Chapter 3. Factory and field

The paupers of Leeds and "contrivance and invention"

Chapter 2 introduced someone who will keep reappearing in this narrative. Charles Turner Thackrah (Fig 3.1) was a native of Leeds, who after medical training in London returned home, and in 1817 became Town Surgeon. This gave him responsibility for the care of the paupers of the city. There were probably a lot of them. Leeds increased in population by almost 70% between 1811 and 1831, and Thackrah got close experience of the effects of the industrial revolution on the workforce, at home and in the factory. In 1831 he published a very influential book, which he revised the following year, with a 38-word title beginning "*The effects of arts, trades and professions…*".[1] The book reviewed the hazards facing well over 100 occupations, and in its range and sympathetic treatment it is reminiscent of Ramazzini's great work of 1700, which we met in Chapter 1. In the Preface to the 1832 edition Thackrah argued that it was of little use for his medical colleagues to restrict themselves to cures, they must look for causes and hence prevention - the underlying principles of occupational hygiene.

When it comes down to practicalities, however, Thackrah was restricted by the limited understanding at that time of the cause of many of the industrial diseases, by his limitations in engineering skills, and perhaps by lack of incentive for those responsible to make the changes he suggested. He could see in which directions solutions lay, but was not in a position to implement them. Nevertheless, he did what he could, and said that he hoped to get "the attention of those, who are not only much more conversant than I, with contrivance and invention, but more directly obligated by social principle, to improve the state of the operatives, by whose labours they are enriched."

Fig 3.1. Charles Thackrah
(The Thoresby Society, the Historical Society for Leeds)

Perhaps the people reading this are the sort of people he was thinking of. But looking back to the state of knowledge in 1830, the controls he mentions in his book give us an insight into what was available then. Here are some.

Local ventilation or enclosure with effective exhaust. He found that salvage of wool from old rags ("shoddy") involves tearing-machines which have a "large box at one end " which "communicates with the machine, and at the other by means of a wooden chimney… the roof. The dust is driven by a strong current from the machine into the box" and the lighter material passes up a chimney to the roof. But Thackrah observes that sometimes the wind drives the dust back down, "and the room is so clouded that persons cannot see each other at the distance of a few yards." He suggests fixing a rotating cowl to the outlet of the chimney to deal with the problem. In a flax mill, he wrote that "the machines are covered by boxes, which collect a large quantity of the dust"

General ventilation. For flock dressers, windows are closed in winter, so Thackrah points out that they need ventilation by warm air. He would like dusty workrooms to have channel in the floor, with an inlet in the building with a fan, pushing the dusty air down the channel to the outside.

Personal protection. Feather dressers cover the nose and mouth with a handkerchief. For grinders and filers of iron articles, he commends Abrahams' magnetic mouthpiece, but as we saw in Chapter 2 this probably would not have helped. Some workers exposed to mercury put glass "between mouth and materials", and when they are working on larger items they fix to the mouth and nose "a kind of proboscis, which hanging down, opens at a distance from the source" of the fumes. Thackrah is one of the few authors to mention noise, although hearing loss must have been commonplace.

For corn millers, he says it might be lessened by cotton wool in the ears.
Mechanisation. For sieving flock, a very dusty process, "Machinery should be more employed". A winnowing process could be done by machine, or the dust could be collected in a box and carried off up a chimney by a fan.
Substitution. The success of substitution requires the identification of the hazardous agent, and one "most baneful process" where this was possible was manufacture of white lead as a pigment. He suggests using zinc oxide or carbonate, which may not be quite so white, but keep its hue longer. Thackrah believes that a substitute for lead glaze could be found in potteries – he suspects it is the low cost which favours lead. We shall see in Chapter 6 that this argument was still going on 100 years and many blighted lives later.
Cleanliness. Washing the hands and face, changing clothes after work, and "the regular use of the bath". Eating should not be permitted in the workrooms.

Thackrah died in 1833 at the age of 38, but his careful documentation of conditions was already influencing legislation. It continued after his death, although as we shall see in later chapters progress was slow. There is a recent review of his Thackrah's book, by J Tim Carter (a past president of BOHS) and Anne Spurgeon, in *Occupational Medicine*, 67(6), 500–501 (2017), https://academic.oup.com/occmed/article/67/6/500/4095227.

Country Life

Most attention and information on workplace hazards at the beginning of the 19th century focused on the dirty and dangerous workshops of the industrial revolution that Thackrah knew, but until 1810 the number of people working in agriculture, forestry and fishing exceeded the number in industry, mining and construction. The labour force on the land did not peak until 1861, at 312,000 farmers and 1,362,000 labourers out of a total population of about 21 million.[2] Of course this large agricultural workforce was dispersed nationwide in relatively small groups, so perhaps any increased disease was less obvious than it would be in the industrial populations that Charles Thackrah was familiar with. Thackrah believed that those cultivating the land ("husbandmen") were "generally healthy" because of the "purity of the air", and compared with the normal industrial environment he must be right.[1] However, it is easy to see that agricultural workers did face their own occupational risks. In Italy in 1700, Ramazzini had written a chapter on the "Diseases of sifters and measurers of grain", saying that the workers suffer serious harm from the dust, with a "dry, obstinate cough" and eyes "visibly inflamed and watery".[3] "Nearly all the workers suffer from shortness of breath" and wasting disease, "and rarely grow old together". He attributed this to dust from the grain itself, and had the insight to mention the many parasites and their excrements, quoting the observations of minute creatures in stored grain by the pioneering microscopist Anton van Leewenhoek. "The workers who do these tasks usually cover their mouths and noses with a kerchief to avoid being suffocated by the dust; they frequently rinse their throat and eyes with cold water and they shake out their clothes." Ramazzini recognised that these measures were insufficient, but as usual could only suggest treatments. He was also concerned that "wheat can produce such poisonous fumes that it kills whoever enters without leaving the door open for a while to let the air escape". This continues to be a hazard with stored organic materials such as wood pellets.

There were probably no better protective measures on offer in Britain by the start of the 19th century than the ones Ramazzini had suggested. Processing of grain meant the laborious process of threshing, to separate the heads of grain from the straw. When done by hand, the sheaves might be stored after harvest – perhaps giving rise to the problems that Ramazzini noted - and the threshing done in the winter. At the time of writing there is a video of threshing with hand flails at https://www.youtube.com/watch?v=Kb__ubj_tM4 , and the dust can be seen in the sunbeam (Fig 3.2). By 1800, threshing machines were available, but these led to winter unemployment and

hardship. This and the cost of the new machines meant that take-up was slow in parts of the country with plenty of labour, especially those remote from the new industrial centres (Fig 3.3).[4] We shall see in the next chapter that for most workers on the land as well as in the city *t*he priority was to survive and to avoid starvation or complete destitution, and avoiding risk of future disease was a luxury they could not afford.

Fig. 3.2. A modern demonstration of flail threshing, in Slovenia. Note the dust in the sunbeam.
Photograph: a still from a YouTube video of threshing in Slovenia, Public Domain, https://www.youtube.com/watch?v=Kb__ubj_tM4

The aches and pains of heavy work

These chapters concentrate on the inhalation hazards and systemic poisons which have usually been the most obvious killers, but farm work must always have caused painful musculoskeletal problems. Chapter 1 mentioned Calvin Wells' analysis of the skeletons of rural workers who were buried in the 10th century cemetery at North Elmham, Norfolk, where osteoarthritis of the spine was the commonest disease.[5] Most men and women were affected by their mid-20s.
"Heavy work such as tree felling, house building and humping weighty loads would explain its presence in the men; agricultural work on refractory soil - hoeing, digging, planting, etc. -and also carrying substantial loads, would produce it in the women. These factors would take greater toll if, as is likely,they became operative in the early teens or even in childhood. Many other contributory causes of torsional or jarring strains of the spine would aggravate the disease and produce the picture which emerges here. In the females some of the most severe of their arthritic changes occurred in the neck and this may, perhaps, have been due to a custom of carrying water buckets and other heavy weights on their heads."

After the spine, the commonest site of osteoarthritis was the feet. Wells commented

"The soil here is fairly heavy and, especially when baked hard by drought or sodden by much rain, it demands great effort to work it. The combined effects of standing flat footed to hoe weeds, kicking at spades or delve the seed trenches, constantly walking across rough fields, stumping around in clumsy boots and often stumbling over clods of unbroken clay, must have produced a myriad of minor traumatic episodes, whose cumulative effect was the osteoarthritis we now find".

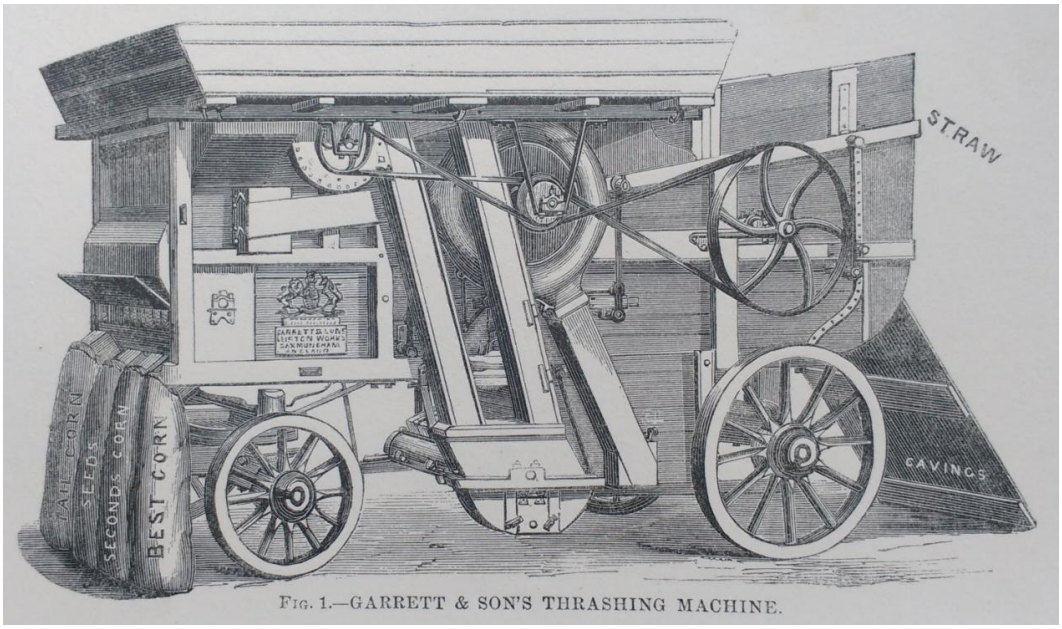

Fig. 1.—GARRETT & SON'S THRASHING MACHINE.

Fig 3.3. Top, Garrett's threshing machine, about 1867. The sheaves are fed in on the top of the machine, at the left end. The heads of grain come into the sacks below and the straw is ejected top right. A similar machine is seen in operation in the lower picture, with a mobile steam engine providing the power. The process here looks clean, but a lot of dust would have been ejected with the straw, and with the grain. Top picture from the National Encyclopedia (1867) and the lower from The Popular Encyclopedia (about 1875)

I have quoted Calvin Wells' account because of his inferences about the occupational practices which would have led to increasing painful changes by the time the workers were in their mid-20s. This will surely have been common whereever hard agricultural or other manual work was the norm. In her fictionalised memoir of her Oxfordshire childhood almost 1000 years later, Flora Thompson wrote: "The elders stooped, had gnarled and swollen hands and walked badly, for they felt the effects of a life spent out of doors in all weathers and of the rheumatism which tried most of them."[6] Thackrah was right to suggest that the pains in the back and limbs which "old men in all occupations" experience, though called rheumatism, "might be dependent on injury of the muscular fibres, the result of excessive labour".[1]

Returning to the changes taking place in British agriculture in the 19th century, the traditional way of sowing seed was by walking through the field and throwing it. This was replaced by seed drills between 1780 and 1880, but during this time there was some sowing by dibbing, which was believed to save seed. A man would be making holes for the seed and three women or children would work with him, dropping the seed in the holes.[4] Whether these were short or long dibbers this must have become painful. Through the same period, however, scythes were replacing sickles for harvesting, and this change must have relieved the back, but perhaps the repetitive swinging and twisting action produced new problems. Horse-propelled reaping machines were introduced in the 1820s, in which rotating bars pushed the standing grain onto reciprocating cutters. They were common by the middle of the century. The increasing mechanisation was driven by economics, but perhaps many backs were relieved.

From the 1830s, artificial fertilisers began to be used, at first phosphates on root crops. Originally, crushed bones (bone meal) were used, and then rock phosphates and guano. As an example, Narborough bone mill in Norfolk used bones from local slaughterhouses; whale bones were brought by barge up the river from the blubber rendering plant near King's Lynn. The bones were boiled to make them brittle and remove the fat, which was skimmed off and used for lubrication, and the bones were then crushed. It is said that even human bones were imported to fertilise the East Anglian turnip crop.[7] Especially on alkaline soils, the bone meal was insoluble, and so phosphate rock or bones were dissolved in sulphuric acid to make superphosphate. Mineral calcium phosphate commonly includes fluorine in its structure, and the acid dissolution forms hydrogen fluoride, which must have added to the unpleasantness of the process until this was properly controlled, but I have not come across any record of this. Factory production of superphosphate must be seen as part of the history of the chemical industry, but to save money, some farmers produced their own by dissolving bones in sulphuric acid on their farms [4], which is probably not what Charles Thackrah had in mind when he wrote about healthy country air.

Charles Thackrah wrote about the need for those with "contrivance and invention" to improve working conditions. They were indeed needed, but before they could apply those skills there had to be people motivated by what Thackrah called "social principle" to convince the public, legislators, and industrialists that conditions of work were unacceptable. That takes us to the next Chapter.

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[1] C. Turner Thackrah, *The Effects of Arts, Trades, and Professions, and of Civic States and Habits of Living, on Health and Longevity: with Suggestions for the Removal of many of he Agents which produce Disease, and shorten the Duration of Life.* London, Longman, Rees, Orme, Green and Longman; 2nd Edn 1832. https://books.google.co.uk/books?id=ennv5jq4FbEC . A recent review of this book by J Tim Carter and Anne Spurgeon is at Occupational Medicine 67:500–501 (2017).

[2] Peter Mathias, The First Industrial Nation, 2nd Edn 1983. London, Methuen.

[3] Ramazzini, Bernardino, *The Diseases of Workers,* in *Works, Vol 1,* Transl Cawthra C; Ed Carnevale F, Mendini M, Moriani G, Blanc P, Slack RS. Verona, Cierri Edizioni, 2009

[4] Susanna Wade Martins, Changing agriculture in Georgian and Victorian Norfolk. Cromer, Poppyland Publishing, 2002

[5] Wells C, *Discussion of the human skeletal remains.* In: *Excavations at North Elmham Park 1967-72*, by Peter Wade-Martins. East Anglian Archaeology *,* Report number 9, vol II pp 247-282. Norwich, Norfolk Museums Service,1980. http://eaareports.org.uk/publication/report9/

[6] Flora Thompson, *Lark Rise to Candleford.* Penguin Books, 1973.

[7] Turner, D (1981) Narborough Bone Mill. Jl of Norfolk Indust Archeology Soc, 3(1) . Quoted in on-line article *Narborough Bone Mill* http://www.norfolkmills.co.uk/Watermills/narborough-bone-mill.html