

Institution: Royal Agricultural University		
Unit of Assessment: 6: Agriculture, Food and Veterinary Science		
Title of case study: Research on allergic respiratory disorders has led to widespread adoption of hay steamers, resulting in improved equine performance, respiratory health and animal welfare and commercial success for the manufacturers.		
Period when the underpinning research was undertaken: 2009-2020		
Details of staff conducting the underpinning research from the submitting unit:		
Name(s): Professor Meriel Moore-Colyer Dr Simon Daniels	Role(s) (e.g. job title): Professor of Equine Science Senior Lecturer of Equine Management & Science	Period(s) employed by submitting HEI: 2006-2014. Full time 2014 to date 2014 to date
Period when the claimed impact occurred: 2013-2020		
Is this case study continued from a case study submitted in 2014? No		
1. Summary of the Impact (indicative maximum 100 words) Research undertaken at the RAU identified the major underlying causes behind equine allergic respiratory disorders categorised as mild, moderate and severe equine asthma. This knowledge led to industrial collaborations and the development and global marketing of commercial hay steamers and increased public and professional awareness of the benefits of low-dust forage on respiratory health in all horses. Hay steamers are now used as part of the daily feeding regime across all equestrian disciplines, improving respiratory health and performance and reducing the need for veterinary intervention through dust-reducing action from steaming. The impact of the research has led to improvements in animal welfare, reduction of horse management and treatment costs, and commercial success for the manufacturers.		
2. Underpinning Research (indicative maximum 500 words) Allergic respiratory diseases (mild, moderate and severe equine asthma) are initiated by airborne respirable dust (ARD) which includes fungi, yeast, bacteria, and pollens released into the stable environment by fodder and bedding. Equine asthma (sEA) affects health and performance in 14% of all horses, with the prevalence as high as 90% in performance horses (Gerber <i>et al.</i> 2017) and 80% in two-year old racehorses (Coüetil 2007). Traditional treatments such as administration of corticosteroids are short-term, can cause laminitis and are prohibited in all competitions. Through a long-term relationship with Propress Equine Ltd (now Haygain Ltd), the Waltham Centre for Pet Nutrition, the Fred and Marjory Sainsbury Trust and CIFRE (France), the RAU secured grant income of £177,000 to investigate this problem. The traditional method employed by the horse industry to reduce ARD was to soak the fodder. Our initial studies compared soaking with steaming to provide the first scientific evidence for the benefits of steaming hay before feeding [1]. Soaking caused loss of nutritional quality by leaching nutrients and compromised hygienic quality by causing bacteria growth in the post-soaked fodder, whereas steaming conserved nutrients, eliminated fungi and significantly [2] reduced bacteria. The study in commercial stables [3] showed that this management regime reduced dust circulating within the general stable zone and more critically, within the breathing zone of the horses. This research provided the necessary evidence from a practical 'real-world' setting for the industry to have confidence that steaming hay combined with a low-dust bedding, significantly improves air quality within stables. This underpinning research led to the development of high temperature hay steamers (HTHS) [4] in collaboration with Propress Ltd (now Haygain Ltd). We then demonstrated that HTHS reduced ARD by 99%, providing the proof of concept for the veterinary profession and industry		

professionals to feel confident to change recommendations for managing horses with respiratory disease. Steaming hay before feeding is now the method of choice for reducing ARD and bacteria in hay while conserving nutrient content and hygienic quality.

Collaborative research was also undertaken in France, as part of a PhD project, to investigate the impact of steaming hay in horses with existing respiratory disease [5]. Severe equine asthma (sEA) cases and healthy control horses were fed dry and pre-steamed hay in an outdoor environment. This research showed a reduction in a range of clinical parameters, including mucous scores, in all horses fed steamed hay and supported the adoption of hay steaming across mainland Europe.

In collaboration with Nottingham University [6,7], we have also examined the initiators of equine allergic respiratory disorders. Samples of stable dust and pure proteins were tested using control and sEA horses from UK, France and Canada. A specifically developed protein microarray platform was used to identify a wide-range of previously unknown sEA allergens such as pollens and latex. This research has greatly increased our knowledge of sEA initiators and has explained why certain fodders, management regimes or seasons might initiate sEA in susceptible horses. This pioneering research has also led to the development of a new method for diagnosing equine allergic disorders. Traditionally, samples of bronchoalveolar lavage fluid (BALF) were required to diagnose allergic respiratory disorders; however, the sampling method is invasive. The new, minimally invasive serum test detects IgE antibodies, and has high specificity and sensitivity, enabling more rapid diagnosis and better-informed prevention strategies for susceptible horses.

Other groups have subsequently replicated our work on the impact of pre-feeding treatments and stable management regimes on equine allergic respiratory disorders. For example, one large study of 741 horses across France and Belgium showed that feeding high-temperature steamed hay and the use of shavings as bedding produced a 65% reduced odds of horses having respiratory disorders and had a 2-fold decrease in the likelihood of finding fungi in the tracheal wash of stabled performance horses [8].

3. References to the Research (indicative maximum of six references)

- [1] Moore-Colyer, M.J.S., Lumbis, K., Longland, A.C. and Harris, P.A. (2014) The effect of five different wetting treatments on the nutrient content and microbial concentration in hay for horses *PLOS ONE* November 26. <https://doi.org/10.1371/journal.pone.0114079>
- [2] Daniels, S. Hepworth, J and Moore-Colyer, M (2020) The haybiome: Characterising the viable bacterial community profile of four different hays for horses following different pre- feeding regimens *PLOS ONE* November 2020. <https://doi.org/10.1371/journal.pone.0242373>
- [3] Auger, E.J. and Moore-Colyer, M.J.S. (2017) The effect of management regime on airborne respirable dust concentrations in 2 different types of horse stable design *Journal of Equine Veterinary Science*. 51:105-109. <http://dx.doi.org/10.1016/j.jevs.2016.12.007>
- [4] Moore-Colyer, M.J.S. Taylor, J. and James, R. (2016) The effect of steaming and soaking on the respirable particle, bacteria, mould and nutrient content in hay for horses. *Journal of Equine Veterinary Science*. 39: 62-68. <https://doi.org/10.1016/j.jevs.2015.09.006>
- [5] M. Orard, E. Hue, A. Courouc  , C. Bizon, M.P. Toquet, M. Moore-Colyer, L. Cou  til, S. Pronost, R. Paillot, M. Demoor, E.A. Richard (2018) The influence of hay steaming on clinical signs and airway immune response in severe asthmatic horses. *BMC Veterinary Research*. <https://doi.org/10.1186/s12917-018-1636-4>
- [6] S. White, M. Moore-Colyer, E. Marti, L. Co  til, D. Hannant, E.A. Richard and M. Alcocer (2019). Development of a Complex Protein Microarray for Immunoglobulin E Profiling in Horses with Severe Equine Asthma *Journal of veterinary internal medicine*. Vol 33. Issue 5 (20 Aug 2019). <https://doi.org/10.1111/jvim.15564>
- [7] S. White, M. Moore-Colyer, E. Marti, D. Hannant, V. Gerber, L. Co  til S. Bisht, E.A. Richard and M. Alcocer (2019) Antigen array for serological diagnosis and novel allergen identification in severe equine asthma. *Scientific Reports* 9. Article number 15170. <https://doi.org/10.1038/s41598-019-51820-7>

[8] Dauvillier J., Woort F. ter, Erck-Westergren, E. van, (2018). Fungi in respiratory samples of horses with inflammatory airway disease. *Journal of Veterinary Internal Medicine*. 1-8
<https://doi.org/10.1111/jvim.15397>

4. Details of the Impact (indicative maximum 750 words)

The research undertaken at RAU with our collaborators in developing the method of hay steaming has had a significant impact on the global equine industry since 2013. Through its widespread adoption, we have:

- Significantly improved horse welfare globally
- Reduced the incidence of respiratory disease in horses
- Reduced not only the cost of veterinary intervention, but the potential side-effects of medication used to treat equine allergic disease
- Improved equine performance, in both the leisure and bloodstock industries.

The availability of commercial hay-steamers has allowed the process of steaming hay to be easily implemented in equestrian stables worldwide. Our research has had impact, through the verification of the technology, which has resulted in the commercial adoption of new high-temperature steamers in the UK and internationally and the consequent improved health, welfare and performance of horses.



The latest range of Haygain Steamers and diagram to illustrate the technology. The steamer has three elements: a manifold system that injects high temperature steam evenly through the bale, a thermally insulated chest, and a steam generator that ensures steam of over 100°C reaches the hay, killing the mould, fungi, yeast and bacteria and reducing 99% of dust respirable particles.

In 2009 Propress Equine Ltd. launched its first commercial high-temperature steamer HG 1000, onto the UK equine market based on research at the RAU. Since 2013 further developmental work has demonstrated the efficacy of all models in terms of hygienic, nutritional and practical aspects of the technology for reducing the ARD in forage.

New models have increased market penetration, and collaborative work with vets and equestrian professionals in knowledge-exchange activity provided the desired verification of the effectiveness of the technology. Rapid up-take prompted the spinout of the SME [Haygain Ltd](#). In 2014 Haygain steamers were put into every horse barn by the organizing committee at the [World Equestrian Games](#) in Normandy, providing a key endorsement [1]. In the subsequent 6 years, Haygain has sold its product in 20 different countries across the globe [2]. There have been 17,000 Haygain steamers sold to-date at a market value £34m. Three other UK-based commercial companies [Simply Steam](#), [Ascotuk](#) and [equiSteam](#) now market hay steamers, based on our research findings.

The implementation of this research has been a joint effort between Haygain Ltd and the RAU who jointly sponsored a knowledge-transfer programme with lectures at 20 veterinary CPD days, over 50 industry talks, print press and on-line articles [3], forums, blogs [4] and web sites. In 2020 alone there were over 100,000 site visits to the Haygain website from Europe, USA, Canada and Australia.

Numerous equine industry bodies recommend hay steaming over soaking as an effective dust-reducing strategy in stables, thereby disseminating recent knowledge to horse owners world-wide and promoting practitioner development. The British Horse Society (115k members) incorporates hay steaming as part of an effective dust reducing strategy in their [Respiratory Health](#) leaflet. The magazine [Horse and Hound](#) (circulation 23k per month) has featured the RAU's research on steaming and the development of the Haygain technology, and highlights the latest information on improving the stable environment and information on sEA in articles spanning over 7 years. Hay steaming is now a search term in [Wikipedia](#) which extensively cites the RAU's research and research papers [6].

The [racing industry](#) is worth £3.45 billion to the UK economy, representing 17,400 jobs, 550 trainers, 6,500 stable staff, 450 jockeys and 14,000 horses in training in UK. The health and welfare of the bloodstock is therefore of significant importance to the national economy. 9 out of 10 racing trainers at Newmarket use Haygain steamers (est. 2,500 horses), and 2/3rds of the top 100 trainers in UK steam their hay [7]. Significantly, RAU research was instrumental in highlighting to the world equine community the prevalence of many more allergens and provided the research that has validated the efficacy of steaming for reducing the horse-dust interaction which is the cornerstone of prevention and treatment of equine asthma.

It resulted in meetings which specifically addressed the issue: the [Dorothy Havemeyer Workshop](#) on "Inflammatory Airway Disease; One Syndrome, Multiple Pathways" in Cabourg, France in 2014 and the [World Equine Airway Symposium](#) in Copenhagen 2017 (270 delegates). Evidence-based talks presenting the RAU's research on high-temperature steaming had a major impact on the attending industry professionals and veterinarians who have since promoted this as the preferred method for treating horses with respiratory disorders [5,8]. Effective environmental management of equine allergic disease also reduces the need for drug-based therapies (e.g. corticosteroids) which are costly, can cause laminitis and are prohibited for competition horses.

In conclusion, the RAU's research has had a significant impact on the preventative management of allergic respiratory disorders in stabled horses across the globe. The research underpinning hay steaming has validated the technique as the most effective way of reducing the horse-dust interaction producing benefits to horse owners in terms of improved performance, decrease incidence of loss of use, time lost from training, and reduction of veterinary bills. The range of hay steamers now caters for all sizes of equine enterprise and this increased market penetration has positively impacted the health and welfare of all categories of horses. The technology is now the preferred method recommended by the veterinary profession, for reducing the respirable challenge associated with feeding fodder to horse.

5. Sources to Corroborate the Impact (indicative maximum of 10 references)

[1] Contract between Alltech FEI World Equestrian Games and Haygain Ltd. held in Normandy 27th August and 7th September 2014, loaned 30 hay steamers, 10 nebulisers and 10 misters.

[2] Haygain website sets out details of its product, its development over the years, and endorsements from 22 champion eventers, 12 show-jumping champions, leading trainers, horse-owners and 26 leading veterinarians.

<https://haygain.co.uk/pages/haygain-hay-steamers>

<https://haygain.co.uk/pages/champions-1>

<https://haygain.co.uk/pages/veterinarians>

Notable testimonials include: Emmanuelle van Erck-Westergren, DVM, PhD Dip. ECEIM (Equine Sports Medicine Practice, Waterloo, Belgium, Belgian team veterinarian, FEI Equine Prohibited Substances List Expert Group)

"Changes in environmental management are essential to bring long term relief. Haygain hay steamers are a simple, fool proof solution to improve our horse's respiratory health. I recommend it for my patients and those owners who have adopted it really see the daily benefit it brings to their horses and would not revert to normal hay; and the horses love it!"

Dr Chad S. Davis Regional Equine Associates Central Hospital, Virginia, USA

"One of my primary focuses within our practice is sport horse medicine and nutrition. Since 2009, I have begun using the Haygain hay steamer as an integral part of treatment for respiratory disease and allergy-affected horses. Primarily they reduced dust, including the spores and moulds found in all hay types, reducing the extent of medications required to control COPD/Heaves in horses. [...] Summer-affected allergy horses have shown success with reduced clinical signs and decreased medical management from previous years and the only change in their treatment plan has been a Haygain hay steamer".

[3] Magazine coverage of Hay steaming and sEA from the industry press

https://issuu.com/anderson-co/docs/european_trainer_issue_55_v3/61?e=5870891/39169394
<https://www.horseandhound.co.uk/reviews/stable-and-yard/haygain-hg-one-hay-steamer>
<https://www.horseandhound.co.uk/news/study-finds-links-latex-equine-asthma-702710>
<https://horsesport.com/magazine/nutrition/back-to-work-feeding-program/>
<https://thehorse.com/155466/steaming-vs-soaking-reduce-hay-nsc-levels/>
<https://thehorse.com/113993/steaming-effect-on-horse-hay-studied/>
<https://stablemanagement.com/industry-news-information/steaming-soaked-hay-is-essential-for-horses-on-low-non-structural-carbohydrate-diets>
<https://everythinghorseuk.co.uk/haygain-hay-steamers-for-horse-health/>

[4] Blogs:

<https://equipepper.com/2020/07/09/steaming-hay-the-pros-cons-and-cost/>
<https://haygain.co.uk/blogs/news-and-events/equine-asthma-breakthrough>
<https://www.haygain.us/blogs/news-and-events/full-steam-ahead>

[5] Veterinarians and industry coverage of hay steaming as a method to reduce sEA.

<https://www.youtube.com/watch?v=4YvtDBV4LCE>
<https://www.youtube.com/watch?v=TUXE4Gj5R6U>
<https://www.horsetalk.co.nz/2019/06/27/steamed-hay-better-equine-athletes/>
<https://www.proequinegrooms.com/tips/health-and-well-being/steaming-vs-soaking-hay-the-basics>
<https://equimed.com/news/health/nature-publishes-research-revealing-novel-findings-related-to-severe-equine-asthma>
<https://www.equisteam.com/why-steam-hay>

[6] Knowledge development: Wikipedia page on hay steaming

https://en.wikipedia.org/wiki/Hay_steaming

Steaming hay has rapidly grown in popularity in the last 10 years since commercially available high temperature hay steamers have been developed and is accepted as an improvement to the old tradition of soaking hay, providing significant additional benefits. At this point, most high-performance horses in Europe, and increasingly America, are already being fed steamed hay on a daily basis. At the same time, the general horse population in the UK, Germany, and other European countries are increasingly being fed steamed hay.

[7] Information supplied by Haygain Ltd., based on their recorded sales, and supplied to the RAU.

[8] After the 2017 Conference, the Horse [website](#) included the following report on the presentation of the RAU research:

"when making improvements for even a single horse with asthma, it's crucial to include the whole barn in dust-management plans. Use caution when soaking, as well, as studies have shown that soaked poor-quality hay can contain bacteria and fungus.....A newer concept that could benefit horses with asthma is hay steaming. Study results have shown that steamed hay has lower bacteria and fungus growth. Steamed hay also has a reduced carbohydrate content, but steaming doesn't appear to reduce a hay's protein content."