

Institution: University of Nottingham
Unit of Assessment: 6; Agriculture, Veterinary and Food Science
Title of case study: Prevention of dry period infections in dairy cows
<p>1. Summary of the impact</p> <p>The University of Nottingham (UoN) has been at the forefront of research into intramammary infections during the non-lactating (dry) period in dairy herds. This research, disseminated through presentations to key stakeholders and veterinary textbooks, has changed clinical and farmer practices as evidenced by international disease/welfare reports, national control programmes and increased use of non-antibiotic teat sealants. The work has culminated in the launch of a novel software tool that uses the research findings to provide a farm-specific decision aid, which benefits the business activities of dairy farmers and improves animal health and welfare.</p>
<p>2. Underpinning research</p> <p><i>Key researchers:</i> Professor Martin Green; Professor of Cattle Health and Epidemiology (UoN 2006 – present) Dr Andrew Bradley; Clinical Reader in Dairy Production Medicine (UoN 2009 – present) Dr James Breen; Lecturer in Cattle Health and Production (UoN 2009 – present) Chris Hudson; Lecturer in Cattle Health and Production (UoN 2009 – present) Professor Jon Huxley; Professor of Cattle Health and Production (UoN 2006 – present)</p> <p>Research results that underpinned this impact can be categorised into two major areas;</p> <ul style="list-style-type: none"> • Research into management interventions to reduce dry period infections – Building on earlier research from the Green group that established the occurrence and importance of dry period intramammary infections in dairy cows, research (funded by the Wellcome Trust; [a]) produced papers detailing how to evaluate and reduce dry period infections and thus reduce mastitis. These studies enhanced the understanding of disease patterns and dynamics and were the first to concurrently examine cow characteristics, farm facilities, and herd management strategies during the dry period that influence the rate of clinical mastitis and raised somatic cell counts in the following lactation [1, 2]. Results, for the first time, identified workable, non-antibiotic methods to reduce the impact of dry period infections. These key studies [a & c] also highlighted the importance of selecting appropriate dry cow treatments for individual cows rather than on a herd basis and this, alongside earlier work on the use of teat sealants, has dramatically improved the understanding of dry cow therapy. For example, whilst the use of antibiotics in combination with teat sealants has been shown to be beneficial for cows with intramammary infections at drying off, their combination use in uninfected cows was shown to be potentially damaging, especially in low somatic cell count herds [3]. The complexity of choices surrounding dry cow management and therapies led to further research (described below) around optimising clinical decision making during this period. • Research to quantify the uncertainty in, and make predictions for dry period interventions – The between-herd variation in infection dynamics and the uncertainty associated with strategic preventive strategies were evaluated using Bayesian modelling techniques. Predictions were made to quantify the outcome of dry period control methods so that clinical decision-making could be optimised [4; a]. This work was extended by identifying herd-specific predictors for the occurrence of dry period infections [5] and a new method to predict milk losses that arise from dry period infections [6; c & d]. The richness in these data was combined to provide a novel probabilistic herd decision-making tool that takes into account specific farm circumstances and provides probabilities of specific health and economic outcomes [c]. This system was developed with help of Zoetis Animal Health and is currently being used by dairy herd advisors (Source 1 below).
<p>3. References to the research</p> <p>1. Green, M.J., Bradley, A.J., Medley, G.F. and Browne, W.J. (2007) Cow, farm, and management factors during the dry period that determine the rate of clinical mastitis after</p>

calving. *Journal of Dairy Science*, 90(8): 3764-3776. DOI: 10.3168/jds.2007-0107.

2. Green, M.J., Bradley, A.J., Medley, G.F. and Browne, W.J. (2008) Cow, farm, and herd management factors in the dry period associated with raised somatic cell counts in early lactation. *Journal of Dairy Science*, 91(4): 1403-1415. DOI: 10.3168/jds.2007-0621.
3. Bradley, A. J., Breen, J. E., Payne, B., Williams, P. and Green, M. J. (2010) The use of a cephalonium containing dry cow therapy and an internal teat sealant, both alone and in combination. *Journal of Dairy Science*, 93(4):1566-1577. DOI: 10.3168/jds.2009-2725.
4. Green, M.J., Medley, G.F., Bradley, A.J. and Browne, W.J. (2010) Management interventions in dairy herds: Exploring within herd uncertainty using an integrated Bayesian model. *Veterinary Research*, 41, 22. DOI: 10.1051/vetres/2009070.
5. Madouasse, A., Browne, W.J., Huxley, J.N., Toni, F., Bradley, A.J. and Green, M.J. (2012) Risk factors for a high somatic cell count at the first milk recording in a large sample of UK dairy herds. *Journal of Dairy Science*, 95:1873–1884. DOI: 10.3168/jds.2011-4801.
6. Madouasse, A., Browne, W.J., Huxley, J.N., Toni, F. and Green, M.J. (2012) A semi-parametric model for lactation curves: development and application. *Preventive Veterinary Medicine*, 105; 38-48. DOI: 10.1016/j.prevetmed.2012.02.009

Underpinning research projects at University of Nottingham were:

- a. 2006 - 2010: Project title: Use of Bayesian statistical methods to investigate farm management strategies, cow traits and decision-making in the prevention of clinical and sub-clinical mastitis in dairy cows.' PI Prof Martin Green, University of Nottingham. Funded by Wellcome Trust (Fellowship – WT076998). £404,000.
- b. 2006 - 2010: Project title: An Evaluation of Milk Recording, Somatic Cell Counts and Reproductive Performance in a Large Cohort of Dairy Herds in England and Wales. PI Prof Martin Green, Co-I Dr Jon Huxley. Funded by a University of Nottingham Interdisciplinary Studentship Award. £60,000.
- c. 2010-2011 – Project title: Optimising Dry Period Management in Dairy Herds. PIs Prof Martin Green, Dr Andrew Bradley, Co I Dr James Breen, Dr Jon Huxley, Christopher Hudson. Funded by Pfizer (now Zoetis) Animal Health. £47,000.
- d. 2012-2013 - Project title: An Evaluation of Somatic Cell Counts across Europe, with a focus on Dry Period Performance. PI Prof Martin Green, Dr Andrew Bradley, Co I Dr James Breen, Dr Jon Huxley, Christopher Hudson. Funded by Zoetis Animal Health. £58,000.

Evidence of the international quality of the research is indicated by the publication of the papers in top international, peer-reviewed journals (*Journal of Dairy Science* and *Veterinary Research* are the top rated journals in the fields of dairy and veterinary research respectively), invitations for the researchers to present the work at numerous international conferences, continued funding of the work including funding from the Wellcome Trust, appearance of the findings in current, standard veterinary textbooks and use of the research findings in international disease/welfare reports and third party plenary presentations. Further evidence of international dissemination and exploitation of research findings is demonstrated by the recent grant [d] to define dry period infection dynamics in several European countries including Netherlands, France, Germany, Italy and Spain.

4. Details of the impact

Bovine mastitis, an inflammation of the mammary gland following bacterial invasion, is the foremost endemic infectious disease of dairy cattle and presents a major challenge to dairy industries worldwide. Mastitis is one of the most important diseases of farmed livestock and is financially the most significant disease of dairy cattle, causing annual production losses of more than £170M in the UK and US\$ 2.0B in the USA. The welfare implications of mastitis are severe and the impact of bovine mastitis on the environment is also important. In Great Britain the incidence of the mastitis in dairy cattle is between 47 and 65 cases per 100 cows per year.

The key element of mastitis control is to prevent new intramammary infections and this means understanding when they occur. Prior to 1998, understanding of the importance of the dry period as a time for new intramammary infections was virtually non-existent. A series of papers over the

Impact case study (REF3b)

next 5 years from the researchers who are currently at Nottingham, using sophisticated molecular epidemiology, clearly demonstrated that dry period intramammary infections were an important source of mastitis in many dairy herds. This and the programme of Prof. Green and colleagues at UoN from 2006 onwards, revealed that the rate of clinical mastitis after calving could be used as an excellent indicator of dry period infections; that there is important variation between farms in patterns of bacterial isolates during the dry period; and that a variety of farm, cow and environment factors influence the risk of dry period infections and subsequent bouts of clinical and subclinical mastitis. Further research using modern Bayesian statistical techniques, identified that it is essential to account for variation between farms and uncertainty of the effects of interventions to optimise clinical decision making to prevent dry period infections.

This UoN-led programme of research has led to a complete change in the understanding of new intramammary infections and an entirely new approach to control of the disease. The benefits for animal welfare are clear, with reduced incidence of infection, and consequently the dairy industry benefits financially. The effect of the research is seen in the following areas:

Change in the approach to mastitis control - Current control programmes now focus on identifying the magnitude and importance of dry period infections on a unit and then adapting control measures to focus on dry period management and preventive treatments as required (**Sources 3-6**). Independent international disease/welfare reports cite this research to indicate that the monitoring and control of dry period intramammary infections are essential (**Source 5**).

The development and widespread use of non-antibiotic teat sealants to prevent disease has been heavily based on the research described in this statement (**Source 1**). The use of 'OrbeSeal' (an internal non-antibiotic teat sealant) has increased dramatically since 2008 both in the UK and worldwide. Approximately 30-40% of UK dairy cows now receive the product and tens of millions of doses of the product are sold per annum worldwide (NB: exact sales figures are strictly confidential – **Source 1** can be approached if required).

Development of on-farm software - Pfizer (now Zoetis Animal Health) commissioned research to develop a stochastic (probabilistic) simulation model to incorporate the UoN research results, to enhance decision-making in dry period management. This software is currently in use (**Source 1**). The software model uses the dynamics of dry period infection and information about risks and management interventions to help an individual dairy herd make management decisions. The tool allows the evaluation of management interventions and predicts the probability of a return on investment for each intervention (or combinations thereof) being considered. This software was launched in 2012 and the Area Veterinary Manager of Zoetis stated "*Zoetis have launched a dry cow management on farm decision tool, designed from research conducted at the University of Nottingham, by Prof Martin Green and colleagues. The new tool will give veterinary surgeons a platform to offer better evidence based solutions for dry cow management which should result in significant benefits in disease levels, farm finances and cow welfare*" (**Source 1**). The tool is particularly useful in enhancing discussions between advisors and farmers, and different approaches to mastitis control and in this respect will perform a useful function as an additional resource for mastitis advisors participating in the UK national mastitis control scheme (DairyCo Mastitis Control Plan – www.mastitiscontrolplan.co.uk).

Development of commercial software - key commercial software packages have been developed to monitor dry period infection rates (*Herd Companion*, *TotalVet* and *Interherd software*), which use indices based on UoN research. These allow vets to routinely monitor dry period infections and improve disease control (**Source 2**). The underpinning research for all of the above areas of impact concerning dry period mastitis was provided by the listed UoN staff and incorporates prolonged and varied research in this area.

As described above, the impact of this research extends to an international stage. Further evidence of this is a project commissioned in 2013 to evaluate dry period infection dynamics in several European countries including Netherlands, France, Germany, Italy and Spain. (Grant code UoN 3812 "An Evaluation of Somatic Cell Counts across Europe, with a focus on Dry Period Performance", funded by Pfizer/Zoetis Animal Health).

5. Sources to corroborate the impact

1. Area Veterinary Manager, Ruminants Business Unit, Central England, Zoetis UK Ltd. *Provides corroboration for sales of OrbeSeal worldwide and the impact of the research on commercial software relating to dry period intramammary infections and their prevention.* 2013.
2. Commercial software has been developed to incorporate the monitoring of dry period mastitis which is a direct result of the research and this is currently being used (and the research cited) by veterinary practices in mastitis control (see software programmes 'Interherd' and 'TotalVet' and also the following examples:
http://www.endellveterinarygroup.co.uk/pdfs/farm/Advanced_Interherd_Training_Course.pdf 2010;
<http://www.total-vet.co.uk/static/product-feature-G.php> 2012.
Provides corroboration for the impact of the research on commercial software relating to dry period intramammary infections and their prevention.
3. EFSA statement on monitoring and control of dry period intramammary infections
<http://www.efsa.europa.eu/en/efsajournal/pub/1141.htm> 2009. *Provides corroboration for change in approach to mastitis control.*
4. The research has been used as a key component of the UK national mastitis control plan
<http://www.mastitiscontrolplan.co.uk/>. *Recently published text books cite the research to describe the relevance of dry period intramammary infections and their importance in mastitis control* (e.g. "Mastitis Control in Dairy Herds", Blowey and Edmondson, 2010, Chapter 4).
5. *Evidence of routine use of the research findings into methods to inform monitoring and control of mastitis;* <http://www.ca.uky.edu/aqc/pubs/ID/ID209/ID209.pdf> 2012.
6. *Evidence of wide dissemination of the research.* International plenary presentations by third parties cite the research to demonstrate to importance of the dry period – e.g. "Mastitis control from science to practice" Schukken *et al.*, Proceedings of the international conference 2008, p21-35
http://books.google.co.uk/books?id=a39A9I3yNO0C&pg=PA27&lpg=PA27&dq=Mastitis+control+from+science+to+practice%E2%80%9D+Schukken+et+al.,+Proceedings+of+the+international+conference+2008&source=bl&ots=XOF7Zzh_sh&sig=KrESbJeyLSikRzNfejgejoCLSB1&hl=en&sa=X&ei=GxAUd7zO#v=onepage&q=Mastitis%20control%20from%20science%20to%20practice%E2%80%9D%20Schukken%20et%20al.%2C%20Proceedings%20of%20the%20international%20conference%202008&f=false)