Article:
Holmes, M (2019) Melancholy Consequences: Britain's Long Relationship with Agricultural Chemicals Since the Mid-Eighteenth Century. Environment and History, 25 (1). pp. 117-134. ISSN 0967-3407

https://doi.org/10.3197/096734018X15137949592106

Melancholy consequences: Britain's long relationship with agricultural chemicals since the mid-eighteenth century

Abstract

Chemicals used to control agricultural diseases and pests have formed a significant aspect of rural life in Britain since at least the mid-eighteenth century. This paper argues that agricultural chemicals have long been subject to public health and environmental concern. Harnessing agricultural textbooks, periodicals and newspaper reports, this paper charts the use of arsenic and copper sulphate as means of preventing fungal disease in wheat over the course of the eighteenth and nineteenth centuries. During this time the dangers and benefits associated with chemical seed steeps – a mixture of water with arsenic or copper sulphate in which seeds were immersed – were thoroughly explored: landowners and agricultural improvers released their own recipes, suggested alternative remedies for fungal disease and even carried out crop trials to test the efficiency of chemical preventatives. Yet by the mid-nineteenth century, seed steeps had become an issue of public health and government concern, as noxious substances poisoned game birds intended for human consumption. Embracing a 'long-run' history of agricultural chemicals enriches current debates on the use, regulation and impact of these products.

Introduction

In 2008 *The Independent* newspaper carried an article by science writer Rob Johnston, who attempted to refute a series of 'myths' supposedly held by supporters of organic farming. Among Johnson's grievances was the notion that organic farmers do not use pesticides. In fact, Johnson argued, organic farmers use so-called 'organic' pesticides which circumvent modern safety tests and can be highly dangerous. One of his examples was the use of copper solutions to treat fungal disease, as unlike 'modern [and] biodegradable pesticides, copper stays toxic in the soil for ever.'[1] The article brought about a point-by-point rebuttal from Lord Peter Melchett of the Soil Association, an organic farmer's organisation, reminding readers that the Soil Association had never claimed not to use organic pesticides. Moreover, copper compounds 'occur naturally in the soil, and most copper is applied by non-organic farmers to correct copper deficiencies. None is found in organic food.'[2] Yet with a few tweaks, such an exchange would not be out of place in a nineteenth-century newspaper, at a time when the use of substances such as arsenic and copper compounds to treat fungal disease in wheat was a matter of great public concern.

A growing body of historical scholarship has documented the environmental and health impacts of agricultural chemicals in Britain and the Western world. Controversies over the use of chemical controls in agriculture have moved beyond the historiographical shadow cast by the DDT scandal - as popularised by Rachel Carson's *Silent Spring* (1962) - to stand as

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[1] Rob Johnston, 'The great organic myths: Why organic foods are an indulgence the world can't afford', *The Independent*, 30 April. 2008. Available online at: http://www.independent.co.uk/environment/green-living/the-great-organic-myths-why-organic-foods-are-an-indulgence-the-world-cant-afford-818585.html

[2] Peter Melchett, 'The great organic myths rebutted', *The Independent*, 07 May. 2008. Available online at: http://www.independent.co.uk/environment/green-living/the-great-organic-myths-rebutted-822763.html

significant historical phenomena in their own right. For decades, environmental historians have traced the relationship between pesticides, public health and nature conservation.[3] Agricultural chemicals occupy a borderland between these three spheres: for instance, the conceptualisation and popularisation of toxicity in medical writings has been linked to the origins of the environmental movement.[4] Elsewhere, pesticide-induced illness in post-World War II California has been related to the decline of public health perspectives which saw the body as isolated from the environment.[5] Toxicity continues to be a notable theme in historical writing. Yet with the exception of health crises associated with arsenic-based Paris green solution during the late nineteenth century, studies on the impact of agricultural chemicals have largely been restricted to the twentieth century.[6]

Earlier instances of chemical controls in agriculture have been briefly considered by historians of agriculture and the environment. Pest and disease control during the nineteenth century has been characterised as rudimentary, acquired by tacit knowledge and often ineffective. This may be in part due to existing narratives of pragmatic and rational approaches to disease control triumphing over traditional legal, social or religious practices.[7] Meanwhile, popular works have acknowledged that toxic substances such as arsenic pervaded rural life in nineteenth century Britain. Arsenic was used in numerous ways, from sheep dipping to the preparation of taxidermists' specimens.[8] As a tool of poisoners, the element was also associated with criminality.[9] Yet the use of arsenic and other toxic

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[3] Examples include Thomas R. Dunlap, 'The Triumph of Chemical Pesticides in Insect Control 1890-1920', *Environmental Review* 2 (1977): 38-47; Joshua Blu Buhs, 'Dead Cows on a Georgia Field: Mapping the Cultural Landscape of the Post-World War II American Pesticide Controversies', *Environmental History* 7 (2002): 99-121; James E. McWilliams, '"The Horizon Opened up Very Greatly": Leland O. Howard and the Transition to Chemical Insecticides in the United States, 1894-1927', *Agricultural History* 82 (2008): 468-495. Most recently, these themes have been explored at the 2015 'Living in a Toxic World, 1800-2000' conference at the 8th European Spring School on the History of Science and Popularization. See special issue of *Endeavour* 40 (2016).

[4] John C. Burnham, 'How the Discovery of Accidental Childhood Poisoning Contributed to the Development of Environmentalism in the United States', *Environmental History Review* 19 (1995): 57-81.

[5] Linda Nash, 'The Fruits of Ill-Health: Pesticides and Workers' Bodies in Post-World War II California', *Osiris* 19 (2004): 203-219.

[6] On Paris green see James Whorton, *Before Silent Spring: Pesticides and Public Health in Pre-DDT America* (Princeton: Princeton University Press, 1974). John F.M. Clark, 'Bugs in the System: Insects, Agricultural Science, and Professional Aspirations in Britain, 1890-1920', *Agricultural History* 75 (2001): 83-114, 92.

[7] Jonathan Brown & H.A. Beecham, 'Crop Pests and Diseases' in Gordon E. Mingay (ed.), *The Agrarian History of England and Wales, 1750-1850*, 8 vols. (Cambridge: Cambridge University Press, 1967-1989), vol. 6: 311. D.M. Secoy & A.E. Smith, 'Superstition and Social Practices against Agricultural Pests', *Environmental Review* 2 (1977): 2-18, 2.

[8] James C. Whorton, *The Arsenic Century: How Victorian Britain was Poisoned at Home, Work, and Play* (Oxford: Oxford University Press, 2010); John Parascandola, *King of Poisons: A History of Arsenic* (Washington: Potomac Books, 2012).

[9] Along with the popular works already mentioned, a scholarly literature also exists on the use of the 1836 Marsh test to detect arsenic poisoning. On the history of forensics and

chemicals – including copper compounds – as a fungal preventative for wheat has been largely overlooked.

My paper seeks to redress this omission, identifying three key periods in the evolution of chemical controls within British agriculture from the mid-eighteenth to mid-nineteenth centuries. I begin with the appearance of recipes for arsenic and copper seed steeps (a chemical solution used to soak seeds) in agricultural textbooks and periodicals, alongside contemporary misgivings on their use, from the mid-eighteenth century.[10] These works questioned the effectiveness of arsenic and the safety of its human handlers. I then examine concerns that game birds poisoned by arsenic seed steeps posed a hazard to public health: an issue covered extensively by the Victorian press during the winter of 1848-1849. Finally, I consider mid-nineteenth century Parliamentary legislation against arsenic-based seed steeps. These developments all suggest that agricultural chemicals were considered a threat to human and animal health at a surprisingly early date. This history of agricultural chemicals contributes to a growing literature on pre twentieth-century toxicity, while further reinforcing connections made by historians between public health, nature conservation and environmental damage. Moreover, many of the themes raised by this history – the production of scientific knowledge, role of the media and the response of the state to an environmental crisis – speak directly to the more general challenges posed by pollution and farming today.

The moral ambiguity of arsenic seed steeps

Toxic chemicals play an integral role in many British farms, combating unwanted pests and diseases. This state of affairs may seem like a recent development: ushered in during the 'chemical age' of the twentieth century.[11] Yet the application of potentially dangerous chemicals to the land is not a new innovation. During the eighteenth century, arsenic was commonly used as a seed steep for wheat, a process which involved mixing or washing seeds in an arsenic-based solution (the rest comprised of water or brine) prior to sowing.[12] This process was one of several harnessed to combat smut: an economically devastating fungal disease of wheat. As early as 1756, Thomas Hale, landowner and author of *A Compleat Body of Husbandry*, claimed to know several farmers 'who put Arsenick into their Brine for Wheat, and apprehend it very beneficial.' At this time, arsenic was a relatively new entry among a

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arsenic, see Katherine D. Watson, *Forensic Medicine in Western Society: A History* (London: Routledge, 2011) and José Ramon Bertomeu-Sánchez, 'Managing uncertainty in the academy and the courtroom: normal arsenic and nineteenth-century toxicology', *Isis* 104 (2013): 197-255.

[10] Many agricultural periodicals and textbooks cited by historians unfortunately relate to large arable farms run by outstanding or experimentally-minded tenants or landowners; although the multiple editions of agricultural textbooks as least reveal a market for their findings. Christabel S. Orwin and Edith H. Whetham, *History of British Agriculture 1846-1914*, 2nd ed. (Newton Abbot: David & Charles, 1971), 36.

[11] Emma Rothschild, 'The turn towards toxins: an essay review', *Endeavour* 40 (2016): 128-130, 128.

[12] For a list of sources mentioning arsenic, see Diane M. Secoy and Allan E. Smith, 'A Compendium of Inorganic Substances Used in European Pest Control before 1850', *Agricultural and Food Chemistry* 24 (1976): 1180. The compendium is not comprehensive, but provides an invaluable starting point for researchers.

plethora of substances used on seeds for the prevention of disease, elimination of pests or promotion of growth. Hale's agricultural guide alone listed several alternatives to arsenic, including salt, lime, nitre and coppers (presumably copper compounds). Hale himself considered the use of the arsenic to be 'a detestable Practice'.[13]

Awareness of and contact with European agriculturalists had much to do with the initial adoption of arsenic into British disease control regimens. John Mill's *A New and Complete System of Practical Husbandry* (1762) described arsenic seed treatment by several farmers across the French provinces and a subsequent health controversy reported by a physician at Essay.[14] A 1767 English translation of Duhamel du Monceau's *The Elements of Agriculture* raised concerns that partridges and pigeons might be poisoned following consumption of steeped seeds.[15] Hale's initial – admittedly anecdotal – record of the use of arsenic steeps in Britain was followed by a series of references in agricultural textbooks from the 1780s. Yet Duhamel du Monceau's concerns over the unintended effects of arsenic steeps were not immediately raised. Robert Andrews, Esquire of Auberies (near Sudbury), related his own arsenic recipe for the prevention of smut in the 1786 volume of leading agricultural improver Arthur Young's *Annals of Agriculture*. Andrews claimed that boiling arsenic would remove its poisonous properties 'as to prevent the destroying of fowls, or birds, that may pick up the uncovered seeds.'[16] E. Holmes of Scorton wrote to Young's *Annals* on July 9th 1787 to vent his frustration with dangerous seed steeps:

> Upon the authority of ancient Roman writers on agriculture, I suppose we have adopted and invented many brines, pickles, steeps and nostrums, some unmeaning, and others evidently pernicious, to prevent this disease [smut].[17]

Fellow Yorkshireman William Marshall took a different stance. Marshall endorsed arsenic as a preventative against smut in his 1788 work on the rural economy of Yorkshire, one of his correspondents having made use of 'arsenic-water' to keep his wheat free of smut for over twenty years. Other Yorkshire farmers were less enthusiastic. Marshall recorded that some were wary of arsenic steeps, fearing accidental poisoning from carelessness – either their

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[13] Thomas Hale, *A Compleat Body of Husbandry* (London: J. Hodges on London-Bridge; T. Trye near Gray's-Inn Gate; and S. Crowder and H. Woodgate in Pater-Noster Row, 1756), 372-373. 'Nitre' referred to sodium or potassium nitrate. Hale's mention of 'Copperas' may be an early reference to copper sulphate, or blue vitriol. All of these chemicals would have been used in solution to steep seeds.

[14] John Mill's *A New and Complete System of Practical Husbandry*, 5 vols. (London: Printed for R. Baldwin, W. Johnston, S. Crowder, T. Longman, J. Coote, J. Hinxman, W. Nicoll, and S. Davis, 1762), vol. 2, 403-404.

[15] M. Duhamel du Monceau (tr. Phillip Miller), *The Elements of Agriculture*, 2 vols. (Dublin: G. Faulkner, 1767), vol. 1, 193.

[16] Robert Andrews, 'On the Smut in Wheat', in Arthur Young, *Annals of Agriculture*, 45 vols. (Bury St. Edmund's: J. Rackham, 1785-1808), vol. 6, 174-175. According to Andrew's recipe, half a pound of arsenic could be used to steep fifty bushels of wheat, a ratio he claimed to have successfully used for a number of years.

[17] E. Holmes, 'On the Smut', in Arthur Young, *Annals of Agriculture*, 45 vols. (Bury St. Edmund's: J. Rackham, 1785-1808), vol. 8, 115-117.

own or their servants' – and for the well-being of agricultural labourers.[18] Direct contact with the toxic substance in preparation or sowing was a key obstacle, in spite of Andrews' insistence on safety through boiling. Yet the fatal consumption of arsenic-steeped seeds by birds, as envisioned by Duhamel du Monceau, had not been observed in Britain.

By the turn of the century, arsenic was considered a valuable preventative against smut by many agricultural writers and farmers. In the eighth edition of *The Farmer's Calendar* (1809), agricultural improver Arthur Young finally weighed in on the arsenic debate. Young performed several experiments, discovering that steeping seeds in a solution of arsenic gave a smut-free crop.[19] Yet less than a decade after Young lent his support to arsenic steeps, awareness of the danger to game birds first appeared in Britain. Sir John Sinclair, agricultural improver and Member of Parliament, wrote in 1817 that arsenic was strongly objected to as a smut preventative on grounds of 'the hazard attending it, and its destruction of game.'[20] Sinclair cited multiple alternatives for the prevention of smut, from ash to lime water, kiln-drying and even powdered wormwood in stale urine.[21]

Debate on the merits – and dangers – of arsenic also appeared in the publications and activities of learned societies and farmers' clubs.[22] Critics of arsenic steeps were prominent among British societies. The third edition of *The Complete Farmer* (1777) was more than suspicious of arsenic steeps. Its authors, members of the Society for the Encouragement of Arts, Manufacturers and Commerce, stated:

> Since M. Tillet [Mathieu du Tillet, Director of the Troyes's Mint and author of a 1755 dissertation on smut] has given us a method simple and innocent in itself, but little costly, and of great efficiency to clean spotted grain [infected by smut], it is to be presumed that no body will use this pernicious drug [arsenic], from which such melancholy consequences may ensue, if by accident any of it should be mixed with the meal, and if the light corn is given to the poultry or cattle; besides, this poisoned feed must kill all the partridges and pigeons that eat the uncovered grain.[23]

That the pernicious drug would not be adopted by their countrymen was indeed quite a presumption, as the application of arsenic continued across European fields throughout the nineteenth century. Other chemical solutions to smut also emerged: Sinclair was aware of the research of French writer B. Prevost, referring to his experiments on the nature of smut and its spread in *The Code of Agriculture* (1817).[24] Prevost had commented on the use of

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[18] William Marshall, *The Rural Economy of Yorkshire*, 2 vols. (London: T. Cadell, 1788), vol. 2, 10-11.
[19] Arthur Young, *The Farmer's Calendar*, 8th ed. (London: Richard Phillips, 1809), 469.
[20] John Sinclair, *The Code of Agriculture* (London: B. McMillan, 1817), 341.
[21] John Sinclair, *The Code of Agriculture* (London: B. McMillan, 1817), 341.
[22] In a very similar manner, eighteenth-century medical practitioners found their experiments and drug trials examined and critiqued by peers, informing their discipline's theory and practice. Andreas-Holger Maehle, *Drugs on Trial: Experimental Pharmacology and Therapeutic Innovation in the Eighteenth Century* (Amsterdam: Rodopi, 1999), 170-199.
[23] A Society of Gentlemen, Members for the Encouragement of Arts, Manufacturers and Commerce, *The Complete Farmer*, 3rd ed. (London: J.F. and C. Rivington, S. Crowder, T. Longman, B. Law, T. Lowndes, G. Robinson, T. Cadell and R. Baldwin, 1777), 92.
[24] John Sinclair, *The Code of Agriculture* (London: B. McMillan, 1817), 341-342.

arsenic steeps as early as 1807, although he would later recommend the use of copper sulphate – commonly known as blue vitriol – as a safer and more effective solution.[25] Crop disease remained a problem requiring innovative, but often dangerous, solutions. European experiments provided valuable information for British agriculturalists, yet accurate facts on the correct usage of arsenic were hard to come by. Leonard Dawson's 1827 *New British Farmer* could only report that 'it is said [smut] may be prevented by steeping the seed… in a weak solution of arsenic.'[26] Details on safe and effective concentrations and methods of application were not readily available.

Crop disease remained of great concern to agricultural improvers during the 1840s, including founding members of the Royal Agricultural Society of England. The journal of the Society was created in 1839 to disseminate the results of agricultural experiments.[27] From 1840-1849, only fifteen and a half percent of submitted articles came from those in 'scientific professions' – chemistry, botany, veterinary science – meaning the journal was largely the preserve of the landed and literate, rather than scientists.[28] The first paper submitted to the journal came from its editor Philip Pusey in 1840. A landowner himself, Pusey described the poor state of agricultural science in England and the need to control crop losses from disease and pests.[29] By the middle of the nineteenth century, little or no progress had been made by agricultural science against plant disease: a shortfall borne out by the Irish potato blight in 1845.[30] Disease had a pernicious effect on the livelihood and finances of farmers and landowners. Smut could rapidly spread among wheat and infect neighbouring fields if left unchecked, leaving a potentially devastating impact in its wake.

An expanding network of provincial farmers' clubs sought to provide their members with valuable information on effective disease-control practices.[31] The *North Wales Chronicle* reported in 1841 that a local farmers' club had prevented smut with the application of

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[25] Prevost's recommendation of blue vitriol was readily taken up by Sinclair. See John Sinclair, *Hints Regarding the Agricultural State of the Netherlands* (London: B. McMillan, 1815), 26.
[26] Leonard Dawson, *The New British Farmer* (Manchester: J. Gleave and Sons, 1827), 315.
[27] Edward J. Russell, *A History of Agricultural Science in Great Britain 1620-1954* (London: Allen and Unwin, 1966), 67. Sarah Wilmot, *The Business of Improvement: Agriculture and Scientific Culture in Britain, c.1770-c.1870* (Cheltenham: Historical Geographers Research Group, Institute of British Geographers, 1990), 90-91. Plant diseases did appear on the societies' list of agricultural problems. Yet little was known of their nature, or effective methods of prevention or cures.
[28] Sarah Wilmot, *The Business of Improvement: Agriculture and Scientific Culture in Britain, c.1770-c.1870* (Cheltenham: Historical Geographers Research Group, Institute of British Geographers, 1990), 18-19.
[29] Philip Pusey, 'On the Present State of the Science of Agriculture in England', *Journal of the Royal Agricultural Society of England* 1 (1840): 1-2.
[30] Christabel S. Orwin and Edith H. Whetham, *History of British Agriculture 1846-1914*, 2nd ed. (Newton Abbot: David & Charles, 1971), 31.
[31] Harold S.A. Fox, 'Local Farmers' Associations and the Circulation of Agricultural Information in Nineteenth-Century England' in Harold S.A Fox & Robin A. Butlin (eds.), *Change in the Countryside: Essays on Rural England, 1500-1900* (London: Institute of British Geographers, 1979), 48-50. Nicholas Goddard, 'Agricultural Societies' in Gorden E. Mingay (ed.), *The Victorian Countryside*, 2 vols. (London: Routledge and Kegan , 1981-1986), vol. 1, 252.

powdered arsenic.[32] Members of the club had conducted their own experimental trials. Planting powdered and untreated crop, they discovered that three-quarters of the arsenic-free wheat succumbed to smut: the powered crop emerged unscathed.[33] Others were less enthusiastic to see chemical, particularly arsenic-based, preventatives in agriculture. John Stevens Henslow, Professor of Botany at Cambridge, submitted an article on an insect pest – the wheat midge – to the Journal of the Royal Agricultural Society of England in 1842. Henslow recommended farmers to dispose of chaff dust by hand to reduce the insects' numbers.[34] In the same volume C. Hillyard advocated the soaking of wheat in brine and slacked lime as a preventative against smut, which would avoid the possibility of accidents arising from arsenic steeps.[35] Despite concerns, some British farmers turned to experimentation with lethal chemicals to alter the balance of nature in their favour.

Melancholy consequences were clearly envisioned from the application of arsenic to grain, despite the support of European agriculturalists for the substance. Yet for both cultural and economic imperatives, fungal disease could not be left unchecked. Fungal diseases were a clear affront to the promises of agricultural improvement: or what one historian describes as the union between the profitable and beautiful.[36] The pursuit of aesthetics or financial gain drove the interest of squires, landowners and farmers toward any and all remedies for smut. Hence alternative solutions, including blue vitriol and brine were promoted by key members of the agricultural community. Arsenic continued to be recognised as a potential counter to smut, despite acute awareness of its toxicity to humans and animals.[37] By the mid-nineteenth century, arsenic steeps had moved into another textual medium: the Victorian newspaper. Attitudes towards seed steeps rapidly shifted, as poisoned game birds signified a new threat to urban consumers and public health.

Partridge poisonings and public health

In 1848 a brace of deceased partridges arrived at the door of Dr. Henry William Fuller, of St. George's Hospital in London. The birds had been found upright in fields across Hampshire, their eyes still open – a most mysterious crime scene that led the doctor to suspect poison. Suspicion confirmed by the presence of metallic arsenic in chemical tests, Fuller took a very Victorian approach to further his impromptu forensic investigation. Acting on the ethically-dubious suggestion of his aptly-named friend Mr. Stone, Fuller recounted:

> I carefully cut the flesh off the breast and legs of one of the birds, and gave it, together with the liver, to a fine healthy cat. She ate it with avidity, but in about half

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[32] 'On Smut in Wheat', *North Wales Chronicle*, 07 December. 1841.
[33] 'On Smut in Wheat', *North Wales Chronicle*, 07 December. 1841.
[34] John Steven Henslow. 'Observations on the Wheat-midge', *Journal of the Royal Agricultural Society of England* 3 (1842): 39.
[35] C. Hillyard, 'On Wheat', *Journal of the Royal Agricultural Society of England* 3 (1842): 303.
[36] Susanna Wade Martins, *Farmers, Landlords and Landscapes: Rural Britain, 1720-1870* (Cambridge: Cambridge University Press, 2004), 9.
[37] Arsenic users faced a trade-off between danger and utility in other sectors: for instance, medicine. See William R. Cullen and Peter Capper, *Is Arsenic an Aphrodisiac? The Sociochemistry of an Element* (Cambridge: Royal Society of Chemistry, 2008), 15.

> an hour she began to vomit, and vomited almost incessantly for nearly twelve hours, during the whole of which time she evidently suffered excessive pain.[38]

By the mid-nineteenth century, at the height of what has been termed 'high farming', some arable farms in Britain had become contaminated sites. Dangerous chemicals including arsenic and copper sulphate were utilised in an ongoing battle against smut in wheat. Victorian high farming involved practices that drove up populations of certain game birds in arable habitats. Characterised by the extensive use of fertilisers, limited mechanisation and mixed arable rotations, high farming provided ideal habitats for partridges.[39] The bird's population size therefore rose on the same fields that carried arsenic seed steeps: a tainted environment was set to enter the food chain. Fuller's partridges acted as canaries in coal mines, alerting his Victorian contemporaries to the danger of arsenic seed steeps. The side-effects of agricultural poisons had previously been confined to domestic animals, or to agricultural workers who had come into direct contact with the substances. Investigations into the decline of game birds revealed a more general hazard to public health, which reverberated throughout the Victorian press over the winter of 1848-1849.

Despite the ravages of smut, eighteenth and early nineteenth-century sources on arsenic reveal that the use of the poison in wheat was controversial. A seemingly safer and more effective alternative was copper sulphate, or blue vitriol, endorsed by writers such as Sinclair on the authority of Prevost.[40] Blue vitriol certainly increased in popularity during the nineteenth century, but had its own consequences. In 1843 reports emerged of the mass poisoning of game birds by blue vitriol on Irish estates. This incident acted as a prelude to a far larger scandal of arsenic steeps in England, which erupted in 1848. The press played a major role in these controversies. Newspapers focused popular and state attention on rural users of arsenic. Arsenic seed steeps were no longer confined to the countryside, but were thought to make their way into consumers via the bodies of poisoned birds.

In 1843 the *Northern Whig* newspaper reported the extermination of the partridge population in many parts of Ireland, consequence of the practice of pickling seed wheat in poisonous chemicals.[41] Naturalist William Thompson approached a gentleman agricultural chemist in the wake of the article, only to be informed that farmers in County Antrim and Down used 'nothing more poisonous' than sulphate of copper (blue vitriol) to steep wheat.[42]

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[38] Henry W. Fuller, 'On the Use of the Arsenic in Agriculture-Poisoning by Arsenic, and Symptoms of Cholera-The Possible Effect of the Game Laws', *The Lancet* 2 (1848): 648.

[39] Michael Shrubb, *Birds, Scythes and Combines: A History of Birds and Agricultural Change*, (Cambridge: Cambridge University Press, 2003), 53. William S.M. D'Urban and Murray A. Mathew, *The Birds of Devon* (London: Taylor and Francis, 1892), 261 stated that the 'partridge alone is abundant and increasing in number due to improved cultivation of the land.'

[40] John Sinclair, *The Code of Agriculture* (London: B. McMillan, 1817), 341; John Sinclair, *Hints Regarding the Agricultural State of the Netherlands* (London: B. McMillan, 1815), 26.

[41] 'Causes of the Scarcity of Partridges in Ireland', *Northern Whig*, 28 October. 1843. In William Thompson, *The Natural History of Ireland*, 5 vols. (London: Reeve, Bentham and Reeve, 1849-1856), vol. 2, 58-59.

[42] William Thompson, *The Natural History of Ireland*, 5 vols. (London: Reeve, Bentham and Reeve, 1849-1856), vol. 2, 59. The agricultural chemist stated that the application of blue vitriol would have had hardly any effect in diminishing the number of partridges.

Consulting another 'distinguished chemist,' Thompson was told that one pickle of wheat subjected to arsenic would be as injurious as four or five steeped in blue vitriol.[43] From a modern environmental perspective, a movement from away from arsenic to blue vitriol was not necessarily an improvement for health or the environment. Vitriol's less dramatic effects could potentially have resulted in delayed damage, while the perspective of vitriol as a safe option may have caused a more liberal and indiscriminate application of the chemical. Yet the general decline of Irish partridge populations described in the *Northern Whig* must be considered in the context of other factors: a burgeoning urban population, subsequent diminution of farms, laws legalising the sale of game and the role of steamships in opening up English and Scottish markets to Irish game.[44]

Across the Irish Sea, a marked decline of the partridge population in England was first noted only a year after the 1843 publication of the *Northern Whig's* exposé. Accomplished sportsman and writer Peter Hawker partially attributed this decline to the placing of vitriol among seed wheat to prevent smut.[45] Hawker raged not only against vitriol, but growers and poachers, who together created 'a combination of circumstances, all against the sportsman.'[46] By the mid-1840s, both arsenic and blue vitriol steeps attracted the attention of newspaper writers and correspondents. A correspondent to the *Exeter Flying Post* described his attempt to recreate European botanist Carl Sprengel's arsenic recipe (of one part arsenic for fifty of water), but found it detrimental to his crop. This complaint was subsequently dismissed by the *Hampshire Advertiser* as the result of a misprint in the English translation of Sprengel's book.[47] The true extent of rural arsenic use only exploded into the national consciousness following the 1848 publication of Fuller's investigation in *The Lancet* medical journal and the endorsement of his findings by the Victorian press.

Many of Fuller's findings on the use of seed steeps were by no means original. Reports from one of Fuller's correspondents, Dr. Heale from Staines in Surrey, indicated that agricultural workers were common victims of arsenic poisoning. Yet the danger posed to seed handlers had been recognised since the eighteenth century. What was new in Fuller's article was the spectre of a wider public health crisis. Fuller theorised that game birds poisoned by arsenic steeps could be collected and sold by poachers, injuring unsuspecting customers. The editor of *The Lancet* agreed with this assessment, rushing Fuller's findings to press as a 'medio-legal point of view' of great importance.[48] Yet Fuller's article was not widely circulated in medical periodicals, with only the *Pharmaceutical Journal and Transactions* carrying a

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[43] William Thompson, *The Natural History of Ireland*, 5 vols. (London: Reeve, Bentham and Reeve, 1849-1856), vol. 2, 60.

[44] William Thompson, *The Natural History of Ireland*, 5 vols. (London: Reeve, Bentham and Reeve, 1849-1856), vol. 2, 60-61.

[45] Peter Hawker, *Instructions to Young Sportsmen in All that Relates to Guns and Shooting*, 9th ed. (London: Longman, Brown, Green and Longmans, 1844), 173-174.

[46] Peter Hawker, *Instructions to Young Sportsmen in All that Relates to Guns and Shooting*, 9th ed. (London: Longman, Brown, Green and Longmans, 1844), 173.

[47] 'Arsenic Steep for Wheat', *Hampshire Advertiser and Salisbury Guardian*, 07 October. 1843.

[48] Henry W. Fuller, 'On the Use of the Arsenic in Agriculture-Poisoning by Arsenic, and Symptoms of Cholera-The Possible Effect of the Game Laws', *The Lancet* 2 (1848): 649. Thomas Wakley was editor at the time.

reprint the following year.[49] Yet Fuller was not the only medical writer to raise the danger of animals poisoned by seed steeps.

Toxicologist Alfred Swaine Taylor published his magisterial work *On Poisons* in 1846 as an addition to his existing interests in medical jurisprudence. The work was largely a series of sensationalist accounts of criminal trials involving poison. Yet Taylor also reported upon the activities of French authorities investigating cases of poisoning involving agricultural chemicals. French physician Dr. C.P. Galtier had examined a case in which a pig fed on wheat soaked in blue vitriol had been killed and sold, with seventeen people who ate the flesh being seized with a violent colic.[50] Fellow Frenchman and member of the Paris Academy of Sciences M.A. Guérard similarly examined instances of arsenic poisoning in sheep.[51] Taylor's discussion of poisons in the rural context drew heavily on the earlier work of French commissions and agricultural writers.

Fuller and Taylor found their works extensively cited by the Victorian press. Multiple newspapers carried a complete version of Fuller's article, before directing their readers towards Taylor's work. In London alone, *The Times*, *The Standard* and *Bell's Life in London and Sporting Chronicle* carried the partridge story in this manner.[52] Numerous papers across various British counties introduced the story in an identical manner, including *The Hull Packet*, *The Ipswich Journal* and the *Hampshire Advertiser*.[53] Not every report was a carbon copy, with some newspapers printing comments or reassurance for readers. The *Cornwall Royal Gazette* was an example of the latter:

> It may be satisfactory to our readers that we cannot find that Cornish farmers use arsenic in the preparation of seed-corn for tillage. And, with regard to the game recently exhibited for sale in Truro, we have generally remarked sufficient evidence of gun-shot wounds. Neither have we any doubt that the very respectable and only

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[49] Henry W. Fuller, 'The Use of Arsenic in Agriculture', *Pharmaceutical Journal and Transactions*, 8 (1849): 349-350.

[50] Alfred S. Taylor, *On Poisons, In Relation to Medical Jurisprudence and Medicine* (London: Lee and Blanchard, 1848), 139.

[51] Alfred S. Taylor, *On Poisons, In Relation to Medical Jurisprudence and Medicine* (London: Lee and Blanchard, 1848), 139.

[52] 'On The Use of Arsenic in Agriculture', *The Times*, 18 December. 1848; 'On the Use of Arsenic in Agriculture – Its Dangerous Effects on Game', *Bell's Life in London and Sporting Chronicle*, 17 December. 1848; 'On the Use of Arsenic in Agriculture – Poisoning by Arsenic, and Symptoms of Cholera – The Possible Effect of the Game Laws', *The Standard*, 12 December. 1848. *Bell's Life in London and Sporting Chronicle* was of growing importance, at this time beginning its emergence as Britain's premiere sporting newspaper. See Tony Mason, 'Sporting News, 1860-1914', in Michael Harris and Alan Lee (eds.), *The Press in English Society from the Seventeenth to the Nineteenth Centurie*s (Rutherford, Fairleigh Dickinson University Press, 1986), 169.

[53] 'On The Use of Arsenic in Agriculture', *The Ipswich Journal*, 16 December. 1848; 'On the Use of Arsenic in Agriculture – Poisoning by Arsenic, and Symptoms of Cholera – The Possible Effect of the Game Laws', *Hampshire Advertiser and Salisbury Guardian*, 16 December. 1848; 'On the Use of Arsenic in Agriculture', *The Hull Packet and East Riding Times*, 22 December. 1848. In Scotland an identical article appeared. 'Use of Arsenic in Agriculture', *The Aberdeen Journal*, Wednesday, 3 January 3. 1849.

> licensed vendors of game here will take care, now that the above facts [in Fuller and Taylor's works] are before the public, to make such inquires as to the how and whence, as will remove all doubt of the quality of their game.[54]

The Cornish paper's investigation was characteristic of a backlash against the use of arsenic in agriculture. Proper licensing of game and the scrutiny of the press was only one avenue to protect the public. Other papers went further, printing arsenic-free steep recipes for their agricultural and horticultural readers. These were often based on blue vitriol. Experimental reports from an 1845 French commission at Rouen were used by some British newspapers to conclude that sulphate of copper (blue vitriol) was a safer and more powerful means of preventing smut in wheat.[55] Yet the Bromsgrove Farmers' Club was reportedly informed by a visiting agricultural chemist that both arsenic and blue vitriol were of dubious utility. Instead, Club members conducted experiments with lime and the washing of wheat.[56]

Continental experiments were also called upon by British agricultural magazines in the wake of Fuller's publication. In the 1849 *Agricultural Gazette*, the results of crop trials carried out by an 1842 Rouen commission were interpreted as a demonstration of the ineffectiveness of arsenic in preventing smut.[57] In contrast to many other reports, the dangers of blue vitriol were noted, even though the same French trials confirmed its powerful preventative properties against smut.[58] The same article by Dublin-based author E.H. Durden appeared in the *Exeter Flying Post* later that January, complete with Durden's promotion of his own arsenic-free steep (comprised of sulphate of soda and quicklime).[59] In 1849 Fuller's article was printed by the long-running *Farmer's Magazine*.[60] The magazine went on to report on the most recent monthly council meeting of the Royal Agricultural Society of England and Wales. Here, accidents caused by the employment of arsenic as a seed steep were discussed by Dr. Calvert, Mr. Dyer and Mr. Tweed.[61] Disagreements

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[54] 'On the Use of Arsenic in Agriculture', *Cornwall Royal Gazette, Falmouth Packet and Plymouth Journal*, 22 December. 1848.

[55] 'On the Employment of Arsenic in Agriculture', *The Bury and Norwich Post, and East Anglican*, 10 January. 1849; 'On the Employment of Arsenic in Agriculture', *The Essex Standard, and General Advertiser for the Eastern Counties*, 12 January. 1849. Both papers quoted Duhamel du Monceau's *The Elements of Agriculture* (1767) on the damage incurred to poultry and game birds as a result of arsenic steeps.

[56] 'Agriculture &c.', *Berrow's Worcester Journal*, 14 December. 1848.

[57] E.H. Durden, 'On the Employment of Arsenic in Agriculture', *The Gardeners' Chronicle and Agricultural Gazette* (London: Bradbury and Evans, 1849), 11.

[58] E.H. Durden, 'On the Employment of Arsenic in Agriculture', *The Gardeners' Chronicle and Agricultural Gazette* (London: Bradbury and Evans, 1849), 10-11.

[59] Prevention of Smut in Wheat', *Trewman's Exeter Flying Post or Plymouth and Cornish Advertiser*, 25 January. 1849.

[60] Henry W. Fuller, 'On the Use of the Arsenic in Agriculture-Poisoning by Arsenic, and Symptoms of Cholera-The Possible Effect of the Game Laws', *The Farmer's Magazine* 19, 2nd Series (1849): 82-83.

[61] The Royal Agricultural Society of England, 'Seed Wheat', *The Farmer's Magazine* 19, 2nd Series (1849): 270-276, 273.

emerged in the meeting over the relative merits of arsenic as a smut preventative in comparison to blue vitriol or the simple washing of wheat seed with water.[62]

Fuller's 1848 article created a sudden and widespread awareness of the potential dangers of arsenic use. Prior to the 1840s, concerns regarding arsenic steeps had been limited. Individual farmers rejected the substance on grounds of safety, supported by the occasional agricultural writer. Arsenic was actively promoted in farmer's periodicals and the agricultural sections of newspapers. Fuller and Taylor's publications marked the entry of wider public health concerns into the seed steep debate, doing much to connect the deliberate or accidental poisoning of animals with the danger to their human consumers. These revelations may have lapsed into obscurity – as seemed to occur with the 1843 Irish poisonings – had it not been for their rapid and widespread uptake by newspapers. The subsequent press backlash of 1848 marked an about-face in attitudes to arsenic steeps. The cure had literally become worse than the disease, demanding action to protect public health: blue vitriol, on the other hand, practically escaped censure.

Regulation and restriction of seed steeps

Rising concern over the potential danger of arsenic-contaminated game forced the hand of government. Fuller's 1848 article had theorised that poisoned partridges could enter into the food supply via illicit means. Poachers were known to supply dealers in game, a largely unregulated market, meaning that poisoned birds could be easily collected and sold on to consumers. The use of arsenic in British fields was also pernicious to the enjoyment of sportsmen and hence the profits and social status of the game-breeding landowner. These powerful interests, represented by such figures as John Sinclair and Peter Hawker, criticised seed steeps: yet arable growers insisted that chemical steeps were necessity to combat smut. On the one hand, legitimate agricultural disease control had to be maintained. On the other, the use of poison to destroy game birds and injure life had to be controlled. Examples of the deliberate poisoning of game with arsenic-laced seed or plant matter emerged, cementing a correlation between criminality and arsenic. Parliamentary acts joined Fuller in blaming poachers and dubious dealers in game for poisoned birds, resulting in legislation to banish arsenic steeps from the countryside.

Restrictions aimed at poachers who deliberately poisoned game can be seen in a series of Parliamentary acts from mid-1840s with extensions in the 1860s. In 1844 the Night Poaching Act extended the powers of its 1828 namesake, forbidding the hunting of game on common land such as public roads.[63] Four years later, the Hares Act was introduced, dealing directly with the killing of game through poisonous ingredients. Introduced to Parliament in July of 1848, the Hares Act appeared before the publication of Fuller's article later in that year. The Act was not aimed at agricultural users, but instead had more in common with the 1844 Night Poaching Act, closing legal loopholes on dubious hunting activities. On the use of poisons, the Act declared that its contents (which liberalised legal hunting via the removal of Game Certificates) should not make it lawful to lay poison for the killing of game, stating:

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[62] The Royal Agricultural Society of England, 'Seed Wheat', *The Farmer's Magazine* 19, 2nd Series (1849): 270-276, 273.

[63] An Act to extend an Act of the Ninth Year of King George the Fourth, for the more effectual Prevention of Persons going armed by Night for the Destruction of Game, Parliamentary Papers [hereafter referred to as PP] 29 (1844): 301-302.

> That nothing herein contained shall extend or be taken or construed to extend to the making it lawful for any Person, with Intent to destroy or injure any Hares or other Game, to put or to cause to be put any Poison or poisonous Ingredient on any Ground, whether open or inclosed, where Game usually resort, or in any Highway.[64]

A Scottish version of the Act contained identical restrictions on poisons.[65] This strict wording was deemed necessary to counter arsenic as a tool of illegality in the countryside. A reviewer of Taylor's *On Poisons* cited an 1846 incident involving the mass poisoning of pheasants, which had fed upon seed laced with arsenic.[66] Taylor's book also noted an occurrence of blackcock (black grouse) poisoning in that same year, where the birds were deliberately fed oats and shoots intermixed with arsenic.[67] Despite such examples of sabotage and the press flurry caused by Fuller, further legislation on arsenic use would not appear until the 1860s. Seed steeps did not entirely disappear from national consciousness during the intervening decades. Beverley Morris published his history of British game birds in 1855, which reprinted the 1843 *Northern Whig* article. Yet Morris seemingly introduced the piece as a curiosity for his readers, believing that the cultivation-friendly partridge was overall suited to all forms of progress in agriculture.[68]

By 1860, seed steeps had seemingly been banished from the pages of the press. It may have been that the winter of 1848 acted as a brief scare, abandoned in the absence of a tangible public health crisis. A simpler explanation would be that farmers simply abandoned chemical steeps in fear of a public or legislative backlash.[69] However, this explanation is undermined by the passing of the 1863 Poisoned Grain Prohibition Act and subsequent prosecutions.[70] The Act prohibited the injuring of bird or animal via the use (or supply) of poisoned seed, with a ten pound fine for those convicted.[71] On initial reading, it may appear that comprehensive action had finally been taken against seed steeps. Yet, while arsenic use was strictly forbidden, the prohibition did not extend to the use of blue vitriol in agriculture:

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[64] Hares Act, PP 29 (1848): 305-308, 307.
[65] Hares (Scotland) Act, PP 30 (1848): 309-311, 310.
[66] 'On Poisons, in Relation to Medical Jurisprudence and Medicine', by Alfred S. Taylor, F.R.S., Lecturer on Medical Jurisprudence and Chemistry in Guy's Hospital' *The British and Foreign Medico-Chirurgical Review* 2 (1848): 359-360, 360.
[67] Alfred S. Taylor, *On Poisons, In Relation to Medical Jurisprudence and Medicine* (London: Lee and Blanchard, 1848), 139.
[68] Beverley R. Morris, *British Game Birds and Wildfowl* (London: Groombridge and Sons, 1855), 61.
[69] On the Third Reading of the Sale of Arsenic Regulation Bill in 1851, seed steeps were brought up before the House of Lords by the Earl of Carlisle. Yet this was only to confirm that 'no such objection could apply to the uses to which it [arsenic] was put in connection with agriculture—such as the steeping of seed, the rubbing of sheep, and the destroying of vermin.' HL Deb 24 March 1851, Vol. 115, cc. 422-424.
[70] A late prosecution of farmers occurred in 1899. 'Sowing Poisoned Wheat', *Leicester Chronicle and Leicestershire Mercury*, 9 December 9. 1899.
[71] Poisoned Grain & c. Prohibition, PP 121 (1863): 474.

> Nothing in this Act shall prohibit, for use in Agriculture, the exposing or offering for Sale or selling, or the sowing and setting, of any Grain or Seed which had been steeped or dipped in, or with which had been mixed, a Solution of Sulphate of Copper or Blue Vitriol, in the Proportion of One Gallon of Water at the least to One Pound Weight of Sulphate of Copper or Blue Vitriol, and so in proportion for any greater or less quantity.[72]

Evidence presented to the House of Commons prior to the passage of the Act condemned arsenic, yet portrayed blue vitriol as harmless. The House heard how one landowner, Mr. Lawes of Hertfordshire, had employed an 'analytical chemist' who claimed that 'blue vitriol or sulphate of copper was used with perfect success for the prevention of smut in wheat; it was a simple and economical preservative, and did not affect the germination of the seed, or injure poultry or birds of any kind.' Another landowner, Mr. C. Randell of Chadbury, also spoke favourably of the 'perfectly effectual, very economical' blue vitriol.[73]

Despite reports of vitriol-related scandals in France, blue vitriol was clearly seen as a safer option for agriculturalists. Later writers would list the Hares Act and Poisoned Grain Prohibition Act alongside earlier restrictions on poaching and the taking of game: an accurate classification.[74] With the loophole on blue vitriol, it is of little surprise that the destruction of birds and animals continued. Incidents were not only confined to the rural farm, but also occurred in urban green spaces. In the same year as the passing of the Poisoned Grain Prohibition Act, a letter appeared in *The Essex Standard* to report such an event. The writer told the sorry tale of a beloved Colchester cat. The cat fell victim to poison after consuming dead birds, which had been killed by the scattering of poisoned wheat in the town's pleasure and market gardens.[75] In this particular event, the letter writer introduced a new argument against chemical controls. Their use was considered an 'inhuman practice', resulting in much 'suffering and misery upon the birds and cats'.[76]

By the time Parliament made its intervention, an almost exclusively negative perspective of arsenic seed steeps existed. Medical jurisprudence and government regulation restricted the rural use of arsenic, introducing a new and dangerous aspect for its users: legal liability. Social movements towards the humane treatment of animals also condemned the use of poison on moral grounds. Yet the use of chemical controls in agriculture did not disappear. The falling popularity of arsenic and legal restrictions on its use as a fungal-preventative only increased the incentive for growers to turn to blue vitriol.

Conclusion

This paper has offered an overview of chemical controls in British agriculture from the mid-eighteenth to mid-nineteenth centuries. During this time, arsenic and copper-based seed steeps played a significant role on many British farms. Despite the known dangers associated

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[72] Poisoned Grain & c. Prohibition, PP 121 (1863): 474-475.
[73] HC Deb 08 July 1863, Vol. 172, cc. 377-389.
[74] J.R.V. Marchant and Watkin Watkins, *Wild Bird Protection Acts 1880-1896* (London: R.H. Porter, 1897), 21-23; Christabel S. Orwin and Edith H. Whetham, *History of British Agriculture 1846-1914*, 2nd ed. (Newton Abbot: David & Charles, 1971), 45-46.
[75] 'Poisoned Wheat and the Birds and the Cats', *The Essex Standard and General Advertiser for the Eastern Counties*, 10 April. 1863.
[76] 'Poisoned Wheat and the Birds and the Cats', *The Essex Standard and General Advertiser for the Eastern Counties*, 10 April. 1863.

with substances like arsenic, the challenges of crop disease ensured their rural use for a significant period of time.[77] Ultimately the impact of arsenic steeps upon game birds turned the Victorian public and the British Parliament against the use of arsenic in agriculture. Copper sulphate, or blue vitriol, created less controversy. Copper compounds were undoubtedly less toxic and did not suffer from the same association with poaching and criminality endured by arsenic users. Simple inorganic pesticides, such as arsenate of lead, would persist in mainstream British farming until the advent of mercurial fungicides in 1929.[78]

An existing body of literature on toxicity has largely focused on the 'chemical age' of twentieth century.[79] These investigations have unearthed a number of pertinent themes in the study of toxicity: the production of scientific and regulatory knowledge, industry and state responsibility; the unseen victims of contamination and role of activists in exposing risk.[80] Such themes are not alien to this study of agricultural chemicals in the eighteenth and nineteenth centuries. We have seen how naturalists and doctors uncovered the risks posed to animal and human health by arsenic and copper steeps, the role of the British state in regulating arsenic, and its appropriation of blame for mass bird poisonings to criminals and saboteurs. 'Invisible' people, or those 'who are often the first victims of contaminations' appear in the guise of rural workers and unwitting purchasers of contaminated meat.[81]

Yet a series of challenges for historians of toxicity and the environment have also been identified. Not least, how historians can engage with contemporary debates on chemical pollution, whether as 'translators of science, interpreters of risk, advisors on previous mistakes and future policies, voices for vulnerable populations, or some combination of the above'.[82] Can a long-term history of chemical pollutants, stretching back centuries, clarify this issue? I believe that long-term histories of toxicity can 'offer new data

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[77] It is possible that the developing field of agricultural chemistry actually encouraged farmers' use of arsenic. A series of European experiments carried out on wheat soaked in arsenious acid tested the hypothesis that the crop grown from treated seed would be poisonous. This hypothesis was refuted in 1843, demonstrating that arsenic-treated wheat would not harm consumers. 'On Poisons, in Relation to Medical Jurisprudence and Medicine', by Alfred S. Taylor, F.R.S., Lecturer on Medical Jurisprudence and Chemistry in Guy's Hospital' *The British and Foreign Medico-Chirurgical Review* 2 (1848): 359-360, 360.

[78] John Sheail, *Pesticides and Nature Conservation: The British Experience 1950-1975* (Oxford: Clarendon, 1985), 16; Michael Shrubb, *Birds, Scythes and Combines: A History of Birds and Agricultural Change*, (Cambridge: Cambridge University Press, 2003), 175. Copper sulphate continued to be used against smut until its replacement by organomercury in the early 1950s.

[79] Nathalie Jas, 'Chemicals and environmental history', *Ambix* 61 (2014): 194-198, 194; Rachel Emma Rothschild, 'The turn towards toxins: an essay review', *Endeavour* 40 (2016): 128-130, 128.

[80] List taken from Nathalie Jas, 'Chemicals and environmental history', *Ambix* 61 (2014): 194-198.

[81] Nathalie Jas, 'Chemicals and environmental history', *Ambix* 61 (2014): 194-198, 197.

[82] Emma Rothschild, 'The turn towards toxins: an essay review', *Endeavour* 40 (2016): 128-130, 130.

and perspectives for enriching current debates on the regulation of toxic products.'[83] On the one hand, the history of arsenic seed steeps demonstrates how those in the fields of natural history and medicine, supported by the press, were able to raise public consciousness of a threat to human and animal life: a process which eventually led to stringent regulation on arsenic use. Yet on the other, the threat of blue vitriol was missed: partly as the result of government trust in British analytical chemistry over other forms of knowledge. More generally, the long-run history of agricultural chemicals in Britain suggests two means of enriching future debate on the place of chemicals in farming: firstly, by recognising that various chemicals have long played a role in 'traditional' farming practice; secondly, that appeals to the safety of substances on the grounds that they are 'natural' or 'organic', rather than 'synthetic', are themselves hazardous.

Imagine the 2008 debate on organic farming replayed in the pages of *The Independent*, this time with a crucial difference: that both parties were fully aware of the history of copper sulphate and its use as a seed steep in Britain. How might the resulting argument have played out? Johnston may well have found extra ammunition for his tirade against organic farming, arguing that 'organic' compounds like copper sulphate have long been known to be dangerous to wildlife and human health. Lord Melchett would likely be forced to alter his argument, but could argue that copper sulphate is less dangerous than other chemicals. For instance, copper compounds may have been used in England since the mid-eighteenth century, with comparatively few instances of damage to health and the environment. Or the Soil Association may have forbidden its members from using copper compounds in any disease control role. Regardless of what route this counterfactual debate would take, the introduction of a new element – history – would reshape a modern controversy on the future of farming.

[83] Ximo Guillem-Llobat and José Ramón Bertomeu Sánchez, 'Living in a toxic world, 1800-2000', *Endeavour* 40 (2016): 67-69, 69.