Institution: University of Bristol

Unit of Assessment: 5 – Biological Sciences

Title of case study: Improved animal health and welfare and economic benefits for farmers from better management of parasites in livestock.

1. Summary of the impact:

Research conducted at the University of Bristol between 2003 and 2012 on the ecology, epidemiology and control of parasitic flies and worms has improved animal health and welfare in the UK and is addressing a major constraint on global food production – animal disease, particularly in the context of climate change. These are some of the impacts:

- In 2011, industry benefited from research on blowfly strike which has provided scientific evidence that strategic early treatment of sheep reduces season-long disease risk and results in financial savings for farmers, particularly where earlier emergence of flies occurs in response to warming temperatures.
- Between 2008 and 2012, farmers realised a 73% direct saving in the monitoring of gastrointestinal nematodes due to the development of a composite faecal worm egg count (FEC) test and a decrease of up to 75% in the number of treatments given to lambs.
- Farmers and livestock benefited from the slower development of anthelmintic-resistant parasites as a result of targeted treatment using the composite FEC test developed.

2. Underpinning research:

Research at the University of Bristol, led by Professor Richard Wall and Dr Eric Morgan, focuses on the ecology, epidemiology and control of parasitic flies and worms. Wall has worked at UoB since 1985 and was appointed to a personal chair in 2000; Morgan was appointed as a university lecturer in 2002 and promoted to senior lecturer in 2010. Their work has ranged widely over studies of the epidemiology of disease, risk factor analysis, spatial disease modelling, morphological and molecular characterisation of parasite populations and the development of targeted and environmentally sensitive control approaches. This research has been carried out entirely at the University of Bristol with the assistance of PDRAs (J.R. Stevens, I. Cruickshank), PhD (K.E. Smith, A. Fenton, J. Broughan, B. Bisdorff, H. Rose, L. Ellse & J. Van Dijk) and MSc (M. Walters) students, who have been named as co-authors on the research papers published. Where agencies such as the Animal Health and Veterinary Laboratory Agency (AHVLA) have provided data, key agency staff have also been included as co-authors on the publications.

Blowfly strike: Blowfly strike is the infestation of living hosts by fly larvae. It is a particularly important disease of sheep in the UK, where over 80% of farms may be affected each year and more than half a million animals infested (source A). Professor Wall's ongoing research has contributed significantly to current knowledge in a wide variety of areas, particularly blowfly epidemiology and ecology and, recently, the probable impact of climate change. Between 2003 and 2004, Wall and his colleagues investigated regional variation in the prevalence of blowfly strike in Great Britain as part of a broad survey of disease on British farms. The research was specifically looking for changes in disease prevalence that might have occurred since the withdrawal of compulsory dipping legislation in 1989/92 [1]. They found that blowfly strike remained a widespread problem, with the highest prevalence in the south west of England, and that there had been little change since 1989/92. This evidence confirmed the national severity and prevalence of the condition, highlighting the need for improved disease management. Building on this baseline, Wall's work subsequently used modelling studies to evaluate likely spatial and temporal changes in the prevalence of blowfly strike that might be expected in response to predicted climate change in Great Britain [2]. His findings have shown that under predicted warming scenarios, there is likely to be an increase in the risk of strike, an earlier spring emergence of blowflies and an elongated blowfly season [2, 3]. Wall's research also used stochastic models to examine the likely effects of changes in husbandry and control strategies. These studies demonstrated that appropriate timing of control is critical and that a change in shearing date, from early June to early April, can also significantly reduce risk of strike [3]. The model predictions were tested in farm-based studies, which confirmed that the early-season treatment of ewes with insecticides can reduce season-long strike incidence through its effects on fly population dynamics [4]. It is this recent research, illustrating the need for early-season treatment of sheep, which has been taken up by industry and incorporated into the advice that Novartis Animal Health provides to farmers regarding the use of their products. Economic modelling by Wall has suggested that appropriate strategic treatment

may result in savings of about £200 per farm per year which, in the current economic context of sheep husbandry, is an appreciable benefit.

Gastrointestinal nematode infection: Gastrointestinal nematode (GIN) infection is a major production-limiting disease in grazing cattle and sheep. Its control relies heavily on chemical treatment, but the development of resistance to anthelmintic drugs renders such a strategy unsustainable and costly when drug failure occurs. Targeted treatment based on indicators such as FEC, weight gain or observed symptoms such as diarrhoea, is an approach that should enable efficient control while generating refugia for drug-susceptible parasite genotypes. However, this approach is limited by the costs involved in monitoring these types of treatment indicators. Composite FEC testing offers farmers a more economical means of monitoring levels of nematode infection in their livestock. However, the accuracy of composite tests is affected by the number of individual samples included, how thoroughly the samples are mixed and the underlying degree of parasite aggregation between individual hosts. In 2005, Morgan developed methods of optimising the composite FEC protocol for commercial sheep flocks [5]. He worked in collaboration with the Animal Health and Veterinary Laboratories Agency (AHVLA) to develop and validate the composite FEC test (5), which was made available in AHVLA regional veterinary laboratories in 2006. Another challenge in the treatment of GIN infection is climate change: variations in parasite epidemiology in response to climate change make treatment based on predicted risk of disease increasingly unreliable. In 2008, Morgan demonstrated that changing seasonal patterns of clinical nematode disease as a result of climate change [6], and explained some of the key changes using a refined understanding of parasite life history. He described for the first time the detailed influence of temperature on the development, hatching and survival of larval *Nematodirus battus*, an economically important and highly pathogenic sheep parasite [7]. These novel insights into the ecology of the free-living stages of this parasite have led to predictive simulation models which are being used to issue risk forecasts to vets and farmers. These advances have enabled farmers to better predict and monitor the impacts of GIN on livestock and protect them accordingly.

3. References to the research

1. Bisdorff B, Milnes A, Wall R (2006) Prevalence and regional distribution of scab, lice and blowfly strike in sheep in Great Britain. *Veterinary Record* 158:749-752. doi:10.1136/vr.158.22.749.
2. Rose H, Wall R (2011) Modelling the impact of climate change on spatial patterns of disease risk: sheep blowfly strike by *Lucilia sericata* in Great Britain. *International Journal for Parasitology* **41**: 739-746. doi: 10.1016/j.ijpara.2011.01.012.
3. Wall R, Ellse L (2011) Climate change and livestock disease: integrated management of blowfly strike in a warmer environment. *Global Change Biology* **17:** 1770-1777. doi: 10.1111/j.1365-2486.2010.02361.x.
4. Walters M, Wall R (2012) Evaluation of dicyclanil (CLiKZiN®) treatment for the early-season protection of ewes against blowfly strike. *Veterinary Parasitology* **188**: 200-202. doi: 10.1016/j.vetpar.2012.03.016.
5. Morgan ER, Cavill L, Curry GE, Wood RM, Mitchell ESE (2005) Effects of aggregation and sample size on composite faecal egg counts in sheep. *Veterinary Parasitology* **131**: 79–87. DOI:10.1016/j.vetpar.2005.04.021.
6. Van Dijk J, David GP, Baird G, Morgan ER (2008) Back to the future: developing hypotheses on the effects of climate change on ovine parasitic gastroenteritis from historical data. *Veterinary Parasitology* **158**: 73-84. doi: 10.1016/j.vetpar.2008.08.006.
7. Van Dijk J, Morgan ER (2008) The influence of temperature on the development, hatching and survival of *Nematodirus battus* larvae. *Parasitology* **135**: 269 – 283. doi: 10.1017/S0031182007003812

Funding: To support the work described, funding from Defra, NERC, BBSRC, FERA and the EU, as well as industry, to the value of £1,151,500 has been awarded, largely through peer-reviewed grants and competitive tender.

4. Details of the impact

Context: Future agriculture must deliver more food to a growing global population, but with fewer resources and greater awareness of environmental impact, as well as changing political and

economic paradigms and a more unpredictable climate. Parasites and disease represent a major constraint on future production, animal welfare and food security. Parasites cause debilitating and destructive clinical diseases of livestock, causing major problems and losses. Research at Bristol into many of these disease-causing parasites has helped in the development of targeted controls, and shown how control methods can be adapted to cope with a changing climate.

Novartis Animal Health incorporates blowfly strike research into their product advice to farmers*:* In 2011, Novartis Animal Health, an international pharmaceutical company specialising in the prevention and treatment of various widespread animal diseases and parasite infestations, incorporated Wall's blowfly research into the advice they provide to farmers regarding the use of some of their products (B). Wall's research demonstrated the need for early protection of sheep due to increased strike risk as a result of a lengthening blowfly season.
"Prof Wall's recent findings highlighted not only the importance of blowfly protection at this time of year," said Helen Langham (C), Brand Manager at Novartis Animal Health UK Ltd, "but also helped facilitate a practical solution to the farmer by demonstrating the benefit of a control strategy using a Novartis product introduced to the market in 2011, CLikZiN®. Consequently, this work has enabled increased awareness of the need for early season protection, and together with Prof. Wall's previous research, will help in the advancement of education within the industry."

Also in 2011, Novartis Animal Health sponsored a continuing professional development course for animal medicines advisers (D), entitled *Blowfly Strike – Early Treatment Best,* which is based on Wall's research. As of 29th October 2012, 375 professionals had completed this training module (E).

Novartis Animal Health has directly benefited from the research conducted at the University of Bristol as it has provided evidence to support the best use of their blowfly strike prevention product, CLikZiN®, which is ideally suited to early treatment due to its particularly short withdrawal period. The research has formed the basis for Novartis' educational material aimed at animal health professionals. CLikZiN® is used by farmers worldwide, demonstrating the international applicability of this research.

Sheep and sheep farmers benefit from this research as it not only shows the efficacy of early treatment with CLikZiN® but also provides evidence that small changes in husbandry practices can help reduce the incidence of strike and cut costs. This information has been made available through numerous mainstream media outlets, such as *Farm Animal Health* and *Farmers Guardian,* farmer meetings and National Sheep Association events. Better control of this disease will result in less economic loss for farmers and improved welfare of the animals.

Composite FEC test reduces monitoring costs for farmers and is incorporated into national recommendations for targeted worm control strategies of sheep: The composite FEC test, developed by Morgan in collaboration with AHVLA, has been offered to farmers in the AHVLA regional veterinary laboratories since 2006. Over 2,000 tests have been conducted since its introduction (1,563 since 2008) (F). Analyzing these samples using single tests would have cost farmers £193,812 (based on the 2012 AHVLA price list), but the composite test cost them only £52,439 – a 74% saving. As well as this direct reduction in monitoring costs, farmers save in terms of treatment costs as FEC monitoring can lead to a decrease of as much as 75% in the number of treatments given to lambs (G, pg 9). Targeted treatment is a key part of the Sustainable Control of Parasites in Sheep (SCOPS) initiative of Defra, the National Sheep Association and Eblex, and is expected to prolong the efficacy of existing and novel anthelmintic drug classes. Both the composite FEC (H, pgs. 35 & 44; I, recommendation 6) and the risk of autumn nematodirosis (H, pgs. 5 & 14), based on research at Bristol, are now included in official recommendations to veterinarians and farmers through SCOPS. SCOPS published four case studies on farms that adopted the SCOPS principles between 2007 and 2011, including composite FEC monitoring. All cases demonstrated the value of FEC monitoring in targeted parasite treatment (J). In addition, all four farms realized significant improvements in flock performance after four years of putting all SCOPS recommendations into practice (J).

Surveys of farmers at Sheep South West Meetings in three separate years indicate that the uptake of FEC monitoring and the awareness of SCOPS recommendations are slowly increasing within the industry. Morgan surveyed 232 farmers in 2007, 2009 and 2011. Farmer knowledge of using

FEC as a strategy to slow the development of anthelmintic resistance went from 0% in 2007 to 1% in 2009 and 13% in 2011 (unpublished data). Knowledge of SCOPS recommendations, which came out in 2007, improved from 39% in 2009 to 59% in 2011 (unpublished data).

Research at Bristol has also improved disease forecasts, which are produced by the National Animal Disease Information Service (NADIS) and distributed by EBLEX to approximately 5,000 (K) producers monthly. Specifically, Morgan's work on seasonal changes in *Nematodirus battus* risk due to climate change has improved spring and autumn disease forecasts. His work showing the influence of temperature on free-living stages of *N. battus* has helped link spring disease more tightly to temperatures, further improving disease forecasts.

Process leading to impact: Professor Wall and Morgan work actively to disseminate their research findings to animal health professionals and ultimately to farmers. Their research is disseminated through: i) peer-reviewed publications and trade journals; ii) presentations at meetings with farmers and veterinarians; iii) presentations and attendance at events such as Sheep South West and National Sheep Association events; iv) annual SCOPS meetings where Morgan has been invited as an expert; v) invited talks at the Sheep Veterinary Society; and vi) conferences and meetings such as the British Association of Veterinary Parasitology. Both Wall and Morgan work directly with industry and are active invited members of the advisory boards of international pharmaceutical companies such as Merial, Bayer, Pfizer and Novartis Animal Health. Wall and Morgan also work directly with industry and policymakers and have been invited onto international expert panels to aid policy development in support of sustainable parasite control and enhanced global food security (L).

International recognition

In 2013, Wall was awarded the prestigious international WAAVP/Bayer prize for research excellence, the citation stating that "Professor Richard Wall has delivered an outstanding and significant contribution to research in the field of veterinary parasitology."

5. Sources to corroborate the impact

A. SCOPS (2012) *Blowfly strike in sheep.* URL: http://archive.defra.gov.uk/foodfarm/farmanimal/diseases/documents/scops-blowfly180507.pdf [Accessed online 15th October 2012].
B. Novartis Animal Health (2011) *Recommended usage periods of CLiK®,CLiKZiN® and CROVECT® for year-round ectoparasite cover.*URL: http://www.farmanimalhealth.co.uk/images/uploads/product_counter_sheets/FAB_Sheep_Ecto_Wall_Chart.pdf [Accessed online 7th November 2012].
C. Langham, H. (Brand Manager, Novartis Animal Health UK Ltd.). Letter June 20, 2012.
D. OvertheCounter (2011) *Blowfly Strike – Early Treatment Best (ID61)*. URL: http://www.overthecounter.cc/training_modules_view.asp?module=Sheep&id=62 [Accessed online 30th October 2012].
E. Page, L. (Marketing and CPD Training, GH Publishing). Email to N. Temple. October 29, 2012.
F. White, A. (Access to Information Enquiries Manager, Animal Health and Veterinary Laboratories Agency).
G. Meat Promotion Wales (2011) *The Parasitology Action Plan for Wales 2011: An action plan for the Welsh sheep and beef industry.* [http://hccmpw.org.uk/index.php/tools/required/files/download?fID=2310]
H. Abbott KA, Taylor M, Stubbings LA. (2012) *Sustainable worm control strategies for sheep 4th edition: A technical manual for veterinary surgeons and advisors.* Sustainable Control of Parasites in Sheep. [http://www.scops.org.uk/content/SCOPS-Technical-manual-4th-Edition-June-2012.pdf].
I. SCOPS (2012). *Taking the First Steps*. URL: http://www.scops.org.uk/taking-the-first-steps.html [Accessed online 7th November 2012].
J. SCOPS (2012) *Case Studies.* URL: http://www.scops.org.uk/vets-case-studies.html [Accessed online 7th November 2012].
K. Lloyd, C. (Industry Development Manager, Eblex). Email to N. Temple. November 29, 2012.
L. Protecting the Future of Your Flock. Strike Expert Report (2013), published by Novartis Animal Health – 3000 copies distributed.