, worn out equipment and buildings
• Improving the milking environment for both personnel and animal
• Keeping up with the neighbours
In addition to the above, a number of other issues should be included in the list of considerations. Unfortunately, the following are sometimes either forgotten or ignored:

- Meeting the requirements of both legislation and milk buyer
- Implementation of best practice, including adequate teat preparation and disinfection measures
- Information management
- Minimising the effects of the transition from old to new facility

**COWS PER HOUR VERSUS GOOD HUSBANDRY**

The question asked most frequently by many farmers is “How many cows can be milked per hour?”. This often leads to increasingly extravagant claims being made by installers. It is worth spending a moment to consider the following typical timings of milking routines:

**Table 1. Typical milking parlour work routine times, minutes per cow**

<table>
<thead>
<tr>
<th>Element</th>
<th>No Automation</th>
<th>HB</th>
<th>HB</th>
<th>Index</th>
<th>Rotary</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Full</td>
<td>Reduced</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Let in/Feed</td>
<td>0.10</td>
<td>0.1</td>
<td>0.1</td>
<td>0.03</td>
<td></td>
</tr>
<tr>
<td>Clean Teats</td>
<td>0.20</td>
<td>0.2</td>
<td></td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Foremilk</td>
<td>0.10</td>
<td>0.1</td>
<td></td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Attach Cluster</td>
<td>0.15</td>
<td>0.15</td>
<td>0.15</td>
<td>0.09</td>
<td>0.1</td>
</tr>
<tr>
<td>Take Off Cluster</td>
<td>0.10 ACR</td>
<td>ACR</td>
<td>ACR</td>
<td>ACR</td>
<td>ACR</td>
</tr>
<tr>
<td>Disinfect Teats</td>
<td>0.05</td>
<td>0.05</td>
<td>0.05</td>
<td>0.05</td>
<td>0.05</td>
</tr>
<tr>
<td>Let Out</td>
<td>0.05</td>
<td>0.05</td>
<td>0.05</td>
<td>0.03</td>
<td></td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>0.25</td>
<td>0.15</td>
<td>0.15</td>
<td>0.05</td>
<td>0.05</td>
</tr>
<tr>
<td>Total</td>
<td>1.00</td>
<td>0.8</td>
<td>0.45</td>
<td>0.45</td>
<td>0.4</td>
</tr>
<tr>
<td>Cows per man hour</td>
<td>60</td>
<td>75</td>
<td>133</td>
<td>133</td>
<td>150</td>
</tr>
<tr>
<td>Cows per 2 men</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>300</td>
</tr>
</tbody>
</table>

It is self evident that claims of high numbers of cows per hour are often based on omitting the elements of the routine which have the greatest bearing on minimising the risk of mastitis infection, teat preparation and pre-milking stimulation.
TEAT PREPARATION

An ADAS study investigating sources of bacterial contamination showed that:

- Clean teats of cows at pasture may contribute less than 100 bacteria/ml
- Clean teats of housed cows may contribute 10,000 bacteria/ml
- Milk from cows with dirty teats can have bacterial counts up to 100,000 bacteria/ml

Table 2. ADAS Study 1983/4 into effects of teat preparation

<table>
<thead>
<tr>
<th>Season &amp; housing</th>
<th>No Preparation</th>
<th>Washed and Dried</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winter - Housed Cows</td>
<td>9642</td>
<td>5230</td>
</tr>
<tr>
<td>Summer - Cows Grazing</td>
<td>2445</td>
<td>2149</td>
</tr>
</tbody>
</table>

Foremilking is an essential part of the milking routine. It should be remembered that removal of foremilk is:

- Required by the Dairy Hygiene legislation
- A contractual requirement with milk buyer
- An effective measure of identifying abnormal milk

Clearly, the amount of time required to clean cows can be minimised by management practices in the housing area and during grazing. The time taken to remove and inspect foremilk can be minimised where cow positioning is optimised and where the design of the stalling minimises the risk of milkers being kicked.

It is naïve to think that teat hygiene measures and pre-milking stimulation can be omitted without increasing the risk of mastitis infection.

WHAT SIZE OF PARLOUR - HOW MANY MILKING UNITS?

The optimum number of units in any parlour is very much determined by two factors:

- Total milking routine time
- Machine-on time

If the total milking routine time is one minute per cow, then the operator can achieve no more than 60 cows per hour. To achieve even this depends on cow places and units being available and no operator waiting time. Unit-
on time is very much a function of milk yield. A higher yielding herd will require more units in the parlour to achieve a given throughput.

Extra equipment should also be provided for milking infected cows. Ideally, a separate milk rejection line should be fitted and equipped with spare clusters. Apart from minimising the risk of carry-over of pathogens from infected to uninfected quarters and from animal to animal, the amount of disruption to the milking routine incurred by the need to rinse equipment effectively after milking infected animals can be reduced.

**BUILDING LAYOUT**

When planning a new milking facility, a great deal of consideration should be given to the siting of the building and to cow traffic routes.

It is self evident that simple, easy, open routing will speed up cow flow. It also will reduce the risk of milkers upsetting the cows in the period before milking. It should be remembered that adrenaline release in the cow interrupts the oxytocin based milk let down response.

It is also advisable to consider to the environmental aspects of the milking facility:

- Aspects of the collecting yard - coolness in summer, shelter from prevailing weather
- Ventilation - the atmosphere should be pleasant and free from any accumulation of stale air
- Ease of cleaning - if it can be cleaned easily, it will be cleaned

**CHOICE OF STALL TYPE**

There are a variety of types of stalling available. Some are better suited to certain farm circumstances.

It is essential to remember the purpose of cow stalling. For many, it is simply to hold the cow whilst the milking machine is attached. This is missing the main and most important points; cow positioning and cluster position.

In order to ensure consistent teatcup action on all four quarters and even milk out, it is necessary to ensure that the clusters hang squarely. To do this, means ensuring that the cow is positioned correctly relative to the milking equipment. It also means that, where necessary, milk tubes should be supported to prevent them from dragging and twisting the position of the cluster on the udder.
SUPPORT AND SERVICE

Firstly, the ability of the manufacturer and/or their dealer to install competently is vital. The milking equipment should also be tested to ensure correct operation before milking any cows.

Another essential factor in the choice of milking parlour is the availability of qualified, professional support and service. Many milk buyers now demand evidence of regular routine maintenance of milking machinery. The purpose of this is to ensure that the risk of the milking machine being instrumental in udder health problems is minimised.

The most preferable way of achieving this is for a qualified milking machine dealer to provide a regular planned maintenance service carried out in accordance with the equipment manufacturer’s guidelines.

MANAGEMENT SYSTEM

As herd size increases, it is more and more difficult for even the best stockperson to remember and process all relevant information about the individuals within the herd.

A significant factor in the choice of the milking parlour should be the associated automated management system. Aspects to be considered should include:

- Automatic cluster removal
- Milk metering
- Milk conductivity measurement
- Alarm lists showing cows whose performance is deviating from the norm
- Activity monitoring
- Compatibility with sensor equipment under development
- Capability to be networked with remote computers e.g. in farmer’s house

TRANSITION PERIOD

Lastly, but not least, consideration should also be given to the effects of the transition period.

Ideally, but not always possible, the new dairy unit should be on a site new site, minimising or eliminating the possibility of disruption to the cows. When existing milking facilities are modified or updated, the process can often mean a great deal of stress to both man and beast. In addition, where builders and installers are trying to work around cows, the time-scale can become protracted. In general, it is fair to say that cows and builders are not natural partners.
When cows are moved into a new facility, it is inevitable that their unfamiliarity will result in nervousness and apprehension. If the milkers, in their enthusiasm to make the new system work to its potential, are not sensitive to the mood of the cows, milk let-down and completeness of milking can be seriously affected during the first few milkings. In turn, this is likely to result in loss of yield and sub-clinical infections developing into clinical events.

This is particularly important where robotic milking machines are to be installed. Whilst automated milking systems have many attractions and advantages such as:

- Consistent teat preparation
- Quarter milking resulting in no risk of cross quarter contamination
- Individual quarter cup removal, eliminating over milking
- Reduced stress through elimination of the collecting yards

It is inevitable that, during the introductory period, cow attendance and milking intervals can be extremely variable. To ensure that milking performance does not suffer, and that the risk of cows with sub-clinical infections developing into clinical cases does not increase, it is vital that operators use management system information. Alarm lists should be able to highlight any cows not attending sufficiently often and/or at very irregular intervals. The operator should bring these animals to the milking unit at appropriate times.

**CONCLUSIONS**

Whilst throughput, in terms of cows per hour, is an important factor, emphasis must be placed on the need for appropriate hygiene based measures to be applied, on a routine basis. In particular, the manning level must be based on permitting the operator to carry out a complete milking routine, with particular reference to teat preparation, stimulation and teat disinfection.

It is vital that the milking parlour is built in such a way as to ensure consistent positioning of cows’ udders, in such a way as allows correct positioning of clusters.

The system must provide facility for collection and analysis of all relevant management information, together with the ability to generate appropriate reports and alarm lists.
A NEW DAIRY UNIT FOR FOOD PRODUCTION

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SUMMARY

A new green-field-site dairy unit, to replace two old and obsolete units, is being built at Compton. It will house 500-cows, kept on sand-bedded cubicles and milked through a 36-point rapid-exit, cellar parlour. The thought processes behind the decisions, including business and scientific justifications, are discussed.

THE HISTORY

For many years until the late 1980s there were three dairy herds at the Institute for Animal Health. They were managed fairly separately, although all converted to black-and-white cows but used different routines of husbandry and milking. One thing they had in common was a distinct lack of investment. This led to consolidation and restructuring reducing to two herds. At Cheseridge the herd grew from 160 cows to 220 cows, calving all year round. The Superity herd grew to 120 cows with two main calving seasons.

The Cheseridge herd has been housed in a mixture of cubicles, with straw on mats, designed for 1960s cows (!), and a dark kennel unit. Dry cows are in a loose yard. The parlour remains a 1970 installed Alfa Laval 16:16 herringbone, with jars and the original Alfa Yield recording system. Milking is in front of the legs using the HC150 claw and shielded liners. The parlour is cramped, dark with a low ceiling, and past its sell-by-date. The best part is that the original ceramic glazed block walls still clean up as new 30 years later.

The Superity herd is milked through a 1990-updated Alfa Laval 12:12 herringbone direct-to-line parlour (up from a 6:12 unit with the pit widened). The cows are manually identified and fed in the parlour. Whilst there is more light and space it is very hard to keep clean. Cows are in straw yards, originally very wet, but now drier after covering various passageways, and building concrete standings at the feed rails.

Progressively though the 1990s the demands on the farm just grew and grew, to provide cows and calves for the research programme and to be a commercial operation so that the large-scale farm studies reflect the real world. However, the increasing demands were not met with any proper investment in the facilities for the cows. At last the pressures on the obsolete systems became only too obvious and resolved to a simple decision between ‘invest in new facilities or get out of milk’. There is no option if the institute is to remain at the forefront of research on the health of the cow.
and calf, to meet market demands for product quality, to satisfy farm assurance and regulatory directives for animal welfare and to achieve product safety. In 2000 a new dairy unit became a firm target. However, that was only the start of the problems, matching the needs of the farm, with the wishes of the farm and scientific enthusiasts, and satisfying the bureaucratic and accountancy demands that had little experience of farm investment in the previous 30 years! Some involved had visions of a unit that would solve some of the underlying problems of dairy farming that we had struggled with for years whilst others thought a farm came off the shelf. This was a competition for a 1990 farm versus a farm that would reflect our aspirations for 2010. There are as many in the 1990s mentality on the supply part of this industry as anywhere else!

**THE SPECIFICATION**

The specification has become a compromise between the wish list of the farm manager, some of the scientific staff and the reality of what we can afford. Those who thought we had a pot of gold and those who thought a dairy unit cost loose change have not helped us!

The dream includes:

- a herd of 500 cows (all year calving?)
- milking cows in a food production unit
- managing mastitis and milk quality (SCC <100,000 cells/ml, Bactoscan averaging 5,000 impulses, clinical mastitis <10 cases/100 cows/year)
- new levels of socio-economic standards for staff in terms of working conditions, hours worked, rest and leave

**THE PROCESS**

This started with an independent group of consultants looking at our farming needs, examining the institute business plan and making properly considered suggestions. They looked at upgrading of the existing units, rebuilding on existing sites and a green-field site option. The cost of new for old, future structures and direction of the industry and the institute, as well as the limitations of the institute work and working practices were considered. The final solution was to marry the research-based production with our attempts for commercial success and reality, and catering for the specialist needs. The advantages for the local community also came in to the thought process and this has advantages for the environment and the planning process.

The final decision was for a green-field site. This is close to the centralised silage bunkers. It reduces hugely our use of village roads and most heavy machinery movements on these roads at unsociable times. It will allow removal of old and unsightly buildings from the skyline. Mostly a single unit allows centralised control, consistent management and operation and
economies of scale especially in staff. We do not seek actively to lose staff; rather our problem is to find and keep suitable staff in an area of low unemployment and extremely high living costs. A new building allows us to introduce ‘cutting-edge’ technologies and the best practices.

The dairy

The new facility is designed to house 500 cows in cubicles with late dry period animals loose bedded. The heifer calves will be adjacent.

The capacity of the system will allow us to manage our essentially commercial cows with special selectively breed genetic types for the science programme. We current have 55 cows of known MHC-type and this should grow to 100 cows, all producing calves of known genotype. To assist we also need 3 typed bulls on hand. The building has to marry research needs with commercial reality.

When milking we need to combine throughput with flexibility and with quality management. This means the highest quality milk, low Bactoscan and low SCC, and as little mastitis as possible.

In our old facilities we face many of the problems common throughout UK dairying. We have too many cows for the space, the cows become grubby and we are under pressure in the parlour so the routine is restricted. As cow numbers have risen so have the absolute number of cases of clinical mastitis but with only a small rise in the relative incidence. We are fortunate in that the increase all comes from environmental problems. We put into place a long time ago what we learnt and taught about contagious and summer mastitis. We have no Streptococcus agalactiae, we have had no real increase in Staphylococcus aureus – what we get comes largely from damaged teats, and we manage our dry cows and heifers to prevent ‘summer mastitis’. The rise in Arcanobacterium pyogenes can be traced to teat damage as the cubicles have deteriorated. To survive the last two winters in the old buildings all the old cubicles at Cheseridge have been ripped out. We face Streptococcus uberis, so we need to manage our bedding and pasture; and we face coliform infections, so we need to keep the cows cleaner and drier.

Table 1. Incidence of clinical mastitis (number of cases) in 5-year blocks at Cheseridge dairy (5)

<table>
<thead>
<tr>
<th>Year</th>
<th>Str. dysgal</th>
<th>Aes. +ve</th>
<th>S. aureus</th>
<th>Gram -ve</th>
<th>A. pyogenes</th>
<th>Others</th>
<th>No pathogen</th>
<th>Cases / 100 cows/y</th>
</tr>
</thead>
<tbody>
<tr>
<td>1985-90</td>
<td>23</td>
<td>119</td>
<td>56</td>
<td>63</td>
<td>15</td>
<td>6</td>
<td>23</td>
<td>36</td>
</tr>
<tr>
<td>1991-95</td>
<td>28</td>
<td>102</td>
<td>39</td>
<td>119</td>
<td>29</td>
<td>88</td>
<td>27</td>
<td>37</td>
</tr>
<tr>
<td>1995-00</td>
<td>37</td>
<td>146</td>
<td>50</td>
<td>144</td>
<td>43</td>
<td>31</td>
<td>54</td>
<td>42</td>
</tr>
</tbody>
</table>
The bedding systems
The late dry period cow-yard and the calving boxes in the new unit will be deep straw bedded for comfort and convenience in re-bedding.

The cows will be in sand-bedded cubicles for a number of reasons. They are more comfortable, the cows stay cleaner, sand is inert so bacterial pathogen growth and survival is limited (Table 2) leading to less mastitis, and it is cheap. We will have to face a number of problems in managing the bedding. We are addressing the drainage of the cubicles, we need to develop a system to fill the cubicles and to level the sand automatically, we need to have quality control on the supply of the sand and we need to optimise our system of handling the sand-slurry.

Table 2. Relative merits of different bedding systems in supporting bacteria

<table>
<thead>
<tr>
<th>Bedding system</th>
<th>Coliforms x 10^6</th>
<th>Streptococci x 10^6</th>
<th>Staphylococci x 10^6</th>
<th>Coliforms x 10^4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sand</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>Straw</td>
<td>3</td>
<td>110</td>
<td>331</td>
<td>8</td>
</tr>
<tr>
<td>Shavings</td>
<td>7</td>
<td>9</td>
<td>49</td>
<td>6</td>
</tr>
<tr>
<td>Sawdust</td>
<td>52</td>
<td>53</td>
<td>220</td>
<td>5</td>
</tr>
<tr>
<td>Reference</td>
<td>6</td>
<td>-</td>
<td>-</td>
<td>2</td>
</tr>
</tbody>
</table>

We expect that another very important factor will be better hoof condition. Problems we have considered include sand in the milking machine, especially the meters, and the teat preparation method.

The parlour
There are several possible parlour types and sizes that could be installed but only one realistic option. We are installing an 18:18 rapid-exit herringbone as fully automated as possible.

Table 3. Variation in average total milking performance score (cluster position, cow behaviour during and after milking, and completeness of milk removal). Low score is best (4)

<table>
<thead>
<tr>
<th>Parlour</th>
<th>n</th>
<th>Mean milking score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tandem</td>
<td>2</td>
<td>0.5</td>
</tr>
<tr>
<td>50° herringbone</td>
<td>6</td>
<td>2.8</td>
</tr>
<tr>
<td>80° herringbone</td>
<td>1</td>
<td>4.0</td>
</tr>
<tr>
<td>Parallel</td>
<td>3</td>
<td>3.3</td>
</tr>
</tbody>
</table>
Our research has shown that the best milking conditions for cows and milkers are probably found in tandem parlours (Table 3), but not to milk 500 cows. We showed problems with parallel parlours and those with similar packing arrangements. Also, we just cannot do our mastitis research when we see so little of the cow and can only deal with front teats at a full arm length and by touch alone. To give us the space we need a herringbone parlour. The choice is for an acute angle, approximately 33° with 1.1 m centres. This allows us to milk in front of the hind legs, to achieve good cluster hang and a clean take-off. A backing-gate and individual point identification will aid entry. The rapid-exit will give quick clearance as there will be plenty of space for the cows to step out to. On lifting of the gate there will be a flush of the standing also helping to move the cows as well as aid hygiene. The parlour will have 36 units using two milkers, who never leave the pit, allowing us to milk in 2.5 hours. This might be possible with 32 units but room is being left for expansion and the extra units will reduce any chance of milker idle time, a killer to efficiency.

We need all the staff time we can save as we will insist on a full routine for all cows at every milking. This includes full teat preparation to ensure a low Bactoscan and SCC, we want the premium milk price for the 20+ years life of the parlour. The new parlour will have all of the sensors currently available – pedometers, milk conductivity, milk temperature etc. – but with little faith in these for mastitis detection as no study has yet shown them any better than a milker for detection of mastitis (3). Recent MDC funded work has shown a high rate of false indications of mastitis using a conductivity trigger (Table 4).

Table 4. Estimation of false positive and false negative conductivity triggers for a cell count above or below 200,000 cells/ml (1)

<table>
<thead>
<tr>
<th>Conductivity trigger</th>
<th>Quarter SCC ≤ 200,000 cells/ml (%)</th>
<th>Quarter SCC &gt;200,000 cells/ml (%)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>None (&lt;10%)</td>
<td>1080 (70.2)</td>
<td>149 (9.7)</td>
<td>1229 (80)</td>
</tr>
<tr>
<td>10% or more</td>
<td>162 (10.5)</td>
<td>148 (9.6)</td>
<td>310 (20)</td>
</tr>
<tr>
<td>Total</td>
<td>1242 (81)</td>
<td>297 (19)</td>
<td>1539 (100)</td>
</tr>
</tbody>
</table>

We need to foremilk. We will foremilk all teats at all milkings to detect mastitis, to manage milk quality, to stimulate letdown and because it is a legal requirement. We have more than a suspicion that future farm inspections will pay closer attention to milk inspection. It is fully built into our calculations on how this parlour will operate.

The farm management wants the best throughput and to minimise the duration of milking. This can only be achieved by reducing the routine or by maximising the multiple of milking units and staff units. In the absence of automation throughput can only be 60 cows/hour/man (Table 5). Our
choice is calculated to get closer to 160 cows/hour. It includes two milkers
never leaving the pit. We allow no time for letting in as the staff are fully
occupied on the other side of the pit, similarly for letting out. We will use a
full preparation routine on 6 groups of three cows taking approximately 25 s
per cow to pre-dip, foremilk and wipe. We need extra time to dip teats after
milking so we will aim to save on attachment time by using a good technique
and good cluster availability. The milker time per cow is estimated at less
than 45 seconds. This allows conservatively 80 cows/man/hour.

Table 5. Milking routine and parlour capacity, time in seconds

<table>
<thead>
<tr>
<th>PROCEDURE</th>
<th>Full routine</th>
<th>Partial routine</th>
<th>Planned routine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Let in/feed</td>
<td>0.1</td>
<td>0.1</td>
<td>-</td>
</tr>
<tr>
<td>Clean teats</td>
<td>0.2</td>
<td>-</td>
<td>0.3</td>
</tr>
<tr>
<td>Foremilk</td>
<td>0.1</td>
<td>-</td>
<td>0.1</td>
</tr>
<tr>
<td>Attach cluster</td>
<td>0.15</td>
<td>0.15</td>
<td>0.1</td>
</tr>
<tr>
<td>Detach cluster</td>
<td>ACR</td>
<td>ACR</td>
<td>ACR</td>
</tr>
<tr>
<td>Disinfect teats</td>
<td>0.05</td>
<td>-</td>
<td>0.05</td>
</tr>
<tr>
<td>Let out</td>
<td>0.05</td>
<td>0.05</td>
<td>-</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>0.15</td>
<td>0.15</td>
<td>0.15</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>0.8</strong></td>
<td><strong>0.45</strong></td>
<td><strong>0.7</strong></td>
</tr>
<tr>
<td>Cows/ man /h</td>
<td>75</td>
<td>133</td>
<td>85</td>
</tr>
<tr>
<td>Cows/ 2 men /h</td>
<td>150</td>
<td>265</td>
<td>170</td>
</tr>
</tbody>
</table>

We will teat dip because it is the best way at present to apply disinfectant, it
uses less disinfectant and it reduces aerosols and hence improves the safety
of the milkers. The other significant aspects of the parlour are that it will be
direct-to-line with all of the equipment in a cellar. This protects the
equipment and keeps it much cleaner, especially important in a hard-water
area.

Milk quality targets
In maximising the effectiveness of the parlour we have to target the best
milk quality to ensure the premium price from the best paying buyer. That
means we have to address their purchasing policy which must include the
minimum requirements of current farm assurance and legislative needs. We
have also got to be able to respond to future requirements. Hazard
Awareness and Critical Control Path (HACCP) approaches are unlikely to be
adopted in primary production but following Codes of Practice under likely
EU food hygiene directives will be essential, as well as the codes necessary
for international trade. The CODEX Alimentarius will however not be
stricter than EU requirements. Our target has to be milk consistent with a
Bactoscan less than 5,000 impulses and a cell count less than <100,000
cells/ml. Keeping abnormal milk out of the bulk tank is still best done by
examining foremilk and we will adhere to our legal obligation until such time as sensor technology is allowed and effective. Abnormal milk can be minimised by achieving a low incidence of clinical mastitis. Keeping cows clean and dry in our sand-bedded cubicles should reduce our coliform infections and prevent almost all of our Str. uberis mastitis. We will manage the other forms of mastitis by rigorous adherence to the Five-point plan, especially teat dipping and dry cow treatment of all cows.

We have presented a summary of what we aim to do and why. Many others, not least in the UK, will have contrary views. We are currently seeing nationally a significant investment by dairy farmers, unfortunately fore the wrong reason (FMD) and this may be being accompanied by wrong, at least in the medium to longer-term, decisions on refurbishment, updating and investment. Much of what is happening is a product of not learning the lessons in biosecurity, quality management and socio-economic changes. Time will tell what are the better strategies. Who will be here in 3-4 years to show which systems are successful and have survived?

REFERENCES

PLANNING FOR REDUCED STRESS IN THE HERRINGBONE

John Gerring
Mount Pleasant Farm, Buckland, Faringdon, Oxfordshire, SN7 9PY

THE PROBLEM

Recent trends in the dairy industry have resulted in the need to produce milk at a lower cost, without increasing demands on people and cows. This has resulted in Farm Animal Welfare becoming a dominant issue in order to achieve these objectives, alongside the need to introduce systems that will provide our people with a much-improved working environment. Reducing costs can be achieved from short-term gains. The secret for long-term survival is to ensure that the gains are achieved in harmony with the welfare of the cow and its productivity, and enhancement in the lives of our people.

BACKGROUND

Mount Pleasant Farm is situated in the central part of the country, in an area not ideally suited for milk production but it is ideal in that it is an area of high population density.

The farm consists of 500 acres in total, supporting 400 cows and 150 followers. The cows are divided into two mobs, one calving in the late summer and the other in the late winter. The cows will average in excess of 8000 litres per cow this year. All of the milk is processed and retailed to local shops and homes.

In 1995 we decided to invest in a new milking parlour, having seriously outgrown our 16/16 low-line system. It was causing problems typical of many farms today, i.e. unhappy cows, unhappy milkers, unacceptable mastitis and lameness, and very poor throughput.

With the assistance of ADAS we set out the following objectives for our future parlour:

1. To milk 150 cows per man-hour
2. To have very low stress on cows
3. To have very low stress on people
4. To have minimal mastitis
5. To minimise investment to £80,000

Many farms were visited throughout the UK, where we set up a system to measure the efficiency of these units. I have to say that we were disappointed by what we saw.

Our next move was to interview the British manufacturers of milking equipment. The result of this was that we were faced between some wanting
to help us meet our objectives, although they had no experience of doing so, to others who just walked away from the interview.

THE SOLUTION

At this time panic was encroaching into our team, so it was decided that I would take a four week sabbatical in New Zealand, having already spent time examining cow behaviour, and cow flow in Australia and the USA.

During this period I visited almost 50 milking set-ups, and milked in many of them. They ranged from herd sizes of 150 to 1500, almost all were swing-over herringbones ranging from 16 to 100 sets of cups, throughput ranged from 100 to 180 cows per man hour, and in the milking period animal welfare and husbandry were of a very high standard.

In New Zealand the sale and installation of the stall-work, and the milking equipment is quite separate. So I interviewed both stall-work and milking machine manufacturers. The result was that we commissioned Colin Millar from Reporoa Engineers to install the stall-work, and Waikato Milking Systems to install the milking equipment.

The parlour was working within six months, and consequently Waikato Milking Systems have set up in the UK. Added to this, Colin Millar and I now work together fabricating Parlours and Backing Gates. Our company is called “Mount Pleasant Milking”.

MOUNT PLEASANT MILKING

The philosophy
The Mount Pleasant philosophy is to produce milk at the lowest possible cost in a stress free environment for both people and cows.

To improve performance radically, this requires a completely different approach to milking. We take a greater consideration of the effects on the cow and milker and seeing matters from their perspective.

We always consider the total design.

General position of parlour
How the parlour fits into the farm and all of its need has to be considered. This includes all the practical aspects of its operation for the staff and the cows. The cows will be exiting in our systems to the paddocks and to fresh feed, that should be as easy as possible. We want to have an in parlour slope of 1.5 degrees.

The parlour-related facilities have to be in the correct place. For us these include toilets, the office and the crèche! We consider where the bulk tank has to be and how the tanker will get to it.
Collecting yard
The collecting yard should be rectangular and about 10 metres wide. It is essential to have a good backing gate but this should not be electrified.

Stray voltage
To avoid any problems of stray voltage we install welded mesh over the whole site of the parlour and extend this into the collecting yard. It is important to keep electric fencers well away too.

Parlour entrance
Lead-in rails aid entry of cows to the parlour. There should be no corners.

Light and vision
To see properly in the parlour there has to be good light and shadows should be avoided. We have one side of the building open and all site artificial lighting is directed towards the udder.

Obstructions
Good cow movement requires a safe and unobstructed route. This means no steps, no grids in the floor and good repair to the concrete, so that there are no holes.

Parlour design
I believe in keep electronics in the parlour to a minimum. There should be no feeding in the parlour if possible. ACR are a hindrance. Generally it is important to cut down on noise in the parlour.

The spacing in our parlour is 760 mm between cows. The parlour has a zigzag rump rail and an adjustable breast rail. The pit width is 1500 mm and the pit is 900 mm deep. The other requirement is for a good washdown system.

Exit
Cows need to exit from the herringbone race by going straight forward.

Operators
It is important that the operators are fully and properly trained. When in the pit they have to stay forward at all times.

In parlours where these features have been given full consideration, then the stress levels on cows, and particularly on milkers, have been seen to be dramatically reduced. One can use simple methods to measure the improvement in the stress level on the cows. Make a few observations. Are significantly fewer cows dunging in the parlour? Are the cows standing contentedly, and cudding while being milked?

The first three, of the type of parlour described, have now been in operation for at least one year. The benefits that have occurred from improvement cow throughput and the reductions in mastitis and lameness are shown in
Table 1. The added benefits from this changed environment have come from the better overall health of the cows.

**Table 1. Parlour performance and effect on cow health**

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>INSTALLATION</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Throughput (cows/h)</td>
<td>Before</td>
<td>After</td>
<td></td>
</tr>
<tr>
<td>Herd 1</td>
<td>65</td>
<td>150</td>
<td></td>
</tr>
<tr>
<td>Herd 2</td>
<td>70</td>
<td>180</td>
<td></td>
</tr>
<tr>
<td>Herd 3</td>
<td>65</td>
<td>150</td>
<td></td>
</tr>
<tr>
<td>Lameness (feet lifted)</td>
<td>Before</td>
<td>After</td>
<td></td>
</tr>
<tr>
<td>Herd 1</td>
<td>30</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Herd 2</td>
<td>34</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Herd 3</td>
<td>Not available</td>
<td>Not available</td>
<td></td>
</tr>
<tr>
<td>Clinical mastitis (cases/100 cows)</td>
<td>Before</td>
<td>After</td>
<td></td>
</tr>
<tr>
<td>Herd 1</td>
<td>33</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Herd 2</td>
<td>11</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Herd 3</td>
<td>25</td>
<td>14</td>
<td></td>
</tr>
</tbody>
</table>

The stress removed from milkers is much more obvious.

“My milking time has reduced by 40%.
“My life has changed dramatically”
“I am not tired all the time”

**SUMMARY**

There is enormous pressure on dairy farming at the present time, and that pressure will not go away. Inevitably herd size will increase quite dramatically. Many farmers will cease production; others are looking positively at the future. To stay in milk we must rethink our objectives and strategies. A major part of the rethink is to consider the people that milk our cows and the welfare of the cows themselves. We need a new direction and new vigour to find a way forward. It is essential to reduce the stress on our cows and particularly our people.

Our answer lies in adopting a new philosophy to milking and training our teams to adopt new processes that will enhance their lives and the lives of their cows.
MILK SOMATIC CELLS – WHAT DO THEY DO?

Julie L. Fitzpatrick
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How do animals get disease? The answer is through complex interactions among the host, the environment and the pathogen. It is these interactions that we need to understand in order to control and prevent mastitis in dairy cows. The phenotypic characteristics that a cow displays (P), are a combination of the genotypic value (G), and the environmental deviation (E) i.e. \( P = G + E \). Thus, identification of genes responsible for resistance or susceptibility to mastitis, and of important pathogen and management factors associated with mastitis, should be the aim of current and future research programmes.

Mastitis is not a single disease but is intra mammary infection caused by any of a large number of very different bacteria. For ease of understanding, bacterial pathogens have been subdivided into categories such as “contagious” and “environmental” pathogens and yet, it is becoming clear that the distinctions between the two are less definite than originally thought. Environmental pathogens such as Escherichia coli have been shown to persist in the mammary glands even in the dry period (2), contradicting the dogma held for many years that the dry gland did not support extended growth of E. coli. Similarly, Streptococcus uberis has been shown to persist within the udder and to transmit from cow to cow or quarter to quarter, rather like a contagious pathogen. There are a number of possible reasons for these recent results. First, new molecular and immunological techniques make isolation and identification of bacteria and bacterial strains more accurate; secondly, that bacteria are continually evolving to ensure their survival and persistence in the host or in the environment, and thirdly, that we may be breeding animals that are more or less susceptible to certain bacteria.

The udder is a major mucosal site in ruminant species both in terms of size and in importance for milk production and immunological protection of the neonate. The other major mucosal sites in the cow include the skin, the gastrointestinal tract, the respiratory tract and the reproductive tract. The udder differs from these other sites in a number of ways: the skin, gastrointestinal and respiratory tracts are in regular contact with foreign antigens or pathogens and the immune responses induced in these sites include protection against tissue invasion by pathogens, clearance of infections and, in the gut, tolerance to food antigens. The reproductive tract differs in that its immune system must be able to respond to infections introduced during service and at parturition, while not rejecting the conceptus.
which contains antigens foreign to the dam, that are derived from the sire. In the case of the udder, the mucosal surface is exposed to pathogen challenge less frequently than other mucosal sites, although it is potentially challenged twice daily by bacterial invasion through the teat duct during the milking process. Intramammary infection may also occur at times other than during milking, especially if the teat duct is open or damaged, allowing interaction between bacteria and the surface area of the mucosa which is particularly large, especially during lactation.

The immune response is important at mucosal sites and immune cells, in addition to soluble factors such as antibodies, provide some of the main protective mechanisms against infection in most species. Cells have been shown to be important in protection against other important infectious diseases of cattle including respiratory viruses, metritis and tuberculosis. Cells are, however, not all the same, and include subsets such as B cells, T helper (Th) cells, T cytotoxic/suppressor (Tc/s) cells, natural killer (NK) cells etc. A well-known example of the importance of different cell subtypes in disease include Human Immunodeficiency Virus where the number of Th cells is reduced (3). It is biologically likely, therefore, that cells will play a role in the defence of the udder, although it is difficult to extrapolate from other organs and species due to the wide variation in responses identified in previously published work.

The protection of mucosal sites comes from a complex system of interlinked defence mechanisms which can be classified into the ‘non-specific’ (innate) and ‘specific’ (acquired) immune systems: these systems have the combined ability to destroy or control most pathogens. Innate immune responses are triggered rapidly and focus on structural components associated with particular pathogens such as bacterial cell wall components (1), whereas, the acquired immune system requires a longer period of time to respond than the innate system, but focuses specifically on epitopes expressed by a pathogen. Different cell types are associated with the different arms of the immune response, with neutrophils, macrophages and NK cells considered part of the innate system and T and B cells part of the acquired system, although there is considerable interaction between the two systems.

Cells isolated from milk in normal, non-inflamed, mammary glands have been shown to comprise epithelial cells, B cells, T cells, macrophages and neutrophils. Macrophages form the greatest proportion of cells for most of lactation except in the period of colostrogenesis or towards the end of lactation when neutrophils predominate (8). In the presence of infection, cells are recruited from the tissues surrounding the milk-secreting alveoli and from the systemic circulation and neutrophils form the greatest proportion of the cells in the mammary gland tissues and secretions. The relative
contribution of cells from the local tissues and from the systemic circulation to the mammary secretions is not clear. There is a tendency in some publications to consider all cells as a single population rather than identifying them as comprising different cell subtypes. This has lead to some immune responses being attributed in the literature to say, neutrophils - the cells present in greater numbers than other types during infection - when the measured response may actually be due to cells that are less numerous within the cell population but which may, nonetheless, be equally or more important than neutrophils. Interactions between bacteria and immune cells can happen at three levels in the udder: in the secretion collected in the gland cistern or in the ducts and alveoli; in the tissues surrounding the milk-secreting alveoli; or in the supramammary lymph node that drains lymph from the mammary glands. It is possible that induction of a variety of protective responses may occur at all of these three sites.

At the Symposium on Immunology of the Ruminant Mammary Gland in Stresa in 2000 (17) many of the presentations described laboratory-based studies on the role and function of immune cells. There are far fewer epidemiological or farm-based studies on the role of milk somatic cells in protection of the udder. It has been shown by many authors that high individual cow somatic cell counts (SCC) are positively correlated with clinical mastitis due to persistent infections especially with S. aureus (5). Fewer studies have examined low or very low SCC herds and cows but there is evidence that the risk of clinical mastitis is increased with low SCC compared to those with higher SCC (18). As the protective immune responses occur in individual mammary glands, more information on the role of SCC at the quarter level is required to increase understanding of local immunity against pathogens.

Many experimental studies have shown that high, or even moderate, numbers of somatic cells in milk protect against infection with both major and minor pathogens (3). The cell numbers were increased either by mechanical stimuli (11) or by the introduction of bacteria. What remains uncertain is whether protection is conferred by activated innate immune cells and/or antigen primed immune cells, or whether competition between bacterial species for essential nutrients prevents establishment of infection with the “challenge” bacteria. Similarly, the presence of certain bacterial species of low pathogenicity, sometimes termed “commensals”, has been shown to confer protection against other, more pathogenic bacteria. As it is likely that cells, and other soluble factors derived from cells or elsewhere, increase in the presence of bacteria, it is difficult to ascertain the precise mechanisms involved in udder protection.

There are also likely to be differences in the type of immune responses that are important in clearance of infection caused by different
pathogens. Th cells were shown to be important in protection of the udder in the early stages of infection with *S. aureus* (13), while in later stages, Tc/s cells may inhibit these Th responses (12). In mice it has been shown that responses against intracellular pathogens (e.g. mycobacteria) may result from Th1-type responses where certain soluble factors (cytokines such as interferon-γ and interleukin-2) are released, whereas responses against extracellular factors such as toxins may result from Th2-type responses where the cytokines interleukin-4 and interleukin-10 predominate (9). There is, to date, limited work on this area in relation to bovine mastitis, however, there are potential comparisons that could be made between *S. aureus* as a pathogen that has been shown to persist intracellularly within neutrophils and macrophages, and *E. coli* that produces extracellular endotoxin as an important virulence factor. For some pathogens, cells of the acquired immune response with specific memory of that pathogen may be important in protection, either by directly killing cells or by attracting other immunologically competent cells to the site of infection, while for other pathogens, cells of the innate immune response may be more important. These cells may be involved in phagocytosis and bacterial killing, or by activating and directing cells involved in specific immunity. The role of Toll-like receptors and pathogen-associated molecular patterns in bovine mastitis may be of future interest with the recognition that one form of the receptor regulates endotoxin that is produced by Gram-negative bacteria, while another form of the receptor regulates Gram-positive responses (4).

If it is accepted generally that cells are important in defence of the udder, then the argument remains as to whether it is important to have cells actually present in the mammary secretion ready to interact immediately with bacteria when they penetrate the teat duct or, whether it is reasonable to rely on the recruitment of effector cells from the general circulation into the already infected gland. It is possible that the answer may vary with pathogen type e.g. *E. coli* are known to produce large amounts of endotoxin within 4-6 hours of intramammary invasion and that the systemic effects of the toxin can be very rapid and severe. Cell recruitment has been shown to start around 4 hours and to peak around 12 hours after infection. Other pathogens may produce toxins that act on local tissues and may take longer to have a pathological affect on the host and to induce an immune response. Some of the factors of importance in recruitment of cells into mucosal sites have been identified in other species as intercellular adhesion molecules on blood vessels and immunological and inflammatory cells. Neutrophils express β2 integrin which interacts with intercellular adhesion molecules on blood vessels and permits movement of cells into tissues. The importance of cell recruitment is seen in an extreme example with leucocyte adhesion deficiency in cattle caused by mutations in the β2 integrin molecule (16), where affected individuals are unable to recruit cells into distant sites and develop multiple infections (7).
It is accepted widely that high SCC are undesirable for economic (19) and milk quality reasons. Many genetic studies have shown a positive linear association between SCC and clinical mastitis in that as SCC reduces, then clinical mastitis also reduces (10), suggesting that selection for low SCC also provides benefits to dairy cow welfare. However, the studies on the relationship between SCC and clinical mastitis have often not included pathogen-specific diagnoses of mastitis. Rogers and colleagues (14) showed that sires with the lowest predicted transmitting ability (PTA) for somatic cell scores had daughters that had the lowest clinical mastitis rates for all pathogen types. It is possible, that with cows being culled increasingly for high cell counts and bulls being selected for low PTA for SCC, that the potential increased risk of infection in low SCC quarters may soon become apparent.

Breeding for a certain trait that may be associated with immune function, such as low SCC, may potentially and inadvertently, lead to altered or reduced immunity by other mechanisms, as has been shown to occur in number of species. It is possible that cattle may be selected for breeding that have either poor innate responses, poor specific responses or poor cell recruitment ability. There are numerous genes that may be involved in mastitis resistance or susceptibility but the Major Histocompatibility Complex that is involved in recognition of antigens (15), the Toll genes, and genes coding for adhesion molecules, may be of particular importance. The rate of loss of genetic variation is proportional to the rate of inbreeding and the major influences on this rate are the number of parents used of each sex and how much selection is taking place in the population (20). The number of cattle breeding companies and breeding bulls is declining and hence breed diversity is reducing rapidly worldwide. The effect of this on disease susceptibility, and on mastitis susceptibility in particular, should be watched carefully.

In conclusion, it is likely that somatic cells are very important in mammary gland defence. It may not be total numbers that are important but the cell type, subtype and the products and interactions of those cells that may affect the outcome of infection – cure, persistence of infection, or even death of the cow. It is also likely that the important immune cells will differ for the widely different bacterial species and strains. It remains to be seen if cells must be present within the mammary secretions or the mammary tissues or whether cell recruitment can be relied upon for a speedy and successful response to intramammary infection. It is likely that the answer will come from continued field and laboratory studies with both naturally-occurring and experimentally-induced mastitis.
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MASTITIS PROBLEMS IN LOW CELL COUNT HERDS

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INTRODUCTION

In the early 1990s dairy farmers in Somerset started to complain to their veterinarian that mastitis was making some cows in their herds very sick and that often it was their 'best', lowest cell count cows that were affected. This triggered much of the research into low cell counts and clinical mastitis in herds in the UK over the last ten years. Similar investigations have been carried out simultaneously in both the Netherlands and France. Some results have been consistent, others apparently contradictory. However, as the threads of the research have been pulled together some of the contradictions have proved to be complementary pieces of information.

This paper summarises the results of the last few years’ observational research on clinical mastitis and somatic cell counts and attempts to identify strategies that may be adopted to reduce the problem of clinical mastitis in low cell count herds. You will see that we know far more about the problems than what we should do about them!

MASTITIS AND SOMATIC CELL COUNTS IN MILK

Mastitis and milk somatic cell count concentrations are closely linked. Milk SCC increases in response to intra mammary infection. It now appears that quarter SCC concentrations before infection affects the risk of subsequent clinical mastitis.

Current levels of mastitis

Current estimates of clinical mastitis are that it occurs at a rate of approximately 40-quarter-cases per 100 cows per year irrespective of bulk milk somatic cell count BMSCC (Figure 1). This figure has remained unchanged for almost 20 years.
Figure 1. Relationship between incidence rate of clinical mastitis and mean annual bulk milk somatic cell count in 300 Dutch dairy herds (1)

There is a wide variation in the incidence of mastitis in individual herds. A recent study identified between 0 - 165.6 quarter cases per 100 cows per year in herds with a BMSCC<150,000 cells/ml (E. Peeler, pers. comm.).

**Somatic cell count - herds and cows and quarters**

Somatic cell count concentration (SCC) can be measured from an individual quarter, cow or from bulk tank milk. Measuring quarter SCC provides the most accurate estimates for studying SCC and mastitis, since both occur in individual quarters of cows, but it is not currently economically feasible on commercial farms.

**Bulk tank somatic cell count**

The economic pressure to reduce BMSCC in the UK has been intense and the current estimate is that the national herd BMSCC is approximately 170-180,000 cells/ml, although this figure is hard to verify. If this is accurate then >50% of herds have a BMSCC less than this figure.

**Cows in herds**

The BTSCC estimate is a product of each cow's somatic cell count concentration and the volume of milk she is producing. Using data from 100 herds with a BMSCC <150,000 cells/ml, one of us found that the proportion
of cow SCC less than 20,000 cells/ml was 34% for herds when the BMSCC was <50,000 cells/ml and 13.5% for herds with a BMSCC >150,000 cells/ml. Conversely, the proportion of cows with SCC >200,000 cells/ml was 5% and 18% in these same herds respectively. These results indicate that the distribution of cow cell counts differs as BMSCC increases. There is a greater proportion of cows with very low SCC when the BMSCC is low. Beaudreau et al., (2) demonstrated that for a given BMSCC the proportion of cows with low, medium and high SCC may vary considerably.

QUARTER SCC AND THE RISK OF MASTITIS

It is better to have low SCC quarters than high, but how low?

Edmund Peeler studied 3 herds in Somerset for 12 months. He recorded the quarter SCC concentration of all milking cows each month for one year and related these to all cases of organism specific mastitis. He found that quarters with a SCC less than 20,000 cells/ml were at an increased risk of:

a) all mastitis
b) *Escherichia coli* mastitis
c) *Streptococcus uberis* mastitis

Consider that 30% of quarter SCC were ≤10,000 and 50% ≤20,000 cells/ml, this risk becomes considerable for many herds (Figure 2).

Figure 2. “J” shaped distribution of risk of clinical mastitis against quarter SCC derived from multi-level model of clinical mastitis
Additionally, after the clinical case the quarter SCC tended to remain higher and did not always return to the pre-infection level during that lactation, so, quarters that had had mastitis tended to have a higher SCC over the whole lactation (Green et al., these proceedings). However, quarters with pre-infection levels of less than 20,000 cells/ml had a SCC similar to quarters that had not been infected.

**Increase in the severity of mastitis**

There is also evidence that when low SCC cows suffer clinical mastitis they are more likely to be sick (7). The incidence of clinical mastitis with severe systemic signs was also significantly higher in low cell count herds (3,1,8).

**Cow SCC and the risk of mastitis**

Just as the BMSCC is a product of volume and SCC from each cow so the cow SCC is a product of the volume and SCC from each quarter. This effectively makes the association between quarter and cow SCC quite variable. A cow with an SCC <20,000 cells/ml has a high probability of having 2 quarters with SCC <5-10,000 cells/ml. Once a cow has a SCC ~60,000 cells/ml she is likely to have only one quarter at <5-10,000 cells/ml. Effectively halving her risk of mastitis from low quarter SCC. Surprisingly, once a cow has SCC >60,000 cells/ml she appears to be at no greater risk of having more than one quarter <20,000 cells/ml than a cow with SCC >200,000 cells/ml.

So, ideally all the cows in a herd should have a SCC of 40-100,000 cells/ml. In reality this stability appears uncommon, why is not known.

**Other determinants**

Two important determinants of mastitis and somatic cell count are the host immune function and any inherited traits, both discussed elsewhere in these proceedings. Various other management factors have been linked to mastitis independently of BMSCC. Peeler et al. (5) presented those associated with herds with a BMSCC <100,000 cells/ml. These included many factors previously identified e.g. farmers that reported higher levels of mastitis had cows that leaked milk, also they cleaned loafing yards and bedded less frequently. Many of the management factors that prevented mastitis in these low cell count herds (<100,000 cells/ml) are part of the five-point plan. The one controversial piece of evidence that has now come from several studies is that the use of post milking teat disinfection is associated with higher levels of clinical mastitis in herds with a low BMSCC. However, Lam et al. (4) tested this in an intervention study and found that when producers stopped using post milking teat disinfection mastitis caused by 'environmental organisms' decreased, but in some of the herds mastitis caused by contagious organisms increased. So, use of post milking teat disinfection remains controversial.
CONTROL

We are attempting to control mastitis all the time.

What can we do?

- Ensure that the 5-point plan is being carried out properly,
- Keep lying and loafing areas and pre and post milking yards clean with cleanable surfaces,
- Consider using sand as bedding substrate,
- Record individual cow SCC,
- Monitor cows with a SCC <40,000 cells/ml and check them frequently for early signs of mastitis or systemic disease.

CONCLUSION

There is not a linear relationship between bulk milk somatic cell count and the incidence rate of clinical mastitis. There appears to be a greater proportion of severe (toxic) cases in low bulk milk somatic cell count herds. Evidence is accumulating that at the very low end of the distribution of somatic cells (<20,000 cells/ml), cows may be at higher risk of clinical cases of mastitis, or show more severe signs when becoming infected.

Clearly, somatic cells play an important role in the immunity of the uninfected and not inflamed mammary gland. A complete absence of cells would put cows at risk for disease, and the current reports suggest that a very low concentration of somatic cells increase the risk of clinical mastitis and of severe clinical mastitis.

Where the bulk tank milk SCC averages <200,000 cells/ml it appears that there are susceptible cows within the herd. Not only are the few cows with high SCC at risk of mastitis but those with low SCC (<20,000 cells/ml) are at increased risk as well. This can be a considerable proportion of the herd in herds with a BMSCC less than 150,000 cells/ml.

In herds with bulk milk SCC <150,000 cells/ml there is still sufficient variation in clinical mastitis incidence to identify some management procedures that are associated with both a low bulk milk somatic cell counts and a low incidence of clinical mastitis (5,1). However, we are far from identifying useful and tested strategies that consistently result in low levels of mastitis in low cell count herds.
REFERENCES


REDUCTION IN MASTITIS INCIDENCE FROM SELECTION FOR REDUCED SOMATIC CELL COUNTS – GOOD OR BAD?

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INTRODUCTION

Mastitis remains a major effect on the profitability of dairying, despite sustained efforts over many years to reduce its incidence and prevalence. Prior to 1998, these efforts were by management initiatives. Since 1998, however, when the Animal Data Centre first provided Predicted Transmitting Abilities (PTAs) for Somatic Cell Counts (SCC), it has been possible for farmers to identify bulls predicted to decrease SCC and hence, by correlated response, the incidence of mastitis.

It has not been possible to select directly to reduce mastitis because of problems in collecting information on the incidence and prevalence of mastitis routinely via milk recording organisations. Such problems continue today, although the increasing use of on-farm computer packages offers hope that better data will be available in the future. However, this will involve education, training and the willing co-operation of farmers.

Fortunately, it has been clearly established that SCC is an extremely good indirect measure of mastitis (3). It has the major advantage that it is routinely recorded at regular milk recording visits. The high genetic correlation between SCC and mastitis of approximately 0.7, justifies its use as an indirect measure, with some research studies showing an index of SCC and selected type traits to be equally useful as a direct measure of mastitis.

Despite the known high cost of mastitis and the benefits which will accrue through selection to reduce SCC and hence, mastitis incidence, concerns have been expressed regarding the use of SCC on the grounds it may ultimately affect the animal’s ability to fight infections if very low SCC levels are achieved.

The general objective of this paper is to consider whether this is so and, therefore, whether other means of reducing mastitis by breeding need to be considered.
EFFECTIVENESS OF SCC AS AN INDIRECT MEANS OF REDUCING THE INCIDENCE OF MASTITIS

A number of studies confirm that selection based on SCC will reduce the rate of increase in clinical mastitis. The relative effectiveness of this will depend on whether SCC is used on its own or together with other traits in an index, e.g. together with conformation traits and milking speed (3).

Within the UK it is too early to assess the use of SCC PTAs, as they have only been available for three years. However, the main objective in recent years has been to increase production, which has been very successful. SCC have been viewed very much as a secondary trait and perhaps only considered for bull selection if the herd has a major problem leading to payment scheme penalties.

The current genetic trends in SCC are shown in Figures 1 and 2 for bulls and cows.

Figure 1. Trends in somatic cell count (SCC) predicted transmitting abilities for Holstein Friesians (bulls and cows)
Figure 2. Trends in somatic cell count (SCC) predicted transmitting abilities for cows (6 breeds)

The Holstein trend for both bulls and cows is clearly towards higher cell counts. This is a function of successful selection for production in that breed. In the Ayrshire, Jersey and Shorthorn breeds the trend is also increasing, although it is less pronounced. It is only in the Island Jersey and Guernseys where SCC are declining. On the basis of this information, there is clearly a case for paying more attention to SCC in the national breeding program for some breeds.

The trend in bulls for breeds other than Holstein have not been presented due to the small number of bulls in each annual year of birth group.

### USE OF SCC EVALUATIONS AS A SELECTION TOOL

Sire evaluations are reported in terms of bull PTAs, expressed as a percentage, i.e. % PTA. The overall range of % PTAs found is +/- 30%. In practice however, 95% of the bulls lie in the range +/- 10%.

As with production PTAs, the interpretation is the same. For example, taking two bulls, one with a % PTA of −10% and the other with a % PTA of +10%. The first bull is expected to pass on to its daughters a 10% reduction in SCC levels,
whereas the second bull is expected to pass on a 10% increase. The difference between the bulls daughters is therefore 20%.

In summary, for every 1% in SCC PTA, a change of 1% in cow SCC is predicted.

It is important to note that a negative % PTA SCC indicates a reduction and is therefore good as this should lead to a reduced incidence and prevalence of mastitis.

Examples of SCC PTAs:

<table>
<thead>
<tr>
<th>BULL</th>
<th>REL %</th>
<th>PTA</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>64</td>
<td>-2</td>
</tr>
<tr>
<td>B</td>
<td>73</td>
<td>+35</td>
</tr>
<tr>
<td>C</td>
<td>83</td>
<td>-15</td>
</tr>
<tr>
<td>D</td>
<td>98</td>
<td>+16</td>
</tr>
</tbody>
</table>

Bulls with negative PTAs can be used in all herds. If the PTA is between 0 and +10 then there should be no problem in most herds. PTAs of +11 to +19 indicate caution should be exercised depending upon the SCC average of the herd. SCC PTAs of +20 or greater are very high and will lead to future problems. At all times it is important to consider the reliability of the evaluation.

The current average SCC PTA of the top 50 Holstein bulls ranked on the National Index £PLI and marketed in the UK is +4, indicating a predicted increase in mastitis prevalence if only these bulls were used on the national herd. Figure 3 is a histogram of the current marketed Holstein bulls in the UK. A total of 700 bulls are included. The average SCC PTA is +2 with a standard deviation of 9.

There is a very distinctive normal distribution of bull PTAs. While this indicates a sound evaluation system, it also indicates the availability of bulls that will reduce mastitis prevalence.

To date the general advice given has been to consider SCC as a secondary trait, to be considered after initial screening on production and conformation. The trend away from production towards health and welfare is gathering pace and current initiatives are to include SCC in selection indices, which is not the case at present. Given this change, therefore, SCC will feature more strongly in the national breeding goal. As the trends show, particularly in the Holsteins, there is a need to address the trend towards increased SCC.
Figure 3. Distribution of SCC scores with reliability of 70% or greater for active bulls

WILL SELECTION FOR INCREASINGLY LOWER SCC LEAD TO GREATER PROBLEMS?

The main concern with the use of SCC as an indirect means of reducing mastitis incidence is the effect on SCC as a means of defending the animal against infection. It has been suggested that selection for decreased SCC may reduce the cow’s ability to respond to infection (2) and hence, that some minimum level may be sensible (e.g. 100,000 cells/ml).

Two studies by Philipsson et al. (4) and Rogers et al. (5) examined the linearity of the genetic relationship between SCC and clinical mastitis. The results of Philipsson and colleagues are shown for two Swedish breeds (Figure 4) and clearly demonstrate a linear relationship between the SCC and clinical mastitis. The authors concluded, from the size and the clear linearity of the genetic relationship, that selection for lower cell count is desirable and that a lower cell count reflects, primarily, a reduced incidence of infection rather than a reduced ability to combat infection.

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Figure 4. Linear relationship between cell count and clinical mastitis (4)

Rogers et al., (5) reported that sires with the lowest PTA for SCC had daughters with the lowest incidence of mastitis from all pathogen groups. They also observed that clinical episodes in daughters of sires with a low PTA for SCC tended to be less severe and shorter in duration when compared with clinical estimates in daughters of sires with an average to high PTA for SCC.

These results support earlier studies by Vecht et al. (8) and Coffey et al. (1). They showed that cows with a low SCC in initial tests in the first lactation were at slightly less risk of infection later in lactation and in subsequent lactations, than cows with a high SCC in the initial test. In a review, Timms (7) concluded that cows with an initial test low SCC were not at greater risk to intra mammary infection than cows with an initial test high SCC. These results suggest that selection for low SCCs should improve resistance to mastitis and not reduce the cow’s ability to fight infection.

Other problems concerning low SCC have been raised. Shook and Schultz (6) indicated that environmental pathogens, e.g. Escherichia coli, are becoming increasingly prevalent as a cause of clinical mastitis and tend to produce a very large response for a short duration. Monthly recording would only detect about 10–20% of these infections and with the trend towards longer recording intervals this percentage would increase. If there is a higher incidence of environmental mastitis compared to contagious mastitis, this may reduce the correlation between SCC and mastitis over time, making selection on SCC less effective as a means of reducing mastitis. However, Rogers et al. (5) reported
that sires with the lowest PTA for SCC had daughters with the lowest incidence of mastitis in all pathogen groups, including environmental pathogens. They indicated that mastitis episodes in daughters of sires with a low PTA for SCC are less severe and of shorter duration compared with episodes in daughters of sires with an average or high PTA for SCC. They concluded that monthly sampling adequately reflected mastitis caused by environmental pathogens.

FUTURE DEVELOPMENTS IN THE GENETIC EVALUATION OF SCC

To date within the UK, genetic evaluations are based on a lactation average SCC. In 2002 the Animal Data Centre will be launching a new evaluation system, which will use the test day SCC. This will result in an earlier evaluation for progeny test bulls, as an initial PTA will be available after 3 tests rather than having to wait until the lactation is completed.

This new evaluation system, known as a Test Day Model, will produce a separate PTA for first, second and third lactations. While these will be combined into a single PTA for general use, the three PTAs will be available to enable identification of bulls whose PTA differs significantly according to lactation. The Canadian practice is to produce a weighted average with the first lactation PTA receiving 25% and later lactations 75% of the weight. This is because SCC increases with parity. The ADC will need to consider this in due course.

Interbull now offers an international evaluation for both SCC and clinical mastitis with UK bull information on SCC included for Holsteins, Ayrshires, Jerseys and Guernseys. Mastitis data have been supplied by Scandinavian countries. The Interbull evaluation for SCC provides breeders in the UK with the opportunity to select foreign tested bulls. This is particularly advantageous for Ayrshires, Jerseys and Guernseys, where there were no conversions previously possible. In due course it will be interesting to look at the relationship between SCC and clinical mastitis evaluations for foreign bulls with daughters in the Scandinavian countries.

SUMMARY

With mastitis continuing to produce significant losses due to reduced production and the cost of veterinary treatment, there is a need to do everything possible to reduce the incidence of the diseases.

The current lack of direct information on mastitis, which seems likely to continue, has resulted in the search for an alternative means of selecting to reduce mastitis incidence. Fortunately, in SCC, we have a very useful indirect measure which can be used. It has a moderately high genetic correlation with mastitis (0.7) and a higher heritability than mastitis. It is also recorded routinely by milk recording organisations.
The general objective in recent years has been to breed for increased production and this is resulting in an increasing trend in SCC and hence Clinical Mastitis.

It is therefore essential to take action. SCC PTAs have only been available for 3 years in the UK and have only received limited attention. However, the increasing interest in health and welfare has focussed attention on SCC PTAs and on their inclusion in national selection indices. While concerns have been raised about very low SCC levels affecting the ability of the animal to fight infection, the evidence available to date does not support this. The conclusion from several studies is that SCC should continue to be used as an indirect means of reducing mastitis incidence. Efforts are being made to improve the recording of mastitis events within the new generation of on-farm management packages. However, even if successful, it will take a long time to build-up a reasonable data set.

UK breeders are better placed than ever in terms of the availability of SCC PTAs on bulls. This is particularly true for the coloured breeds where the recent introduction of an international evaluation is providing additional information on foreign bulls being considered for use in the UK. Within the UK, developments are close to completion to provide breeders with a more accurate system to evaluate SCC.

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