

## Article

# Salting the Earth: Intentional Application of Common Salt to Australian Farmland during the Nineteenth Century

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**Abstract:** During the nineteenth century, common salt (NaCl) was liberally applied to Australian farmland as a manure to improve productivity and as a fungicide to prevent, or at least reduce, the impact of rust in wheat. In an age where salinity control is paramount for biodiversity and agricultural productivity alike, it is worth reflecting that during the nineteenth century salt was intentionally applied as a manure to improve soil productivity. This paper traces the origin and extent of this practice in Australia.

**Keywords:** agricultural heritage; dryland salinity; land-use history; wheat growing

## 1. Introduction

Dryland salinity has become one of the main drivers for changes in Australian land-management practices during the late twentieth and early twenty-first centuries. The problems this phenomenon poses for the environment and farm productivity are likely to continue for at least another fifty years. Rising water tables lead to the dissolution of the existing salts in the lower parts of the soil profile and their concentration (caused by evaporation of the moisture) at the upper part of the column. Where the groundwater table is close to the surface, the vegetation has been impacted, and many plants have been replaced by more salt-tolerant species. As the salt concentrations increased further, fewer plants survived, leading to exposed ground and scalding, which set in train erosion processes. Irresponsible water management practices, such as over-irrigation and the clearing of tree cover in rainfall recharge areas, have been identified as the major contributors [1,2]. In many areas of the world, rising groundwater tables and the concomitant dry-land and farmland salinity have become the scourge of the agricultural community; this is certainly the case in much of the Riverina, north-eastern Victoria, and Western Australia [3–6]. The impacts are not confined to agricultural production land but also affect public infrastructure, such as roads and water supply systems [7], as well as heritage buildings and streetscapes [8–11].

In an age of GPS-aided precision farming where farmland and urban salinity are one of the major causes of modern land degradation, it is somewhat ironic, as this paper will discuss, that during the eighteenth and nineteenth centuries farmers purposefully applied liberal quantities of common salt (NaCl) to improve the productivity of the land.

Historical research has the capacity to inform policy responses to current environmental concerns. Historical ecology and environmental history in particular consider the trajectories and impact of past human practices on current environmental conditions, such as historic resource exploitation [12], including species extirpation [13] and introduction [14] and diseases [15], as well as land [16] and river management practices [17]. The paper presented here is concerned with the historic influences on the management of arable soils.

While there is an abundance of research into the colonial settler society of Australia

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and its impact on Indigenous Australian communities and their land use [18–23], as well as the expansion of the pastoral and agricultural industry on the continent [24–27] and the introduction of plant and animal species [28–30], there has been comparatively little work on the rural industries and the associated production and services [31–33]. Some authors have explored the history of plant diseases and their treatment [34,35], but little work has been carried out on the history of information management in that realm.

Grounded in and drawing on work carried out in the United Kingdom [36] and expanding on a previous brief examination of this practice in the Australian context [37], this paper will explore the history of the wide-spread phenomenon of applying salt as a fertilizer and will attempt to assess the extent to which this practice found application in Australia. While, as this paper will show, the lasting effect of the application salt is low, this nineteenth-century practice highlights how colonial settler communities, when faced with challenges to their land-management model, may have been susceptible to misinformation. In the absence of authoritative science- and evidence-based advice many, desperate for solutions, resorted to traditional remedies and ‘folk wisdom’ drawn from other times and other places.

## 2. Historic Foundations of the Use of Salt in Agriculture

Setting aside the biological necessities of sodium in the electrolyte balance of animals and humans [38], salt has long been recognized as a major spice to bring out the taste in food [39] and, in particular, as a bactericide as part of the pickling, and thus the preserving, process of fish, meat, and other produce [40]. Not surprisingly, salt was widely sought after in many communities across the globe. Produced through the evaporation of saline water (sea water or saline springs) or through the direct mining of salt deposits, salt was a commodity that was traded widely and over great distances [41–46]. While the primary use of salt has been in relation to human consumption and food preservation, salts also found use in agricultural applications.

While small quantities of salt were deemed to have beneficial effects, large quantities of salt have long been known for being detrimental. Indeed, the application of salt has been used, reputedly, throughout history to render farmland unsuitable for growing crops. When King Abilimech destroyed the city of Schechem in about the thirteenth century BCE, he salted the earth, reputedly to complete the destruction (Judges IX 45). After Publius Cornelius Scipio ‘Africanus’ had conquered Carthage in the third Punic War in 146 BC, the Roman Senate ordered that the town be razed and ploughed (Appian VIII xx 135) [47] and, reputedly, that the new fields be sown with salt in order to rid Rome, once and for all, of its major antagonist in the Western Mediterranean. While it would appear that in the first instance this salting was more ritualistic than practical [48,49], and in the second that the claim has been proven a nineteenth-century fabrication [50,51], Pope Boniface VIII did salt the city of Palestrina in 1299 [51].

The phytotoxic effects of salt were well-known in antiquity and remained to be so throughout the ages. The sixteenth-century German collection of fool’s stories, *Die Schiltbürger*, contains a story in which the good citizen of the fictitious town of Schilda, faced with wartime shortages of salt, set out to grow salt on their commons. All that could be grown the next year were stinging nettles (which grow on the poorest of soils), which were too ‘salty’ to harvest [52].

During the nineteenth century, common salt was frequently advocated as a means to safeguard sheep pastures against diseases, such as worms and fluke [53–60]. In 1885, salt was also recommended in high concentrations against weeds [59]. While it was agreed that salt was beneficial in general terms, it was also recognized that too much salt would be injurious to the crop [61,62], with weeds being more susceptible than the pasture grasses [63].

The advocacy of the perceived beneficial effects of salt as a fertilizer and the extent of its practice will be the focus of the remainder of this paper.

### 3. Broadcasting Salt as a General Fertilizer

The limited use of salt to improve agricultural productivity and to prevent some animal diseases has its roots in antiquity dating back to the Roman times: Pliny the Elder (xxxi, 33) [64], as well as Cato and Virgil, commented on this [65,66]. Given the renewed interest in Greek and Roman texts during the Renaissance, such knowledge found a revival among educated circles; these sources, albeit centuries old, were still deemed valid knowledge. The first mention of salt as a manure in more recent times dates to the end of the sixteenth century [67]. During the seventeenth century, farmers' lore held that salt could be used as a manure to improve barren soils and fatty loams [66,68,69]. By the early part of the eighteenth century, the use of salt as a manure, both as a phytocide and a (selective) manure, had become well-established [70–72] and continued to be advocated [73]. The significance of salt as a fertilizer was such that in 1768 King George III assented to an act that reduced the duty on the salt unfit for human consumption and destined for use as a fertilizer. The use of salt as a manure was not limited to the United Kingdom but also practiced on the continent [74–76].

A sizeable number of publications discussing the use of salt as a fertilizer appeared in the United Kingdom at the beginning of the nineteenth century [66,77–86]. Some of these became popular and went through several editions in a short period of time [78,87–89].

The concepts soon crossed the Atlantic, and agricultural guides and newspapers published in the USA advocated the application of salt as a manure [90–94], especially to cleanse and strengthen the plant and to improve growth [95,96], to improve yield, to speed up ripening, and to prevent rust and smut [97]. Likewise, the ability of salt to reduce the freezing point of water was seen as beneficial. In the USA, the application of salt to flax and wheat crops was advocated as a means of reducing the impact of frosts [95]. In addition, the application of salt was assumed to improve the productivity of some fruit trees, such as apple, pear, and cherry [95].

Not surprisingly then, these concepts were also brought to Australia as a part of farmers' lore. In addition, throughout the early and mid-nineteenth century, Australian papers frequently reprinted items from the British Press, uncritically accepting the opinions of the motherland as gospel, e.g., [98,99]. Thus, a contribution to the *Brighton Gazette* was reprinted in Adelaide [100] and Launceston [101]. In some cases, that chain of evidence had a long trajectory. For example, an item on "Salt as a preventative of rust" and also mildew, published in the *Perth Gazette* of 4 December 1868, cites Johnson's *Farmer's Encyclopedia* of 1842 [102], which in turn cites an 1818 communication by a Revd. Edmund Cartwright [87].

More often than not, major contributions were reprinted throughout the Australian colonies. An example of this is an item written by a 'J.B.' of Wandin Yalloak, carried by the Melbourne paper, *The Leader*. In this, the author reported some experiments he had conducted (see below and Table 1). The newspaper item was widely reprinted and appeared in Launceston (Tas) [103], Adelaide (SA) [104], Port Elliott (SA) [105], Armidale (NSW) [106], and Sydney [107], as well as in a Sydney weekly with a colony-wide circulation [108]. Three years later it was picked up again, this time reprinted in Maitland (NSW) [109], Boorowa (NSW) [110], and Toowoomba (Qld) [111], as well as by the same Sydney weekly [112].

**Table 1.** Salt manure experiment by J.B. [109].

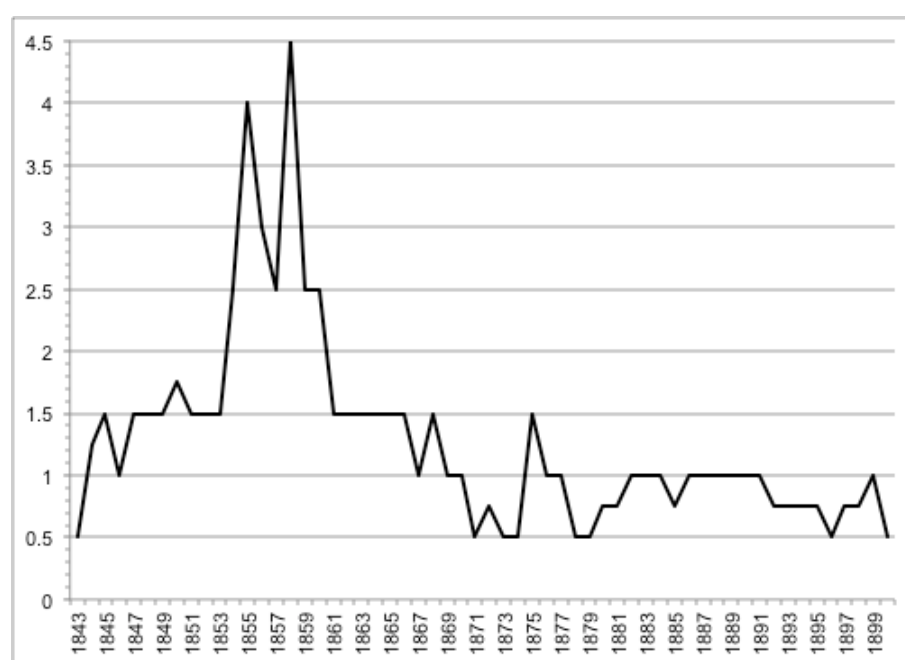
Strip	lb Salt/Acre	Result
1	130	wheat ripened, no rust
2	—	infested with rust, could not be harvested
3	130	wheat ripened, no rust
4	—	infested with rust, could not be harvested
5	65	infested with rust just prior to ripening, harvestable
6	—	infested with rust, could not be harvested

By the 1880s the qualities of salt were still extolled by the authorities. According to the application of salt to common farm crops increased the weight of the grain per bushel, while mixing salt with a top dressing would improve the strength of the straw. Experiments in the United States seemed to confirm this [113].

Johnston [114], however, cautioned that “some chemists...doubt that salt or soda is essential to plants” Indeed, it is worth noting that Justus von Liebig, one of the eminent researchers of fertilizers and manures in the nineteenth century, does not mention the use of salt in his *Principles of agricultural chemistry* even though in his research he draws heavily on British examples and findings [115]. The failure of salt to have any demonstrable positive manurial effect was already well-publicized in England and Australia in 1852 [116] and again in 1862 [117,118]—but it proved to be quite difficult for science to overcome the deeply ingrained farmers’ lore [119].

In addition, purchasing salt as manure was not cheap. With the exception of the period of the mid-1850s, the price of a pound of table salt in New South Wales was at or below 1 d (Figure 1) [120]. The costs of table salt were thus 8 s 4 d per cwt. While we can assume that the price of common and untreated/cleaned salt would have been substantially less, the cost of salt manuring was not insubstantial—especially if the advice was to broadcast up to 5 cwt of salt per acre (Table 2). The situation was somewhat different in Victoria. In 1865, the Victorian colonial government introduced an import duty on salt (£1/ton) to promote a local salt production industry [121,122]. This industry failed to take off as rapidly as hoped [121,123–129].

In consequence, much of the salt was imported from the United Kingdom [130], Germany and India [121]. As a result of the tariff, the price of salt was high, even if the salt was unfit for human consumption [121]. Other colonies exempted non-purified (‘rock’) salt from the import duties [131].



**Figure 1.** Price of a pound of table salt (in d) in New South Wales from 1843 to 1900 [120]. Simplifying the price developments graphed above, we arrive at a general average price of 1½d/lb salt for the period 1845–1853 and 1861–1868; an average of 2½d/lb for the period 1854–1860; and an average of ¾d/lb for the period 1869–1900.

**Table 2.** Quantities of salt per application historically recommended for wheat and other cereals.

Reason	Application Time	Quantity/Acre	g/m <sup>2</sup>	Source
<b>WHEAT GENERAL</b>				
Improve wheat	At sowing	1 bushel	9.0	[95]
Top dressing (standard)	At sowing	1½ bushels	13.5	[97]
Top dressing (standard)	before sowing	200 lbs	22.4	[132]
Top dressing (standard)	At sowing	1½ cwt		[109]
Top dressing (standard)	At sowing	300 lbs	33.6	[133]
Top dressing (standard)	At sowing	300 lbs	33.6	[113]
Top dressing (standard)	At sowing	400 lbs	44.8	[133]
general fertilizer	At sowing	5 bushels [*]	44.9	[134]
general fertilizer	At sowing (first year)	20 bushels	179.6	[135]
general fertilizer	At sowing (subsequent years)	5–10 bushels	44.9–89.8	[135]
general fertilizer	At sowing	10–12	89.8–107.8	[72]
Improve wheat, strong loamy soils	At sowing	120 bushels		[98]
general fertilizer, light soil	just before sowing	5 cwt	62.6	[136]
general fertilizer, medium soil	just before sowing	4–5 cwt	50.2–62.6	[136]
general fertilizer, heavy soil	just before sowing	3–4 cwt	37.7–50.2	[136]
<b>RUST IN WHEAT TRIALS</b>				
Against rust	At sowing	25 bushels	123.5	[137]
trial, NSW	spot treatment of rusty wheat	1 lb/gallon	—	[138]
trial, South Australia	At sowing	80 lbs	9.0	[139]
trial, Colorado	On growing crop	1–5 bushels	9.0–44.9	[140]
trial, Wollongong, NSW	At sowing	1cwt	12.6	[141]
trial, South Australia	At sowing	140 lbs	15.7	[139]
trial, NSW	When crop is 4 inches high	2–5 bushels	18.0–44.9	[142]
trial, South Australia	At sowing	200 lbs	22.4	[139]
trial, Canada	At sowing	300 lbs [**]	33.6	[143]

trial, Corowa, NSW	At sowing	3 cwt	37.7	[144]
trial, NSW	At sowing	4 cwt	50.2	[138]
OTHER CEREALS				
barley, light soil	just before sowing	6 cwt	75.4	[136]
barley, medium soil	just before sowing	4–5 cwt	50.2–62.6	[136]
barley, heavy soil	just before sowing	3–4 cwt	37.7–50.2	[136]
Oats	At sowing	3 cwt	37.7	[145]
oats, light soil	just before sowing	6 cwt	75.4	[136]
oats, medium soil	just before sowing	4–5 cwt	50.2–62.6	[136]
oats, heavy soil	just before sowing	3–4 cwt	37.7–50.2	[136]
rye, light soil	just before sowing	7 cwt		[136]
rye, medium soil	just before sowing	5–6 cwt	62.6–75.4	[136]
rye, heavy soil	just before sowing	4–5 cwt	50.2–62.6	[136]
Improve maize	At sowing	1/3 peck	7.2	[95]
Improve maize	When growing	1 spoon/plant	—	[95]

[\*] Given that one kg of dry salt (at 70% humidity) takes up about a volume of one litre, and a bushel has a volume of 36.37 litres, the recommended application of salt is 18.0–44.9 g/m<sup>2</sup>. Other conversions: 1 cwt (UK) = 50.8 kg; 1 cwt (US) = 45.36 kg; —[\*\*] The newspaper source states 3000 lbs per acre, but this is presumably a typesetting mistake.

#### 4. Rust in Wheat and the Problem of Declining Yields

Australian wheat yields declined in the second part of the nineteenth century, partly due to an exhaustion of the fragile soils after years of tilling, and partly because the strains of wheat grown were not resistant to a variety of diseases, chiefly rust. In New South Wales, European crops were affected by rust within a decade from the start of their introduction, with rust outbreaks on record for 1799, 1803, 1805, 1829, and 1832 [35]. Rust appeared in South Australia in 1853/54 [146], but the infestation did not reach catastrophic proportions until 1863/1864 in New South Wales and Victoria and 1867/1868 in South Australia. This is well illustrated by the coverage of the topic in Australian newspapers (Figures 2 and 3). In 1864, the Colony of Victoria established a committee to investigate rust in wheat, followed by a similar committee in South Australia in 1867 [34].

The stem rust fungus (*Puccinia graminis tritici*) produces millions of small, orange-to-red colored spores, which are blown by the wind onto various plants. Under moist conditions these spores germinate and enter the host plant through its stomata (breathing pores). It was assumed that a harder stem would be more resistant to the colonization by the fungus than the soft-straw wheat varieties [139]. The rust in wheat problem was so large that a number of diverse lines of enquiry were followed. In addition to the establishment of a scientific research direction to oversee the work and to approach the problem from a purely scientific perspective, a series of trials was instituted to assess the viability and effectiveness of a range of traditional remedies [119,147].

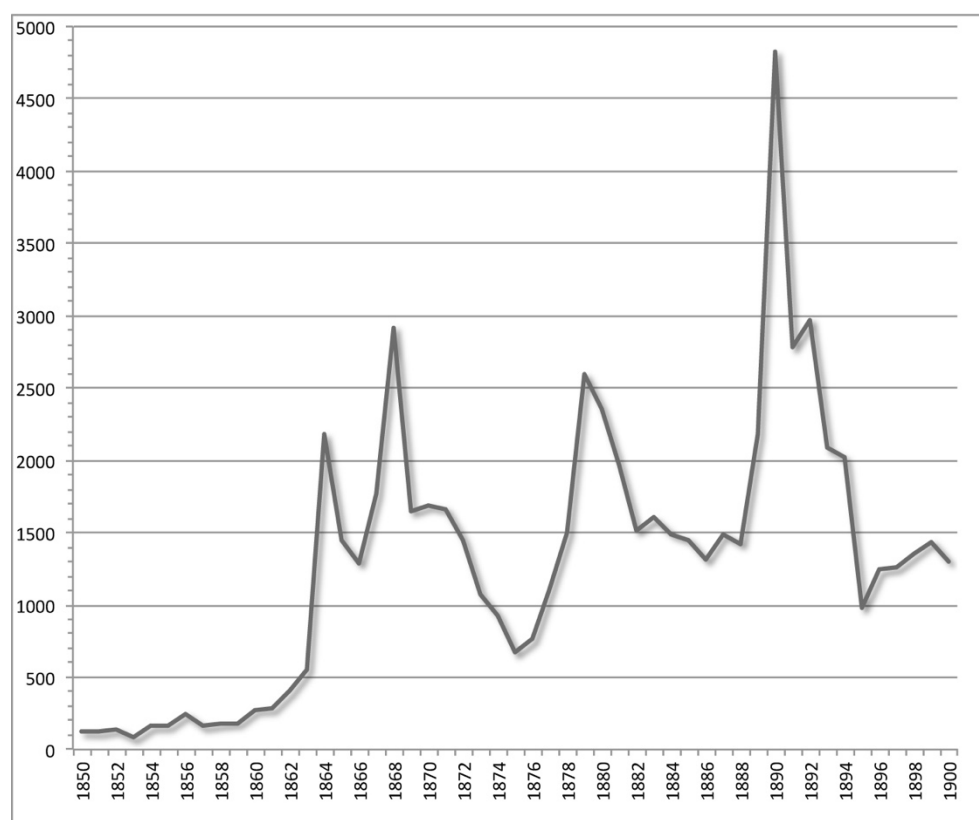
While the focus of the paper is on the Australian situation, we need to be aware that Australian agriculture in the mid- and late nineteenth century was in its comparative infancy. While established on traditional British techniques of farming, these had to be adjusted to the local situation, in particular to the soil fertility, the different manifestations of the seasons, and the climatic extremes of drought and excessive rainfall. Even if it had been solicited, Indigenous Australian land management experience was of little help when dealing with production agriculture using introduced grasses (primarily wheat). Consequently, Australian agriculture was open to suggestions and improvements that had been, or were being, trialed in other settler colonialist countries, namely the USA and Canada. For example, the Albury newspaper, *Border Post*, carried an item in 1890 that reported on Canadian research into rust in wheat and quoted extensive excerpts [143,148].

With Australian agricultural research in its infancy and riven with intercolonial rivalries, and in the absence of authoritative advice, many farmers resorted to traditional remedies, either drawn from old and often-reprinted agricultural publications or sourced

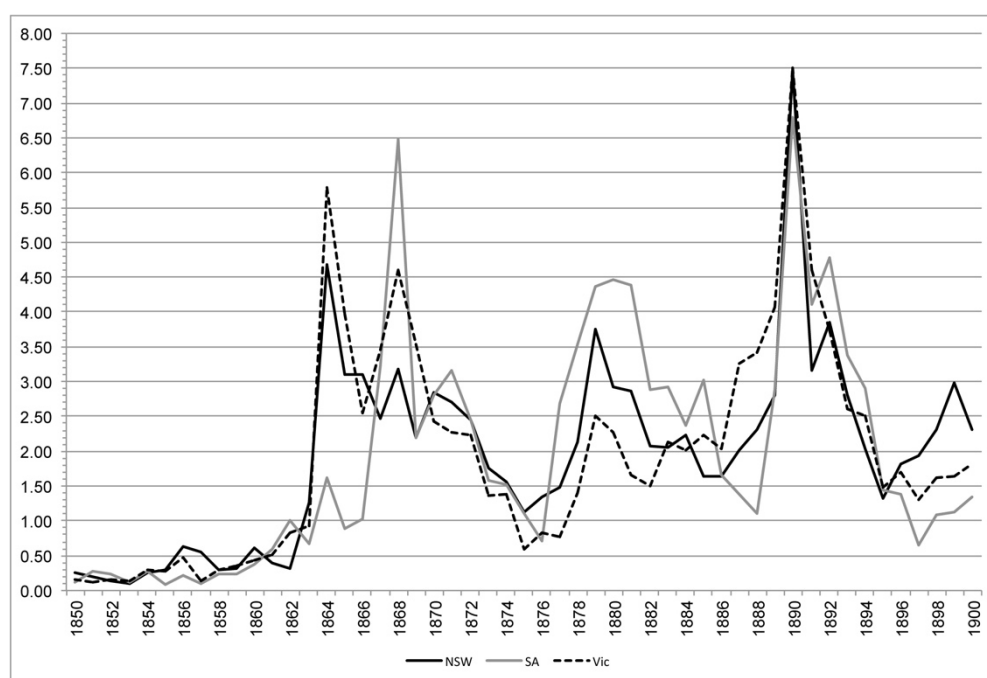
from ‘folk wisdom’, which made the recipients more susceptible to misinformation.

### 5. Salt as a ‘Home Remedy’ to Increase Wheat Yield

From the early days of agricultural production in Australia, salt, seawater, and urine were advocated and used as a steep to pickle seed wheat with the hope of overcoming the wheat’s susceptibility to smut, blight, and rust [98,149,150]. This technique had been based on age-old recipes, *en vogue* in England since the early seventeenth century [70,151] and recommended in the United States as early as the 1780s [95]. In the 1860s, salt and seawater were still in widespread use as seed steeps in Australia [137,152–154]. In the 1880s, the salt or brine pickle, often with lime added, was reported as being extensively used in America and thus formally recommended for Australia [146]. The brine, in which the seed was to be pickled for 5 min, was to be “sufficiently strong to float an egg” [59,155].



**Figure 2.** Annual frequency of rust in wheat mentioned in Australian newspaper items (n = 67,040). Note that the 1890–1893 spike is caused by the wide-spread reporting of the Intercolonial Rust in Wheat Conferences. Data based on a keyword search of Australian newspapers as digitized until 15 June 2015.



**Figure 3.** Annual percentage of rust in wheat mentioned in newspaper items in NSW (n = 17,277), South Australia (n = 18,756) and Victoria (n = 15,175). Note that the 1890–1893 spike is caused by the wide-spread reporting of the Intercolonial Rust in Wheat Conferences. Data based on a keyword search of Australian newspapers as digitized until 15 June 2015.

Even though it had been established by the Queensland government chemist Karl that salt steeping did not work against rust, the 1890 Intercolonial Conference on Rust in Wheat recommended experiments to assess the effectiveness of the salt pickling of wheat seed, indicating the popularity that the ‘remedy’ still held [138]. This recommendation was based on observations that wheat grown close to the ocean and/or under the influence of sea breezes appeared less susceptible to rust [156]. The results confirmed that salt steeping did not work against rust. Salt-based seed steeping to combat rust were once more tried in Europe during the 1910s, again without much success [157]. Salt steeping, however, is effective in separating wheat seed from other admixtures. For example, nematode eggs float up in the brine, which can then be removed. This process is still recommended for developing countries as a simple means of purifying the seed material.

The amount of salt introduced into the ground through seed steeping was likely to be very small, even if the technique was applied in several successive crops. The same principle, however, was also applied on a larger scale.

#### 5.1. Broadcasting Salt as a General Fertilizer

MacIvor [155], in his lectures on agriculture in Victoria, commented that:

*“the application of salt to mangolds must be beneficial...Beans, cabbages, onions, and turnips, are also much benefited by the presence of salt in the soil.”*

William Story submitted a prize-winning essay in 1860 that collated all the known information on agricultural chemistry. His essay, published in 1861 as a pamphlet, found wide distribution and reception. Story noted that while salting was carried out in the United Kingdom, specifically in Cheshire, the application of too much salt was injurious to the crop. He made it quite clear that in his view there was no need to apply salt as a manure in southern Victoria [158].

The range of popular beliefs regarding the beneficial characteristics of broadcasting salt on the land is quite staggering. Story [158], for example, quotes an authority stating that the application of salt to the amount of six bushels per acre was “recommended ... on



meadows after hay was got in, particularly in dry and hot summers". The theory that was advanced was that salt attracted moisture and thus would be beneficial. Its property of attracting moisture was still hailed to be of "a special value in a dry climate" in an article in the weekly newspaper, the *Australasian* [59].

Some farmers, as well as government staff, carried out experiments [146]. Some of these were quite scientific for their time, but not as rigorous as those carried out by Nathan Cobb in the 1890s [119,159]. In 1872, for example, the farmer "J.B." of Wandin Yalloak in Victoria, sowed wheat in six parallel strips and applied varied quantities of salt when the plants were about two inches high [105,109]. At first sight, the result seemed convincing (Table 1).

Not surprisingly, the salt producers then actively marketed the salt "as an admirable fertiliser of the soil." An article in the *Border Post*, quoted from a self-serving brochure of the "Salt Union Ltd." of Cheshire, UK, stated:

*"Salt is recommended as the most powerful substance known for breaking up the soil and setting its constituents free to nourish the roots of plants; it absorbs moisture from the atmosphere and retains it in the soil, it purifies and decomposes all inert matter, makes stubborn soils easier to work, destroys noxious vermin, renovates old pastures, makes sour grasses sweet and palatable, strengthens the straw in cereals, prevents disease in potatoes, dissolves manures, sweetens and preserves fodder, and generally in all agricultural operations is found to be a most efficient and reliable aid"* [160].

By the first decade of the twentieth century, salt had gone out of fashion as a broadcast fertilizer. It was still being advocated for a range of root crops, as well as a means of strengthening the straw of cereal crops [136].

## 5.2. Salt as a Remedy to Rust in Wheat

Salt was also regarded as both a preventative of and a treatment against rust in wheat [109,134,153,161–165]. Many farmers upheld that the application of salt strengthened the stalks and leaves [165,166] and yet affected the yield of wheat only very little [59,139]. From a physiological perspective this is correct as wheat plants growing in saline soils showed a thickening of the cuticle and a reduced size of the epidermal cells, thus leading to a perceived stiffness of the wheat [157], making it somewhat resistant to rust [136,146,165]. On the other hand, harder wheat was less favored by the millers [167,168]. The first Intercolonial Conference on Rusts in Wheat, held in March 1890 in Melbourne, recommended a number of fertilizer trials, among them the application of salt, to assess whether the rust problem could be overcome. The trial of "salt as a manurial application before the seed is sown [was indicated because it] ... has a valuable effect in checking the growth, and making the straw more flinty and firmer, and therefore, better able to resist the encroachment of this fungus" [133]. The head of the Roseworthy Experimental Farm in South Australia, William Lowrie, also recommended a salt trial because, even if it failed, it was a cheap experiment [139]. These recommendations were derived from experimental work conducted in the USA and the UK. A letter sent by William Farrer to the first Intercolonial Rust in Wheat Conference drew attention to the work conducted in the 1880s by Prof. A.E. Blount of the Colorado Agricultural Experiment Station. Blount had stated in a letter to William Farrer that he had "used common salt as preventive, [which was] quite effectual. One to five bushels of refuse or any salt to the acre, sown broadcast upon a growing crop ... will not only become a valuable fertilizer, but will give the straw a siliceous coating capable of in most cases resisting the attacks of the rust" [140].

The recommendation to add salt or saline water to the wheat crop to prevent rust, however, was not confined to Australia or the USA. In Europe, it included not only the use of salt, but also the spreading of herring and herring brine [157]. Russian experiments of the 1930s confirmed that NaCl application in spring reduced rust infection and thus increased yields, but also highlighted that on some soils wheat yields declined due to the

salt application [169]. While wheat is moderately salt tolerant, it is affected by high concentrations in dry soils or by moderate concentrations in waterlogged soils [170–172].

## 6. Experiments with Salt

In 1890, the newspaper media reported that the NSW Department of Agriculture had recommended the trial of salt at concentrations of 2 cwt per acre, to pickle the seed wheat in brine, and to treat rust outbreaks with a spray of 1 lb of common salt per of gallon water [138].

The experiences of some farmers had shown that a broadcast application of salt at the time when rust had been detected did not yield results [173]. In late 1890, the results of the trials came in. Experiments in the Wollongong area had shown that a dressing with 1 cwt of salt per acre had produced “no difference in the rusts on the cereal plants, but the crops on the ground operated on with salt looked stronger than the others” [141].

In his discussion at the first Intercolonial Conference on Rusts in Wheat (Melbourne, March 1890), Lowrie advocated trialing concentrations of 80, 140, and 200 lbs per acre, which is equivalent to 9.0, 15.7, and 22.5 g/m<sup>2</sup> [139]. In response, the director of the NSW Department of Agriculture, H.C. Anderson, argued that each of Lowrie’s test applications was only “a small manurial application. The dressing usually advocated varies from 300 to 400 lbs. to the acre when it is administered in a solid form before the crop starts its growth” [133]. In the event, the *Agricultural Gazette of NSW* of 1890, presenting the official view of the Rusts in Wheat committee, recommended that “2–5 bushels of common salt be broadcast, when the crop is four inches high” [142].

Experiments conducted by George Frederick Berthoud, a farmer at Corowa who had been proactive in the experimentation with wheat varieties [174], used 3 cwt of salt per acre, without tangible benefits [144]. These observations were confirmed by a Canadian study conducted from 1888–1890, which found that rust could be reduced if the overall rust infection was low, but that the salt treatment failed if the rust infection was universal [143].

Despite these negative findings, which were publicized in the local and regional press, the use of salt continued to be advocated as a general fertilizer, for example as a top dressing to accompany a sowing of oats [145]. Even beyond cereals, the ‘curing action’ of salt was advocated. Mangolds, beans, onions, turnips, and cabbages were deemed to especially benefit from salt applications [59]. A farmer from Cootamundra commented “on the sheep camp we generally put salt on the poorest place” [173]. A newspaper item on the treatment of apple scab, quoting the *American Agriculturalist*, recommended the spread of a pint of salt under a small tree, and a quart of salt under a large one [175].

By the late 1890s, however, agricultural science had begun to make inroads and salt was no longer *en vogue* as a fertilizer—notwithstanding the odd throw-back to previous concepts [136]. The development of rust-resistant wheat varieties better suited to Australian conditions, combined with an understanding of superphosphates as fertilizer, changed Australian wheat production for good [152]. By 1908 Thompson noted that the application of salt

*“had not any direct manurial action, as is expected by some; its economic value lies in another direction. When applied in sufficient quantities at the proper time of the year, owing to its germicidal properties it not only destroys rank grasses and vegetable rubbish, but also the hosts of injurious insect pests and their embryos that lie lurking and undergoing transformation in their midst. Converting both into valuable fertilizers, and thus cleaning the land and sweetening the sour pastures”* [65]

While the reputed value of salt was still discussed in the late 1930s [169], the direct application of salt was no longer recommended, and the salts contained in other fertilizers would have been deemed sufficient.

If we consider the timelines of this debate, then it took almost 50 years until these folk remedies had been disproven and supplanted by better methods and another 30 years

until the last vestiges had been extinguished. In human terms, the 50 years equates to almost two generations of agriculturalists, showing the power of the persistence of long-standing remedial concepts.

How much salt has been applied onto the fields? Table 1 compiles the data that could be gleaned from a systematic search of digitized Australian newspapers as they were made accessible via 'Trove' [176]. As can be expected, there is considerable variation in the recommendations. The application of salt on wheat ranged from 9 to 62 g/m<sup>2</sup> per planting season (Table 2), while it could be as high as 113 g/m<sup>2</sup> for root crops (Table 3). To put this into context: the European and North American practice of salting the urban and suburban roads to reduce the risk of black ice requires an application of 8–27 g/m<sup>2</sup> [177], with well-documented negative effects on the health of street trees [178–180].

The application of salt on wheat added to the saline content of the upper sections of the soil column, with near-surface transport to the lower sections of the slopes and some concentration in the lowlands above the floodplains. In the medium term, this would have increased the salinity levels at the root zone of residual trees in largely cleared farmland, as well as in adjacent remnant bushland. At the application were topics, i.e., on a field-by-field basis with a rotation fallow system; the total accumulation would not have been uniform across the landscape but would have manifested itself in patches. Given that clearing the land of native timber was considered as 'improving' the land [24,25], any vegetation impact would have gone unnoticed, or in fact been welcomed, but an attribution to the practice of spreading salt would have been unlikely.

Given that salt is soluble and readily mobilized in the soil matrix, it thus quickly migrates through the soil column, and all the salt applied during the nineteenth century would have long been washed out.

**Table 3.** Quantities of salt per application historically recommended for crops other than cereals.

<b>Root Crops</b>				
Carrots, light soil	early in spring	7 cwt	88.0	[136]
Carrots, medium soil	early in spring	5–6 cwt	62.6–75.4	[136]
Carrots, heavy soil	early in spring	3–4 cwt	37.7–50.2	[136]
Improve mangold crops	?	4 cwt	50.2	[155]
Mangolds and Beet, light soil	a month before sowing	10 cwt	126.0	[136]
Mangolds and Beet, medium soil	a month before sowing	8–9 cwt	100.4–113.0	[136]
Mangolds and Beet, heavy soil	a month before sowing	6–7 cwt	75.4–88.0	[136]
Potatoes, light soil	2–3 weeks before planting	6–7 cwt	75.4–88.0	[136]
Potatoes, medium soil	2–3 weeks before planting	5–6 cwt	62.6–75.4	[136]
Potatoes, heavy soil	2–3 weeks before planting	4–5 cwt	50.2–62.6	[136]
Turnips	at germination	3–5 bushels 8 bushels ideal	27–44.9	[70]
Turnips, light soil	a month before sowing	8–9 cwt	100.4–113.0	[136]
Turnips, medium soil	a month before sowing	6–7 cwt	75.4–88.0	[136]
Turnips, heavy soil	a month before sowing	4–5 cwt	50.2–62.6	[136]
<b>OTHER CROPS</b>				
Cabbage, light soil	early in spring	7 cwt	88.0	[136]
Cabbage, medium soil	early in spring	5–6 cwt	62.6–75.4	[136]
Cabbage, heavy soil	early in spring	3–4 cwt	37.7–50.2	[136]
Flax, light soil	before sowing	3 cwt	37.7	[136]
Flax, medium soil	before sowing	2–3 cwt	25.2–37.7	[136]
Flax, heavy soil	before sowing	1–2 cwt	12.6–25.2	[136]
Hops, light soil	?	6 cwt	75.4	[136]
Hops, medium soil	?	5–6 cwt	62.6–75.4	[136]
Hops, heavy soil	?	4–5 cwt	50.2–62.6	[136]

Peas and beans, light soil	soon after sowing	8 cwt	100.4	[136]
Peas and beans, medium soil	soon after sowing	7–8 cwt	88–100.4	[136]
Peas and beans, heavy soil	soon after sowing	5–6 cwt	62.6–75.4	[136]
GRASSES and PASTURE				
Grasses and Pasture, light soil	early in spring	10 cwt	126.0	[136]
Grasses and Pasture, medium soil	early in spring	8–10 cwt	100.4–126.0	[136]
Grasses and Pasture, heavy soil	early in spring	6–8 cwt	75.4–100.4	[136]
Improve meadows	After cutting hay	6 bushels	53.9	[81]
Improve meadows	Dry summer topdressing	16 bushels [*]		[81]
PESTS				
Apple scab	At outbreak	1 quart/large tree	11.4	[175]
Apple scab	At outbreak	1 pint/small tree	22.7	[175]
Wireworm, on light land	?	3cwt	37.7	[155]
Wireworm, on heavy land	?	2 cwt	25.2	[155]
Cattle and Sheep diseases	In early sprint	5–10 cwt [**]	62.6–126	[65]
Insect pests	At ploughing	8–10 cwt	100.4–126	[65]

[\*] Mixed with 20 loads of soil.—[\*\*] Every 8–10 years.

The main impact would have been the cost of this dubious practice to the nineteenth-century farmers. During the period of 1861–1868, when rust in wheat had become a major problem, the higher salt price would have required an investment of 6s8d to £2/6/1 per acre (9 to 62 g/m<sup>2</sup>), even if low quality table salt was used. During the period of 1869–1900, when salt was advocated as a general manure, that cost had been reduced to between 5s and £1/14/7 per acre depending on the quantity spread across the fields. That reduction in salt price was the effect of the introduction of evaporation techniques that increased the salt concentration in the brine and thus reduced the costs for fuel in the final evaporation stage [181].

## 7. Conclusions

Overall, the historic evidence shows that salt had been a popular—albeit unsuccessful—remedy to prevent the outbreak of rust in wheat. Beyond this, salt had a reputation as a general fertilizer and as such had been applied for a number of purposes. As with all agricultural practices and techniques, the belief in salt as a suitable remedy for rust in wheat and as a general fertilizer was imported by British settler colonialists from the United Kingdom to the Australian colonies. While the new environment, with its different soil and climatological conditions, challenged existing agricultural wisdom, leading to scientific examination of the underlying causes, folk remedies were deeply ingrained and persisted for at least two generations after rust in wheat had become a major trans-colonial problem.

In the absence of statistical data on (a) the extent of the salt production along Australia's eastern seaboard and (b) the volume of actual salt sales into the agricultural communities, we cannot estimate the positive economic impact the demand for salt may have had on the salt producers, nor do we know the impact when salt went out of broadscale agricultural use again.

Finally, even though the application of salt was of a long duration during the second half of the nineteenth and the early part of the twentieth century, its use in the landscape was comparatively patchy. Moreover, as surface-applied salt will enter a solution when wet and will gradually migrate downwards through the soil column, its effect was generally short-lived and little, if any, of the historically applied salt will remain in the soil today.

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