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RESOURCES

Land

In the fifteenth century the world was still fairly empty. Even at the end of the century its total population was less than 500 million. It is estimated that about ten per cent of the globe's land surface at the time was directly used by humans. The total amount of land used as cropland at the time is estimated at about one per cent of the globe's land surface. Living space for wildlife was still abundant. At the end of our period the world's population had doubled. More people meant more exploitation of resources and thus more pressure on land and wildlife. To give just one very telling figure: the area of cropland in the world increased from 180 million hectares in 1400 to 540 million hectares in 1850, almost all of it in regions with centralised states. But intensification of exploitation took place not just in the relatively densely populated regions of the world that are central to our atlas. It also occurred in the many new 'frontier' regions that were created in those four and a half centuries. A description of material life during this era would certainly be incomplete if it did not pay ample attention to such major changes in existing resource-portfolios.

What matters most in societies where agriculture plays a fundamental role in the economy is how much of the total extent of land is or can be used for agriculture. Figuring that out obviously means measuring arable. In North-western Europe, however, in addition to arable, a very substantial percentage of land was used as pasture and meadow. Such land, to which one may add parts of the extensive waste lands, in the context of Western European agriculture was also productive and should be considered as part of what we will call 'agricultural land'. To the extent that such land was used for feeding animals, which played a fundamental role in Western agriculture, but also as a very important, *separate* source of income, it had hardly any equivalent in East Asia. In that sense at least, in China and Japan arable and agricultural land were almost identical. In those countries pastures and meadows occupied only a fraction of the land. That does not mean that arable land was the only land that mattered here for agriculture. Large tracts of land that did not themselves function as arable, were used - and actually *had* to be used - for producing organic fertiliser. For Tokugawa Japan, for example, it has been claimed that for any given area of rice paddy, between five and ten times as much mountain land was needed to supply the grass, scrub brush, leaf fall and small branches that were either trampled into the flooded paddies or fed to livestock. In contrast to pastures and meadows in the West, these lands, however, did not usually make a *separate* major contribution to agricultural income. They were usually but not always fully subservient to the production on the arable lands. In Qing China cash crops, such as tea and fruit, often did *not* occupy cultivated land. Let us first give some basic information on different forms of land use. The areas of arable and agricultural land in the Dutch Republic were so small that they will not be separately discussed. It would not be very helpful to go into much detail for such a small territory. Suffice it to say that more than

half of the agricultural land was used for livestock husbandry that yielded an even higher share of its agricultural income and that in the regions outside the Western half with its highly specialised commercialised agriculture, the rural economy, though certainly well integrated into and in several respects also oriented towards markets, still had some basic traits of a peasant economy.

Table 3-1, Table 3-2 and Table 3-3 provide basic information on the structure of agricultural land use in England and Wales.

Table 3-1 Number of inhabitants, hectares of arable per capita and hectares of agricultural land per capita in England and Wales, 1700-1850

	1700	1800	1850
Inhabitants in millions	6.21	10.61	20.65
Arable in ha per capita	0.72	0.44	0.29
Agricultural land (arable, plus pasture and meadows) in ha per capita	1.37	1.10	0.60

Calculated on the basis of Allen, 'Agriculture during the Industrial Revolution', 104 and Broadberry and others, *British economic growth*, 29.

Table 3-2 Arable and agricultural land as percentages of total land in England and Wales, 1700-1850

	1700	1800	1850
Arable as a percentage of total land	31	30	39
Agricultural land as a percentage of total land	58	75	82

Calculated on the basis of Allen, 'Agriculture during the Industrial Revolution', 104.

In other parts of Europe like the Netherlands, France, Prussia and the Habsburg Lands, agricultural land

Table 3-3 Land use in England and Wales, in millions of hectares, rounded to the next hundred thousand hectares, 1700-1850

	c.1700	c.1800	c.1850
Total	14.6	15.6	15.1
Arable	4.5	4.7	5.9
Pasture and meadow	4.0	7.0	6.5
Waste	4.0	2.6*	1.2*
Woods and coppices	1.2	0.6	0.6
Forests, parks and commons	1.2		
Buildings, water, roads	0.4	0.5	0.9

* Including forests, parks and commons. Waste land was often used to graze sheep and thus functioned as pasture or meadow.

Allen, 'Agriculture during the Industrial Revolution', 104.

- here defined as arable plus pastures and meadows - also comprised a very substantial part of all land: in the first half of the nineteenth century roughly between one half and two-thirds. Here too large tracts of land were reserved for pastures and meadows to feed animals that also fed on waste land. In the Netherlands throughout the nineteenth century, as in Britain, no less than some sixty per cent of the total agricultural land was pasture or meadow. In other parts of Europe that percentage was lower but still quite substantial. Western Europe not only had a lot of agricultural land. It was also of good quality. It has been estimated that in 1700 almost fifty per cent of the total land area of Britain had good quality soil. For France and Germany that would have been some sixty per cent. The situation could hardly be more different in China and Japan. Arable, which far more than in Europe was all but identical to productive agricultural land, in China only occupied slightly *less* and in Japan only slightly *more* than ten per cent of the countries' surfaces. That is a fundamental

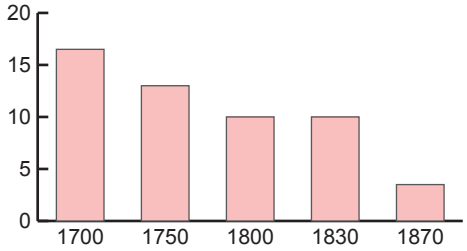
difference that is often ignored in debates about the production and productivity of the Western European versus East Asian agricultures.

A large percentage of arable land in Western Europe, however, continued to lie fallow. As Graph 3-1 shows, even in Britain some ten per cent of arable lay fallow as late as 1830. We find a similar percentage in the Netherlands, the country with in all probability the most advanced agriculture in Europe, around 1800. In the rest of Europe, the percentages where certainly higher. To let land lie fallow in order to let it 'rest' and 'recover' was normal in all regions of Europe. In Germany East of the Elbe around 1800, still almost forty per cent of all arable lay fallow; in the 1860s, still more than a quarter. Map 3-1 provides information on the situation in France.

To feed livestock a substantial part of arable in large parts of Europe was planted with fodder crops, which was yet another reduction in the total amount of land available for direct production for human consumption. The planting of leguminous crops fixed nitrogen and thus in the long run increased food production but planting them too meant not planting crops for direct human consumption.

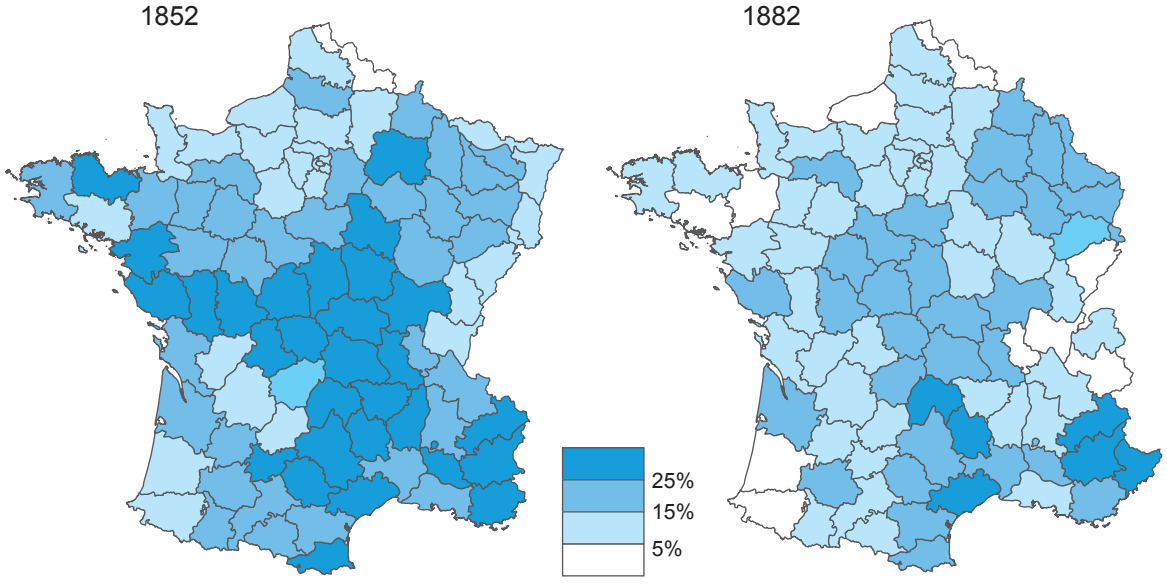
According to the following estimate, population density in China expressed in terms of available agricultural land per capita increased substantially

Graph 3-1 Land use in Britain: fallow arable as a percentage of all arable, 1700-1870



Broadberry and others, *British economic growth,* 89.
The figures are rounded to half percentages.

Map 3-1 Land use in France: fallow arable as a percentage of all arable, 1852 and 1882



In 1871 France lost the Alsace and part of Lorraine to Germany.
Braudel and Labrousse, *Histoire économique et sociale de France*, Vol. III, part 2, 672.

during the period of Qing rule, in particular in regions where rice was the staple crop, as is shown in Table 3-4 and Table 3-5. The figures can only be regarded as an approximation as the country lacked an 'up-to-date' system of land-registration, but it is not unlikely that the amount of arable per farm was halved between 1600 and 1850.

Irrigated land (i.e. rice paddy) comprised about thirty per cent of the cultivated area in 1400 and in 1820. Between 1820 and 1952 this share fell to less than a fifth, which was still much higher than in India and Europe. Table 3-6 shows a recent effort to reconstruct the distribution of cultivated land area in the country. Table 3-7 gives the basic agricultural data for Tokugawa Japan.

Table 3-4 Total population, cultivated land in hectares and cultivated land in hectares per capita for Late Ming and Qing China, 1600-1911

Date	Population (million)	Cultivated land in million hectares*	Cultivated land per capita in hectares*
1600	150	55	0.37
1661	120	48	0.40
1685	139	55	0.39
1724	175	66	0.38
1766	278	71	0.26
1812	367	78	0.21
1850	436	88	0.20
1911	450	97	0.22

* Original data were in *shi mu*. They have been expressed here in hectares, taking one *shi mu* at one fifteenth of a hectare. In practice things were not that clear. In the first half of the twentieth century near Wuxi in Jiangsu for example there were 173 different *mu* sizes and standards. The figures given are approximations. It has been estimated that somewhere between three *mu* = 0.2 hectares (in the late seventeenth century) to five *mu* = 0.33 hectares (in the nineteenth century) of cultivated land were needed to maintain people 'in food and clothing'. Four *mu* has been described as the boundary of cold and hunger.

Based on Shi, *Agricultural development in Qing China*, 173.

Table 3-5 Cultivated area in China, hectares per person in the regions where rice was staple, 1400-1873

1400	0.33
1760/1770	0.18
1873	0.16

Grigg, *The agricultural systems of the world*, 88.

Table 3-6 Distribution of cultivated land area in China by major crops, 1400-1850

	1400	1700	1750	1800	1850
Rice	50.2	33.0	31.0	29.0	27.0
Wheat		23.0	22.0	21.0	20.0
Barley		7.0	7.2	7.3	7.2
Millet		8.0	8.2	8.4	8.2
Corn			1.2	2.3	3.5
Potatoes		0.5	0.5	0.8	1.2
Sorghum		8.1	8.3	8.4	8.3
Other crops	42.1	9.4	9.7	9.8	9.6
Cash crops	7.7	11.0	12.0	13.0	15.0

Broadberry, Guan and Li, 'China, Europe and the Great Divergence', Table 1.

In East Asia, hardly any arable land was ever laid fallow, even in the North of China. What is more, a substantial amount of arable land was double-cropped or used even more intensively. In the eighteenth and first half of the nineteenth centuries, China as a whole had a double cropping ratio of 1.4. In Japan double cropping emerged only in the eighteenth century. Both countries thus effectively had *more* arable than the figures given suggest, whereas Western European countries, where a substantial amount of arable always lay fallow, had substantially *less*.

Table 3-7 Total population, arable land in hectares and arable land in hectares per capita in Tokugawa Japan, 1600-1872

Year	Population (million)	Arable land in hectare*	Arable land per capita in hectares**
1600	12	2,065	0.17
1650	17.18	2,354	0.14
1700	27.69	2,841	0.10
1720	31.28	2,927	0.09
1730	32.08	2,971	0.09
1750	31.01	2,991	0.10
1800	30.65	3,032	0.10
1850	32.28	3,170	0.10
1872	33.11	3,234	0.10

* The data are originally in 1000 *cho*. 1 *cho*= 0.99 ha. It would be a kind of misplaced precision to re-calculate all the figures in hectares at that rate, so I have taken one *cho* to be one hectare.

** The data are originally in *tan* = one tenth of a *cho*.

Based on Miyamoto, 'Quantitative aspects of Tokugawa economy', 38.

Table 3-8 Population per sq. km of arable land, in Japan, China, England and Wales between 1600 and 1873

	1600	1700	1800	1867
Japan	856	825	835	?

	1600	1700	1760-1770	1873
China as a whole	477	425	-	428
South China	-	-	536	509
England and Wales		138	227	344*

Population per sq. km of agricultural land for England and Wales 1700-1800-1850

1700	1800	1850
72	90	166

*1850

Grigg, *The agricultural systems of the world*, 88, 92 and 93.

Table 3-9 Agriculturists per sq. km of arable land in Japan, (South) China, and England and Wales, 1600-1850/1867

	1600	1700	1800	1867
Japan	514	-	495	501
China as a whole	334	-	298*	300**
South China	-	-	376*	356**
England and Wales	-	69	75	86***

Agriculturists per sq. km of agricultural land in England and Wales 1700-1850

1700	1800	1850
36	30	42

* 1760s

** 1873

*** 1850

Based on the previous tables in this chapter. In this table we assumed that over the entire period discussed in this book sixty percent of Japan's population and seventy percent of China's population can be considered agriculturists. For the population of England and Wales, we assumed that the share of the population that was agriculturist was fifty in 1700, thirty-three in 1800, and twenty-five in 1850.

Table 3-8 and Table 3-9 provide a comparison of 'agricultural population densities' in Japan, China, and England and Wales, based on the figures presented in previous tables. All these figures are estimates but their general tenor is not in doubt.

Animals

In Western Europe, draught animals were often kept not just for their power but also, apart from their manure, for their meat, bones, hides and tallow. Strikingly enough the meat of the biggest draught animals, horses, was only rarely eaten. It was often considered 'taboo' to do so. Draught animals were not the only animals (also) kept - or hunted - for their produce. Amongst the many

other animals, one must in any case mention cattle, sheep, pigs and all sorts of poultry, fish and seafood. The list of animal products used or consumed by humans is all but limitless. Let us here focus on dairy, very important in the Dutch Republic, and wool, which played such a fundamental role in the economy of medieval and early modern Britain.

Although for example in 1808 there were 8,500 cows kept in London for milk production and sale, the consumption of fresh milk off-farm began to become important only after 1850. Before that it was mainly drunk at the farms where it was produced or in their immediate surroundings. The milk yields of cows differed substantially according to place and time, as is shown in Table 3-10.

Table 3-10 Average milk yield per cow per year, in litres, 1700-1800

Netherlands in 1800	1,100-1,800
England around 1800	1,200-1,500
Calenberg, Germany around 1800	1,000
Denmark, 1800	500-700
England 1700-1750	700-850

Slicher van Bath, *Agrarian history*, Table V. Apart from the figures for the Netherlands for 1800, that come from a general agricultural survey held at the time, these figures are based on fairly 'isolated' and fragmented sources of information.

Averages do not mean much but yields clearly as a rule where higher in North-western Europe. There is the example of a farm in Friesland in the Dutch Republic on which, as early as in the 1570s, the cows gave 1,350 litres of milk in a year and one in Northern France, where the milk yield per cow was 1,750 litres per year in the 1770s.

The current milk yield per year per cow, which is nowadays measured in kilograms instead of litres - which for our purposes is only a very tiny difference -, is some 9,000 kg in the Netherlands and almost 11,000 kg in Denmark, the country with the highest yield in Europe. Milk can be turned into butter or cheese but doing so has its price. At the beginning of the nineteenth century, it took roughly twenty-five to thirty-five litres of milk to make one kilogram of butter. To turn cow's milk into cheese, one needed some ten litres of milk to end up with one kilogram of cheese. The farmer of the farm in Friesland referred to in the previous paragraph, with an estimated milk yield per cow per year of at least 1,350 litres, turned those 1,350 litres into some forty kg of butter and some twenty-five to thirty kg of cheese. In the nineteenth century milk yields began to rise substantially. (For the calorie losses in processing various types of food, see page 120.)

The importance of sheep for the British economy in the early modern era is beyond any doubt. Let us focus here on their importance as wool producers and ignore their important role as providers of meat. Table 3-11 gives their numbers.

Table 3-11 Number of sheep in Britain, in millions, 1600s-1860s

1600s	16.75
1650s	12.29
1700s	17.36
1750s	13.58
1800s	20.21
1850s	22.88
1860s	25.75

Broadberry and others, *British economic growth*, 106. For the sake of comparison: the total number of sheep in Europe in 1850 was about 180 million.

In the second half of the eighteenth century, one British sheep produced on average almost four pounds of wool per year. In 1790, when Britain's GDP was somewhere between £200 million and £250 million, woollens produced in Britain had a total value of £19 million. Expressed in pounds sterling that was almost double the value of France's woollens' production. As late as 1770, sixty per cent of total value added in textiles in the

British Isles came from the production of woollens. In 1821 that had decreased to thirty-four per cent. But it was only in the 1820s that the consumption of raw cotton in Britain superseded that of raw wool. As is shown in Table 3-12, the number of sheep even then continued to increase. Over the entire period discussed in this book producing and exporting woollens was a mainstay of British agriculture and manufacturing.

Animal produce was of fundamental importance for British and Dutch agriculture. Table 3-12 shows what other large livestock there were on British farms, apart from horses and oxen. The English 'economist' William Petty (1623-1687), in a book most probably written in 1665, claimed, that the total value of all England's animals was about one quarter of that of all its land. His claim is a rather wild guess. But more recent calculations too show their major role in in British agriculture. See Table 3-13 in which lifestock amounts to about one-third of total capital outlays. On top of that there must have been several million poultry (chicken, hens, ducks, geese, turkeys, pigeons), rabbits, hares, bees, and many other animals.

Table 3-14 indicates, using the example of England, how important animals were as a source of value added in North-western European agriculture. Roughly between forty and sixty per cent of value added in its agriculture came from livestock farming.

Table 3-12 Livestock in Britain in millions, 1700-1850

	milk cattle	beef cattle	calves	sheep	swine
1700	0.24	0.22	0.24	17.36	0.78
1750	0.57	0.52	0.57	13.58	1.20
1800	0.84	0.76	0.84	20.21	1.78
1850	1.12	1.01	1.12	22.88	2.31

Broadberry and others, *British economic growth,* 106.

Table 3-13 Agricultural capital in England and Wales as divided by landlords and tenants in million of pound sterling in 1851-1860 prices, 1700-1850

		1700	1850
Landlords	Structures, roads, fences, enclosures	112	232
Tenants			
	Implements	10	14
	Farm horses	20	22
	Other livestock	41	85
Total		183	353

Allen, 'Agriculture during the industrial revolution', 109. Investment in soil fertility, which was substantial, is not included here.

Table 3-14 Share of the pastoral sector in English agricultural value added, in percentages, ten-year averages at current prices, 1550s-1860s

1550s	41.9
1600s	41.9
1650s	35.5
1700s	40.3
1750s	42.2
1800s	51.5
1850s	55.2
1860s	60.0

Broadberry, 'Accounting for the Great Divergence', 118. This share in all probability was substantially higher than in the rest of Europe, and certainly than in East Asia.

For the Netherlands as a whole in around 1810 almost half of total agrarian produce, in terms of value, consisted of animal products, basically dairy, meat and cattle. That percentage will have been even higher in the Western parts of the country. In its entirety it then had a population of some two million people, who in total kept 1.45 million chickens, 1.1 million cattle, 735,000 sheep and 211,000 pigs. Of a total of 1.8 million hectares of

agricultural land, one million hectares were grassland. France at that time, with a population of some thirty million people, had about seven million cattle, amongst which were some one million oxen, and almost five million pigs. Table 3-15 shows the number of farm animals in Western, Central and Northern Europe in 1860 and 1914. The decrease in the number of sheep and the increase in the number of pigs are striking.

Table 3-15 Number of farm animals in Western, Central and Northern Europe, in millions, 1860 and 1914

	1860	1914
Sheep	86*	48
Cattle	48	64
Pigs	23**	47

*Estimated for Sweden
** Estimated for Austria-Hungary
Pounds, *Historical geography of Europe*, 1800-1914, 517.

As stressed earlier on, the central importance of animals in Western European agriculture, as providers of power, manure and income is a major and fundamental difference from East Asian agriculture which deserves more attention than it has received so far in the literature. It is important to point out that animal husbandry in Western Europe not only provided a large part of total agricultural income, but also yielded much more income per unit of labour input. In England in the mid-nineteenth century, in any case, output per worker in animal husbandry was eighty per cent higher than in arable cultivation.

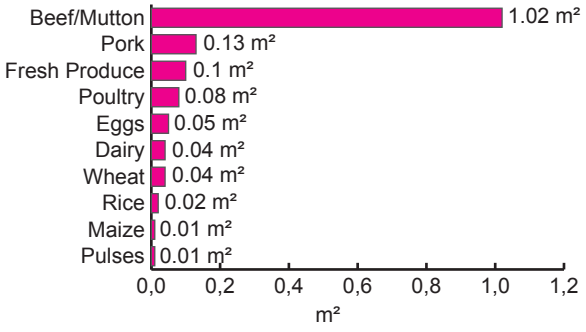
When the importance of animals for agricultural production in Western early modern agriculture is highlighted that is usually done to point out its advantages. A more negative comment though is certainly also in order: raising animals to provide food, from the perspective of creating calories or protein, is quite inefficient in terms of the land and energy involved in producing it, certainly when what these animals eat can also be eaten by humans or when providing them with food requires good soil. Table 3-16 shows the output of edible calories and protein per hectare of various agricultural products. Graph 3-2 goes into more detail for the production of protein.

Table 3-16 Output of edible kilocalories and protein, per hectare

	Dietary kilocalories / ha*	Dietary protein in kg/ha*
Main crop potatoes	7,324	458
Sugar beet	6,733	
Cereals	5,183	260
Early potatoes	4,122	257
Milk	884	101
Eggs	448	76
Semi-intensive beef	312	36
Poultry	290	85
Livestock for fat lamb	227	20

*Includes allowance for imported feedstuffs
Grigg, *Dynamics of agricultural change,* 71. The figures are based on the yields achieved at Reading University farm in the 1960s.

Graph 3-2 Average land use needed to produce one gram of protein in square metres over a crop's annual life cycle or the average animal's lifetime



Roser, *Our world in data.* For further information see the original figure under 'Meat and dairy production'.

Animals overall were quite expensive, also in direct 'money' terms. Let us illustrate this with

the example of horses, trying to take on board the fact that there were huge differences in their quality and in what they were supposed to do. It could make a major difference whether they were used for draught, for riding, for carrying, for pulling wagons or for pulling coaches. Horses for the elites were of much higher quality and much more expensive than horses for common folk. Draught horses were cheaper to buy and feed than pack horses while they could easily pull three times as much as a packhorse could carry. It has been estimated that in the eighteenth century in England packhorses were thirty per cent more expensive per ton mile. After the Restoration of 1660, draught horses costing more than £5 were not considered abnormally expensive in England. So-called 'gin horses' were the cheapest and they were not specifically strong or trained. Riding horses for the elite could easily cost £12 or more. The median price of coach horses over the period from 1660 to 1719 was more than £17. By way of comparison, halfway through the eighteenth century, a 'respectable' lifestyle for an English family cost annually about £17. Horses could become twenty to twenty-four years old, but work horses, as a rule, were treated badly so that they were often already worn out at the age of ten.

The net energy efficiency of horses was not impressive. Their total feed consumption was. A large mature working horse at the beginning of the nineteenth century might eat ten to twelve kg of dry feed per day: about half of it roughage, mostly hay, and the other half grain, as a rule oats. At the beginning of the twentieth century, American farmers were advised to feed their working horses 4.5 kg of hay and 4.5 kg of oats per day. As indicated earlier on, on average, horses would require an amount of land that might feed six to eight men and in exchange for that they could do the amount of work of six to eight men. But they required more and better land than, for example, oxen or buffaloes which could be fed entirely on grass. Animals that were not used for draught also needed land. Whereas it took two hectares of land in Britain to maintain a horse over a year (in the 1830s, feeding the horse on food crops) maintaining a cow for a year (in the eighteenth century) required about 1.25 tot 1.5 hectare of grassland and maintaining a sheep (also in the eighteenth century) little under one tenth of a hectare. So, there was 'competition' for land between people, horses and other animals. We already pointed out that the meat of horses, moreover, usually was not eaten and therefore could not be sold. Unsurprisingly therefore, oxen long continued to be serious competitors.

The amount of land that had to be reserved for animals in Western rainfall agriculture in the form of pastures or meadows was staggering as the figures given on page 77 showed. Pasture refers to enclosed tracts of farmland grazed by domesticated livestock such as horses, cattle, sheep and pigs. The vegetation of tended pasture consists mainly of grasses, with some legumes and herbs. They are typically grazed throughout the summer. Meadows are not grazed at all or used for grazing only after being mown to make hay for animal fodder. Next to pastures and meadows, waste lands and lands that had been harvested were also often used for grazing e.g. by sheep. The growing of all kinds of food crops for feeding animals as practised in the Western Europe apparently made good economic sense. Although feeding horses in Western Europe still required a lot of land, it was only a fraction of the amount of land that had to be 'set aside' to feed horses on e.g. Central Asia's steppe. As indicated, in the 1830s in Britain, two hectares or five acres of land were required to maintain a horse over a year. It has been estimated that in Central Asia, where no food crops were grown, it took 120 acres of grazing land. It would seem that buying and maintaining a horse must have been cheaper in Britain than it was in China in the early modern days.

Whatever may have been the exact advantages and disadvantages of keeping large animals, growing grain on heavy soils in Europe required deep

ploughing and that in turn required large amounts of concentrated power that as a rule only oxen or horses could supply. On big tracts of land and during peak seasons, even horses, as they were stronger and faster than oxen, certainly were an excellent investment. Most scholars would endorse the claim that in China and Japan, as land became scarcer, the use of draught animals decreased, certainly in rice agriculture. In rice-growing regions in China buffaloes had always been used and that continued to be the case but in Japan they were unknown. They did not need large separate meadows. In Late-Qing China as a whole, the amount of land reserved for feeding animals was less than five per cent of agricultural land. In his very extensive research, John Lossing Buck concluded that in the late 1920s and early 1930s twenty-seven per cent of the total heartland area of China was cultivated land, 8.7 per cent forest and 4.6 per cent pastures with a vast sixty per cent being unused or unusable. Ninety per cent of the farmland was arable and only one per cent meadow or pasture. The percentage of land that was unusable or unused in China's peripheral regions was even (much) higher. In 1888 in Japan, 1,338,000 hectares of land were described as 'grassland'. That is about one third as much as the acreage of land under cultivation. Its grass and other low growth were used for feeding animals and, the bulk of it, for mulch for fertiliser. Of the country's total surface at the time only some ten to fifteen per cent was suited to functioning as arable. That horses and oxen were also much less prominent in transport in East Asia than in North-western Europe, need not come as a surprise.

In East Asia the importance of animal products for the economy, overall, was certainly smaller. We already referred earlier on to an estimate of the number of draught animals in China for the period from 1914 to 1918. According to that estimate there would have been five million horses, five million mules and donkeys, and twenty-three million oxen and water buffaloes. But the same estimate also refers to twenty-six million sheep and goats and, very importantly, over sixty-three million pigs. On top of that there were many millions of chickens. Animals that did not require much land were quite numerous. In Japan's agriculture animal produce was of fairly marginal importance. We already referred to the number of horses and cattle in the county. (See pages 56-57.) The number of pigs was also low. In the 1910s it was nearly half a million. It increased to about one million during the period until World War Two.

For East Asia, in this context, separate reference has to be made to the tiny silk worms that were fed with the leaves of the mulberry tree and without which there would not have been silk yarn and silk textiles, which both have always been associated with the 'Far East'. The amount of labour and money involved in this sector for both our countries as a whole cannot be calculated and is certainly not an equivalent of the value of animal produce in North-western Europe but considering the number of people and the amount of labour involved it must have been substantial. Millions of Chinese and Japanese peasants, who themselves never wore silk, were engaged in the cultivation of mulberries, the 'production' of and care for silkworm eggs, the raising of silkworms that spun the cocoons, and the producing of raw silk yarn. Producing that yarn involved drying the cocoons, boiling them, finding the ends of the threads, and reeling the threads in basins of hot water to dissolve the gum that held them together. These were all very labour-intensive activities that often took far more of their time and labour than their staple crops, but they often also yielded more income per workday. Sericulture and the production of raw silk would prove to be of major importance for Japan during the first decades of its industrialisation when they provided employment and income for several million peasants. During those

transformative decades raw silk, moreover, was the country's major export product.

Let us finish with a brief comparison with the current situation. Table 3-17 gives an impression of the presence of animals in the contemporary economy. What is striking, is the enormous increase in the importance of poultry. Horses (and for that matter oxen) no longer play a role in agricultural production, transport or warfare and therefore are not included.

Table 3-17 Number of livestock in millions, rounded to the next million, in 2014.

	Cattle	Pigs	Poultry
China	114	480	5,580
United Kingdom	10	5	165
Netherlands	4	12	105
Japan	4	10	311

Roser, Our world in data, under 'Meat and dairy production'.

Apart from the animals referred to above, there are also more than thirty million sheep in the United Kingdom and some 900,000 horses. Whereas the number of livestock is growing very rapidly in China, it is stagnant or even decreasing in the other three countries listed in the table.
Animals had various functions/ uses in the economies discussed here. Their role in providing power and resources has been described. A very import use, that has not yet been discussed was in transport. Considering the major importance of transport in economic (non-) development, we will discuss transport and the role of animals in it later on, extensively and separately. The same goes for their role in warfare. We will now first discuss their importance as providers of manure.

Animal manure and night soil

The importance of animals for agriculture did not only reside in the power that at least some of them could provide or in the consumer goods they produced. They could also play an important role in keeping the land fertile. In all pre-industrial societies manure was of major importance in fertilising the land, although it has never been the only type of fertiliser whereas on the other hand it was used not only as fertiliser but also, at least in parts of Asia, as fuel. Pre-industrial agricultural history is one big effort to find new kinds of fertilisers and is rife with experiments. Overall, the application of all sorts of organic wastes was massive. Let us first focus on animal and human manure. They were undoubtedly very important but for various reasons it is not easy to determine and compare how much manure was actually used in different places. The quality and composition of the manure - and of all the other fertilisers that were applied - could be very different. The nutrient content of different kinds of fertiliser differed substantially. It was 0.5-0.6 per cent for human and pig manure, but, to already refer to fertilisers that will be discussed later on, 0.3-0.5 per cent for green manure and 4.5 to 7 per cent of fresh weight for oil cakes based on soybean, rapeseed or peanuts. When applied, manure was usually mixed with other substances like hay, grasses, straw, or mud. To make robust claims about its importance and effects one would need to know the composition of such mixtures. The amounts required could be very different for different crops and soils. There could be differences in the frequency with which it was applied. Not all arable was actually cultivated, at least in 'European' agriculture, where a substantial amount of it lay fallow, whereas in East Asia in contrast a substantial amount of the available arable was sown more than once. The way in which manure was applied in East Asia, moreover, in particular in

China, was different from the way that was done in Europe. In China, as a rule, manure was applied per plant while they were growing and not over entire fields *before* planting as was done in Europe. Finally, there is the fact that, next to manure, a very wide range of other materials were used as fertiliser.

Let us start with 'production'. Halfway through the eighteenth century, manure production per year per 'normal', average adult head of cattle in North-western Europe was 4,000 to 5,000 kg. For a full-grown horse that average has been estimated at 6,000 to 7,500 kg. The production of manure per cattle increased steeply over the second half of that century as many animals began to be fed and kept in stables where all their manure could be collected. It often doubled to about 10,000 kg per year. For an average pig in traditional farming manure production will have been 750 to 1,000 kg per year. An estimate we have for early seventeenth-century China puts it at 750 kg per pig. That is quite substantial and will certainly have made a huge difference in China, where there were so many pigs for the very reason that they produced so much manure. An estimate on the basis of the known figure of sixty-two million for the period from 1914 to 1918, would be some forty-five to fifty million at the end of the eighteenth century. For the number of goats and sheep in China, we do not have good estimates. Sheep were described as 'four-legged dung-carts' in England. Considering the huge number of them, that is not irrelevant. Their production will have been about half that of a pig. A 'normal' chicken would produce some fifty kg of manure per year. All these figures, of course, are only rough approximations. Much depended on feed and weight of the animals. The droppings of pigeons may not have been impressive when it comes to quantities but they were considered excellent manure. In Europe keeping pigeons and collecting their droppings therefore was long a right of the lord.

How much animal manure was applied per hectare? For the situation in North-western Europe one comes across many different figures but it seems reasonable to assume that in the late eighteenth century *per harvest* and *per cropped* hectare some 10,000 to 14,000 kg of farmyard manure were applied, often, it has to be added, *next to* other forms of fertiliser. In the literature one can come across figures that are or rather look much higher. There are contemporary sources that refer to 70,000 and even 90,000 kg per hectare at the very end of that century. In the account book of a Dutch farmer it is suggested that in 1571 123,000 kg of farmyard manure were applied to one hectare. But such high figures refer to quantities that were applied only to a specific part of the arable once in several years, and that in any case for the figure for 1571 also included other materials that were mixed with the manure. Animals undoubtedly produced huge amounts of manure. But simply increasing their number, could never have offered a viable answer to the ever-increasing demand for fertiliser.

Animal manure therefore has never been the only fertiliser applied to land. Next to animal manure there was night soil, which overall was far less important as fertiliser in Europe than in East Asia and which will be discussed separately later. Looking at the literature one can only conclude that the range of fertilisers was actually all but unlimited: organic waste, lime, marble, ash, all sorts of oil cake, fish, fish meal and so on and so forth. The essence of keeping land fertile consists in fixing nitrogen. There are many ways to do that, apart from 'classical' manuring, including *not* cultivating land for some time and turning it into grassland that fixes almost three times as much nitrogen as arable. Many farmers in Great Britain, without knowing the chemistry behind it all, experimented with convertible husbandry, i.e. switching land on long rotations between pasture and arable. What had a really major impact, *in parts of Western Europe*, was so-called green manuring via nitrogen-fixing leguminous crops like clover, vetches and alfalfa. It has even been claimed that

in England nitrogen-fixing plants accounted for about half of the rise in yields in the eighteenth century, with the rest being a result of better cultivation, seeds and drainage. The generalisation of leguminous crops, in particular the introduction of clover that fixes much more nitrogen than do other leguminous crops, such as beans and peas, found in traditional rotations, was a major, even 'revolutionary' breakthrough. Its effect differs from planting fodder crops like roots and potatoes in order to feed animals that can produce manure. Those fodder crops *as such* do not add nitrogen. They *reduce* it in the soil where they are planted. All their efforts and inventiveness notwithstanding, many farmers in Western Europe had to buy fertiliser for their land as their own supply became insufficient. That became a major investment. On a farm in Flanders, in modern Belgium, for which we have data the cost of buying manure and paying wages for spreading it, in the late eighteenth century, per hectare amounted to some forty-five per cent of the income per hectare.

In East-Asian agriculture unsurprisingly finding ways to fertilise the land too was a major concern of every agriculturist. The contribution of animals to the total supply of fertiliser was less than in Europe, where the number of animals was higher. In China one could find some compensation in the fact that pigs and chicken, that were important manure producers, required hardly any land to feed them. For the Chinese case too, it is hard to come up with figures that are trustworthy and representative and that can, moreover, be compared with figures for different agricultural systems. In Eastern Huzhou in the North of Zhejiang province in the 1630s some 12,000 kg of fertiliser were applied per hectare of paddy. But this figure refers to *all* fertiliser applied, not just manure. In Western Songjiang, currently part of Shanghai, in the 1830s, more than 22,000 kg of fertiliser were applied per hectare on the land of "wealthier peasants". For Northern China at the end of the eighteenth century, we have the very speculative figure of 14,000 to 21,000 kg of 'manure' per cropped hectare. But it turns out that only thirty per cent of this 'manure' actually was (human and pigs') manure and the rest earth, mud and garbage. Overall, it would seem that the actual amount of manure was only a small part of the 'compost' that was applied to the land in China, which will certainly have had consequences for its effectiveness. Nationwide data are available only for a much later period. For the years 1929-1933 the average amount of *all* fertiliser applied in China per hectare has been calculated as 10,000 to 12,000 kg with rice regions as a rule applying a quarter to a third more than wheat regions. On the largest farms in the double-cropping rice-wheat regions along the Yangtze River, it could be as much as 24,000 kg per hectare. Which again points to substantial regional differences and differences between types of agriculture and crops. It is, moreover, not irrelevant in this context, that the land on which manure was applied in China was often used to produce more than one harvest. For Japan basically, a similar story can be told. Here too fields were heavily manured. Unsurprisingly, considering the small number of animals, animal manure was applied here less than in China and certainly than in Europe. That meant that night soil and a very broad spectrum of organic materials played a major role here.

Land productivity of arable in rice regions was often high in particular on irrigated paddy fields. But that productivity, as already indicated earlier on for the case of Japan, could only be realised on a fairly small part of total available land whereas large stretches of land had to be used to produce organic fertiliser to ensure the continuation of that high productivity. Things will not have been very different in paddy fields in China. That means that looking just at the yields of the land that was in use as arable is rather misleading. Moreover, a huge amount of work and time - and where it had to be purchased, money - was involved in acquiring that fertiliser. In both China and Japan, we also find experimentation with and massive application

of all sorts of different fertilisers: not just animals' manure or night soil, but also compost fertiliser, canal mud, all sorts of waste, ashes, sardines, bean and oil cakes, and so on and so forth. In China the use of beancake and oilcake fertilisers, the waste left from pressing soybeans, cottonseed or rapeseed for oil, became widely spread. Oilcake was lighter, had a much higher nitrogen content per kg and was easier to store and spread than manure fertilisers. In Japan, fish - mainly sardines - and seaweed became more prominent as 'new' fertilisers. Green manuring, so important in Western Europe, was rather rare in China as well as Japan. Just like in Europe, buying commercial fertiliser was an option, but it was not cheap. For many peasants it was their biggest expense. Fertiliser costs per unit of land of paddy land in various places in China could amount to half or even the equivalent of total labour costs. In late Tokugawa Japan fertiliser could cost a peasant as much as seventy per cent of the total income from the crop. That again shows the cardinal importance of fertiliser for agricultural production.

The subject of night soil, as announced, requires separate discussion. In China as well as Japan peasants systematically and diligently collected 'night soil', the Victorian euphemism for human faeces and urine, to spread it over their fields. In Europe only the hinterlands of certain cities and then only to a fairly limited degree, employed human excrement and urine as fertiliser. Until well into the eighteenth century, extensive markets for night soil were quite rare. Exploitation of human sources of fertiliser continued to be rather haphazard and informal. Apart from Flanders, some parts of the Dutch Republic and the immediate surroundings of cities like Paris, Valencia and Saragossa, there was not much use of it on farms, in any case as compared to East Asia. As late as 1780, the inhabitants of Paris annually discharged some 270,000 cubic metres of refuse into their streets. Cesspool cleaners collected less than a tenth of it. In most urban centres in Europe, ordure was considered a nuisance that was often collected and then emptied into rivers. Until the mid-nineteenth century, when waste removal became a task of the municipality, this was the job of specific groups of licensed contractors and their unlicensed competitors.
Whereas in the Netherlands and many other parts of Europe the use of night soil was not unknown or totally irrelevant, it is all but completely absent in surveys of what manure the English used in the early modern era. One can find references to the use of lime, marl, seaweed and sea sand, burned pebbles and stones, refuse, ash, dredges or shreds of textiles, to animal manure (the fertiliser that was most commonly used by farmers and that received the highest praise from writers on husbandry) and, of course, to crops that we nowadays would describe as nitrogen fixing. Demand for night soil apparently was negligible. Collecting it in cities and then transporting it to distant farms was considered too expensive. While in Japan night soil could be used in lieu of rent, in England one had to pay to have it taken away. In this case the contrast with China and Japan could not be greater.

In China's and Japan's cities night soil clearly had become an economic 'commodity'. Night soil had long been a major 'traditional' fertiliser in China but it was only during the late Ming era (the sixteenth and early seventeenth centuries) that an intensive night-soil trade arose. Much effort and manpower were devoted to it. The right to collect it became a commodity too and there emerged a complex organisation for its removal. In Qing China, that trade became known as the 'business of the golden juice'. Seventy to eighty per cent of human waste was recycled there. To give just one, late, example: in 1908, the International Concession of the city of Shanghai sold the privilege of collecting 78,000 tons of human waste and of removing it to the countryside and selling it to farmers for the equivalent of 60,000 silver dollars. The buyer was a Chinese contractor.

In Japan the situation was similar. By the 1650s, almost all of the human waste of Edo, a city that may have had as many as one million inhabitants, was recycled. It was a very valued commodity. In the mid-eighteenth century, incidents of theft of it have been reported. As late as the early twentieth century, an estimated thirty-six per cent of the manure nitrogen that was consumed annually in the whole of the country came from night soil. The collecting of this waste had the added advantage that it kept cities, and thus also their rivers

Table 3-18 Increases in yield ratio because of various types of manuring, in the 1880s

	Yield ratio
Manuring with human excrement	14 to 1
Manuring with human urine	12 to 1
Manuring with sheep and goat dung	12 to 1
Manuring with horse manure	10 to 1
Manuring with pigeon dropping	9 to 1
Manuring with cow dung	7 to 1

Ferguson here refers to data in a book on manures from 1880 by A.W. Crews. Given a higher-quality soil, the yield ratios might even increase to 19 to 1 when night soil was used.

Ferguson, 'Night soil', 399.

and canals, cleaner and healthier than in Western Europe. Some figures, again from a later period, give an impression of the total amounts involved. In Japan in 1908, some twenty-four million tons of human manure were applied to the fields. That was an average of 4,400 kg per hectare of arable. For China, Japan and Korea together in 1911 the total amount applied was no less than 182 million tons. Table 3-18 shows that in principle night soil could be quite an effective fertiliser.

Increasingly there emerged an awareness in Europe that just getting rid of night soil was uneconomic and unhealthy. After 1750, more efforts were made to do something about it. They led to large-scale enterprises which persisted for much of the nineteenth century before canalisation was completed. By the late nineteenth century, about half of Paris' excreta was collected and industrially processed to make ammonium sulphate. But from the 1870s such efforts were superseded and made less relevant by the use of artificial fertiliser.

In recent literature it has become common to refer extensively to the advantages of the East Asian way of using human excrement. Already in the nineteenth century complaints were rife that Europeans were so wasteful with their night soil. Justus von Liebig (1803-1873), the 'inventor' of artificial fertiliser, in 1842 wrote that the agriculture of Europe in this respect was infinitely inferior to that of China. Even Karl Marx wrote about night soil and claimed in his *Capital* that what he called 'excretions' were of the greatest importance for agriculture and that insofar as their utilisation was concerned, the capitalist economy was enormously wasteful. That certainly is correct. It is also correct that the night soil business, moreover, in addition to providing fertiliser to the countryside, served as a sewage system for the urban areas where night soil was collected. Cities in China and Japan where that was the case, were far less unhealthy than cities in North-western Europe which without a permanent influx of migrants from the countryside could not even maintain their population. But there were also huge *dis*advantages to the extensive use of night soil. The practice of using it not only entailed much repetitive, heavy and unpleasant labour but night soil is also a carrier of various intestinal diseases. Moreover, the effects of using it were often actually rather limited because of the fact that it has only a fairly low nutrient content, of which a lot actually tends to get lost, and it is available only in limited amounts. Normally more than two-thirds of the original content of night soil manures disappeared during collecting, storage and application. It has been estimated that the annual yield of human wastes in traditional agriculture averaged

only some three kg of nitrogen plus some potassium and phosphorus. This would seem also to apply to the Chinese and Japanese cases we discuss here: the average annual amount of excreta per adult in China in the first decades of the twentieth century was some 450 to 500 kg. It will have been lower than in the Western world, just like its nitrogen and phosphorus content, due to the fact that East Asians tended to have a lower body-weight and ate food containing less protein. The quality of night soil, namely its nitrogen content (the main plant nutrient in faeces), is closely related to diet, especially the amount of protein in food and that is much higher in meat and fish than in rice and vegetables.

As compared to that of animals, human production of excrements was low anyhow. In East Asia population density in the countryside tended to be very high, which in a way compensated for that. But particularly in a country like Britain, where farms were large and rural population density was relatively low, it was logical to, apart from other fertilisers, try to use animal waste which was much more plentiful even though the gathering of it too could be time-consuming.

Wood

Wood was a very important source of energy in the pre-industrial world and as such it has already been discussed earlier on. (See pages 58-60.) But it also had other uses. It e.g. played an important role in housing. A stone house made of brick required even more wood than a wooden one because making bricks required so much fuel. A disadvantage of wood in this respect was that wooden houses were prone to burning down. In cities, the consequences could be catastrophic. The Great Fire in London in 1666 made 80,000 people homeless. There were ninety-three major fires between 1601 and 1866 in Edo. In the period from 1657 to 1668 alone, there were four major fires. The first one destroyed three-quarters of the town, the last one two-thirds, in a city that may have had as many as one million inhabitants. The increasing use of brick for building in Europe certainly made a difference. Wood was also used for furniture and *in* and *for* all sorts of implements used in agriculture and manufacturing.

A major source of demand, finally, was that for wood for shipbuilding. A tonnage of ship translated into almost as many tons of wood. A large warship of about 1,000 tons required between 1,400 and 2,000 oak trees, each at least 100 years old and three masts of up to forty metres. As the tables on pages 70-71 show, Europe's fleet grew extensively. Oaks were indigenous to all countries in Western and Central Europe. For a long time, Western Europe was (almost) self-sufficient in this respect. In the period from 1760 to 1788, ninety per cent of the timber used in English dockyards was still homegrown. In this case too, Britain's coppicing strategy to keep wood production at a certain level was effective for a long time. We have to realise though that a large amount of shipbuilding for the English navy took place in the American colonies. The situation was similar at the time in France. The story was quite different in the cases of firs and naval stores and the particular wood needed for masts. These were imported from the Baltic lands and, in the case of Britain from the end of the eighteenth century onwards, also from the New World, in particular British North America. These imports were waterborne. They had to be as transporting wood was very expensive. The price of a ton of wood transported over land tended to double every two to four kilometres. For firewood such costs were prohibitive.

In East Asia for most of the early modern era shipbuilding was not a major consumer of wood. Building the fleets on which Zheng He had made his voyages in the fifteenth century, had required staggering amounts of it which may have been one of the reasons why those voyages came to

an end and government never again built such a navy. Any increased consumption of wood for shipping must thus have come from the private sector. There are no indications that China's merchant fleet under the Ming and Qing grew at a rate comparable to Europe's merchant fleets. If scarcity of wood functioned as a brake on expanding that fleet, that was not so much a matter of demand as of supply. Demand for wood for building ships will have been even smaller in Japan, which during the 'closed-country-period' from the 1630s until the 1850s, had hardly any ships sailing the open seas and no navy to speak of.

It is abundantly clear that wood was in high demand in pre-industrial societies as a source of energy and otherwise. Demand was actually so high that both extremities of Eurasia experienced deforestation. The next paragraphs will be dedicated to providing some figures about deforestation to get a better idea about developments over time and differences between various countries.

The medieval European era was one of the greatest deforestation episodes in the history of the world. It is estimated that in the sixth century CE fields accounted for less than five per cent of land use. By the later Middle Ages, this had become some thirty to forty per cent. Sheer population growth played a substantial part in that. Europe's population was about eighteen million around the year 600 CE, about thirty-eight million around the year 1000 CE and about seventy-five million at the beginning of the thirteenth century. Forests as a rule became associated with kings and aristocrats who tried to turn them into their excusive property and hunting grounds.

With increasing population and growing numbers of livestock, deforestation was normally all but unavoidable. The production of food for people and animals and of organic material for fertilising laid a major claim on land as did the production of agricultural implements. Table 3-19 to Table 3-21 show how the coverage of land changed over time, not just in Europe but also in other regions of the world. In Europe over the period from 1700

Table 3-19 Cropland, grass land and forest land change in the 'temperate' world, millions of hectares, 1700-1920

	1700-1850	1850-1920
Cropland change		
Europe	+65	+15
Russia	+61	+84
North America	+47	+129
China	+46	+20
Grassland change		
Europe	-40	+11
Russia	+10	-4
North America	-1	-103
China	-7	-3
Forest land change		
Europe	-25	-5
Russia	-71	-80
North America	-45	-27
China	-39	-17

Williams, *Deforesting the earth*, 277, Table 10.

Table 3-20 Cropland, grass land and forest land change in the tropical world, millions of hectares, 1700-1920

	1700-1850	1850-1920
Cropland	+52	+115
Grassland	+16	+40
Forest change	- 70	- 152

Williams, *Deforesting the earth*, 335, Table 11.

Table 3-21 Proportion of land forested, in percentages, from the early modern era to the late twentieth century

	Japan	Lingnan China	England	France
Early modern era	73	47	9	15
Mid-nineteenth century	69	25	4	14
Early twentieth century	65	7	-	19
Late twentieth century	67	-	7	27

Saito, 'Forest history', 386.

Table 3-22 Per capita woodland, in hectares, from the early modern era to the late twentieth century

	Japan	Lingnan China	England	France
Early modern era	1.6	1.6	0.2	0.4
Mid-nineteenth century	0.8	0.3	0.02	0.3
Early twentieth century	0.6	0.06	-	0.3
Late twentieth century	0.2	-	0.02	0.3

Saito, 'Forest history', 386.

to 1850 cropland doubled from sixty-seven million hectares to 132 million hectares. For the regions in Table 3-19 combined, it increased from 132 million hectares to 351 million hectares.
England and Wales were already all but completely deforested at the end of the seventeenth century. At that point only 7.7 per cent of their land area was forests. The same goes for what now are the Netherlands. There too hardly any forest was left. In France, by contrast, forests at the time still covered fifteen to twenty per cent of the land surface. In Prussia, as late as the late eighteenth century, it was still some forty per cent. Differences in Europe in this respect continued to be major. Table 3-22 and Table 3-23 provide basic data with regard to the available amounts of forest in several European countries, Japan and China.

Deforestation in the West mainly took place during the medieval and early modern era and not so much during the nineteenth and twentieth centuries. Those centuries in several countries even witnessed some reforestation. In China in particular the last decades of the imperial period witnessed a worsening of the situation. That became

Table 3-23 Proportion of forest cover and acres of forest per person, Europe, c. 1868

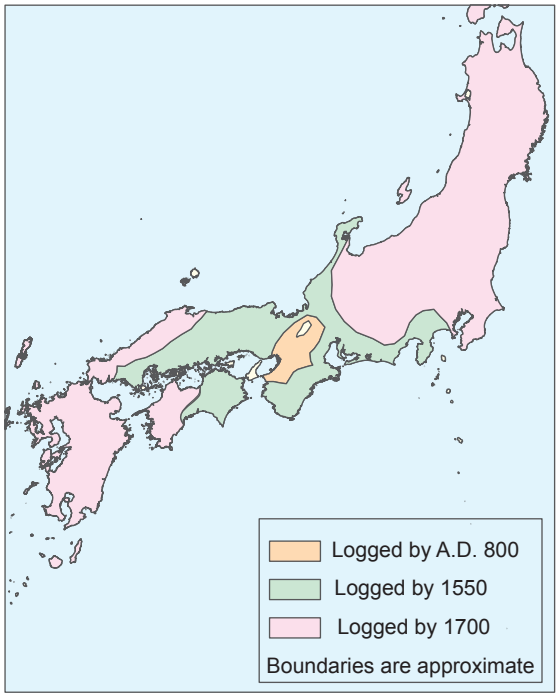
	Percentage forest*	Acres of forest per capita **
Norway	66	9.96
Sweden	60	3.48
Russia	31	1.74
Germany	27	0.28
Belgium	19	0.08
France	17	0.16
Switzerland	15	0.16
Sardinia	12	0.08
Naples	9	0.04
Holland	7	0.04
Spain	6	0.12
Denmark	6	0.08
Great Britain	5	0.04
Portugal	4	0.08

* Rounded to the next per cent

** Rounded to the next 1/100th

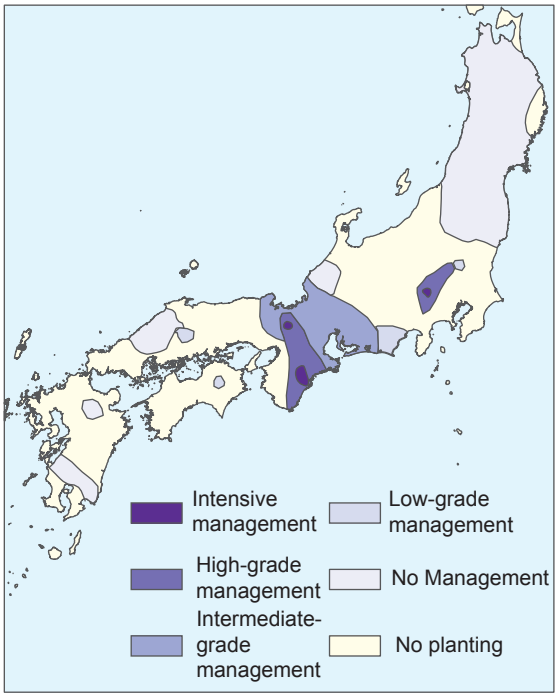
Williams, *Deforesting the earth*, 279. We recalculated the figures Williams gives for forest per capita in terms of acres by taking 2.4711 acres to a hectare.

Map 3-2 Areas logged in Japan on behalf of the construction of monumental buildings



Totman, *The green archipelago*, map 2.

Map 3-3 Late Tokugawa afforestation on private land



Totman, *The green archipelago*, map 8.

fairly disastrous after the fall of the Qing in 1911. Deforestation here as indicated, was connected with a rising population and a lack of effective forest policies. In principle 'Manchuria' could have become a major provider of wood and coal. The resources of that major region, however, apart from bean cake made from soybeans, were not exploited intensely until the second half of the nineteenth century. The differences in development between Japan and China were great and certainly not simply due to natural conditions. Regenerative forestry in early modern Japan was a success that resulted from a widespread policy of sustaining the country's forests. The fact that the country had a better natural environment for natural rejuvenation than Europe also played a part, as did the existence of a flourishing urban market for firewood and charcoal. Map 3-2 and Map 3-3 give an impression of deforestation and reforestation in the country. It has to be added, though, that the policies of regenerative forestry in Japan kept the country's forest quantitively intact but resulted in a much less diverse forest landscape.

Metals: iron and bullion

The industrial revolution that began in the late eighteenth century in Britain would have been impossible without a large supply of cheap iron in particular for use in machinery. Everything points to the fact that, overall, at the beginning of the early modern era, more iron was produced and consumed per capita in Western Europe than elsewhere in the world. But as compared to what would become normal in the industrial age, the amounts of iron produced were still small and its

price relatively high. Even so, a lot of people developed expertise in producing and processing iron - and other metals - used in agriculture for ploughs and other implements but also for making utensils, weaponry and for equipping ships. Demand tended to increase with higher incomes. Every village had a blacksmith. On the eve of its industrialisation, Great Britain, on a *per capita* basis, had the largest stock of blacksmiths, but also mechanics, clockmakers, toolmakers and engineers in the world. Table 3-24 provides estimates for the output of wrought iron in several European countries over the entire early modern era. The increase in production per capita from 1600 onwards is relatively small.

Table 3-24 Estimated output of wrought iron in Europe in 1,000 tons, c. 1500-1790

	France	Sweden	Germany	Great Britain	Europe as a whole	
					in 1,000 tons	*in kg per capita*
c.1500-1790	12	5	5	1	40	0.65
c. 1600	-	7	-	17	125	1.60
c. 1700	25	28	30	24	165	2.00
c.1740-1750	-	40	-	27	145-180	1.5-1.9
c. 1790	140	50	50	80	-	2.20

Van Zanden, 'Early modern economic growth', 81.

In 1078, during the Northern Song period (960-1127), iron production in China may have reached 125,000 to 150,000 tons, according to a much-quoted estimate by historian Robert Hartwell. The iron was produced using bellows and coke-fuelled blast furnaces. It was used for implements, armaments and ships. Scholars who are keen on pointing out how developed Song China was, have related this iron production to production in mining and considered the two of them in combination as an indication of an 'early industrial revolution'. The production figures just presented were surpassed in England and Wales only in the 1790s, so they claim. Actually, however, the figures referred to are fairly modest when we look at them on a *per capita* basis. China under the Northern Song in 1078 had some eighty to one hundred million inhabitants, Great Britain in the 1790s, at the beginning of its industrialisation, only some ten to eleven million. The estimates given for Northern Song China, which are currently considered rather optimistic by most experts, imply a per capita consumption of iron of 1.25 to 1.5 kg at its peak. The figures we have for England and Wales for earlier moments in time point to a per capita iron consumption of some three kg in 1540 and some 6.4 kg in 1640. The figure for 1796 for Great Britain is estimated to have been some fifteen kg per capita. That is quite different from the figures for China. From then onwards, its iron production, which had not been very impressive as compared to that of other European countries (See Table 3-25) and took off only in the 1780s, grew at an unprecedented rate as is shown in Table 3-26 for its pig iron production. It in this context is important to point out that the country also became a major copper, tin, lead and zinc producer. In the Dutch Republic iron production was nihil. There are no indications that iron consumption in Japan in the early modern era would have been high as compared to that of North-western Europe. Demand for it from agriculture or the armed forces in any case will have been comparatively modest. That did not preclude the production of very high-quality products made of iron or steel, such as, for example, swords.

The consumption of iron and steel had already increased somewhat *before* Great Britain went through its Industrial Revolution, but there were limits to that increase because of the limited availability of the main fuels needed to make it, i.e. wood and charcoal, and of streams to drive the bellows

Table 3-25 National shares of wrought iron production in Europe, in percentages, 1725/1750

	Wrought iron
	1725-1750
France	27.0
Sweden	25.4
Germany	8.7
Austria/Hungary	8.7
United Kingdom	8.1
Spain	8.0
Russia	6.2
Italy	2.5
Belgium	-
Rest of Europe	5.3
Total production of Europe (1,000 tons)	165-214

The estimates for total production here are somewhat higher than those in Table 4-24.
Broadberry, Fremdling and Solar, 'Industry', 180.

Table 3-26 Pig iron output in Great Britain, tons per year, 1720-1850

1720-1724*	27,000
1755-1759*	31,000
1780-1784	62,000
1785-1789*	80,000
1791	100,000
1801	200,000
1808	300,000
1824	>500,000
1837	>1,000,000
1850	>2,000,000

* Averages
Figures taken from Riden, 'The output of the British iron industry'.

needed to supply extra air to the fires heating the ore. The spread of new technologies, and their further development, proceeded slowly, certainly outside Great Britain. For example, it took about

Table 3-27 The price of other goods relative to calories in Canton and London in 1704

	Canton	London
Bread		1.00
Rice	1.00	
Meat	21.42	7.17
Milk	10.71	1.91
Tea	107.10	573.66
Sugar	8.57	26.29
Charcoal	10.71	0.41
Lighting	26.78	10.68
Cotton cloth	75.97	51.63
Iron work	22.84	14.34
Nails	30.72	8.96

The prices for the items in the rows for meat to nails equal their actual prices divided by the price of a calorie implied by the prices of rice and bread for Canton and London, respectively.
Allen, 'Mr. Lockyer meets the index number problem', Table 4.

100 years for the Darby coke-smelting process to spread successfully to the European Continent. If the information in Table 3-27 can be 'generalised' to China and Great Britain, it would appear that already in 1704 iron work and nails (and charcoal!) were relatively much more expensive in terms of calories in China than they were in Great Britain.
Iron was so important because it could be used to produce durable capital goods. It is hard to imagine nineteenth-century industrialisation without iron machinery. In a way it might be claimed, that there were metals that were even more important for the economies we are discussing, to wit those that not by accident are called the precious metals and that functioned as the backbone of their monetary systems. Societies in the early modern era depended on nature in the realm of money too. By far the bulk of money in Western Europe and East Asia continued to consist of hard cash in the form of bullion, i.e. gold and silver or copper. Bullion worldwide was the material most widely used for currency, as it was expensive, divisible and better resistant to

wear and tear than most materials. Even in England paper money (as real currency *not* in the form of credit) continued to be fairly insignificant until the nineteenth century. The availability of money, and thus price levels, tended to be strongly related to the stock and supply of a 'natural' product. This meant that the discovery and exploitation of new mines e.g. in Central and South America from the sixteenth century onwards or in California in the 1840s, but also of course the exhausting of existing ones, for example, in Central Europe and later in Japan during the seventeenth century, phenomena which to a large extent are determined by 'natural accidents', could have a huge impact on economic life. It was not due to some 'irrational' fascination that in any case many European and Japanese rulers were so keen on accumulating precious metals: they were their main means of payment. Tokugawa Japan in this respect was somewhat exceptional. In that country, next to gold, silver, copper, and to some extent paper money, rice *de facto* functioned as a separate currency. Land taxes, though partly paid in silver, were measured in rice, as were the stipends paid by the Shogunate and by *daimyo* to their *samurai*. The value of the rice stored in public and private granaries probably exceeded that of circulating metallic coins. When bullion from American mines spread over the world, it became the first commodity of fundamental importance that also became a global commodity. It will be discussed extensively in the chapter on exchanges.

Frontiers and ghost acreages

The fundamental problem of the pre-industrial world consisted in the scarcity of land (in absolute terms and in terms of quality) as provider of resources. Several strategies were developed to do something about this scarcity. They could consist of 'outsourcing' the problem by using land that is located abroad; by using resources from the sea - which of course also are organic and limited or - which was fundamental for the emergence of modern economic growth - by using subterranean resources that could also be, and preferably were, located in a country itself. It would be hard to deny the importance of such additions to a country's resource-portfolio, but it is not easy to quantify them. It has become customary to do so in terms of ghost acreages. Ghost acreage - a concept first used by Georg Borgstrom - can be defined as the amount of land one saves, in this case as a country, by importing land-intensive resources or raw materials from abroad (import ghost acreage); by finding alternatives on water (marine ghost acreage) or by using resources from underground (subterranean ghost acreage). In this chapter we will confine ourselves to strategies on the level of the national economy which are based on import and on the use of marine ghost acreage. Subterranean ghost acreage which acquired a new and fundamental importance with industrialisation, will be discussed later. (See pages 296-298.)

Western Europe, or in any case the economically most developed parts of it, from the Late Middle Ages onwards developed into a 'core region' surrounded by peripheral *European* regions that provided it with basic resources and raw materials. With the Age of Discoveries, the frontier area that could be made to function as an additional reservoir of resources and raw materials was extended with what - since the book by Walter Webb with that title - has become known as the Great Frontier,

Table 3-28 Population density of several regions, people per sq. km, 1500-1800

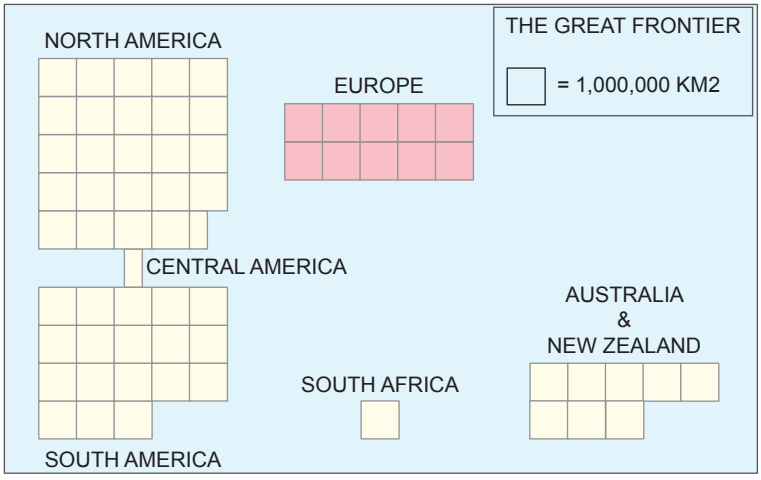
	Europe (without Russia)	China Proper	America	Europe & America
1500	14	25	1.9	3.1
1800	30.8	80	0.6	3.6

Malanima, *Pre-modern European economy*, 16 for Europe, and Sieferle, *Subterranean forest*, 96 for the estimates for the other regions.

i.e. the two Americas, Australia and New Zealand and what is now South Africa. The amount of extra land and sea and thus of resources, that now via this Great Frontier, in principle, became available to Western Europe was staggering. For the amount of extra land and the effect on population density see Table 3-28 and Figure 3-1.

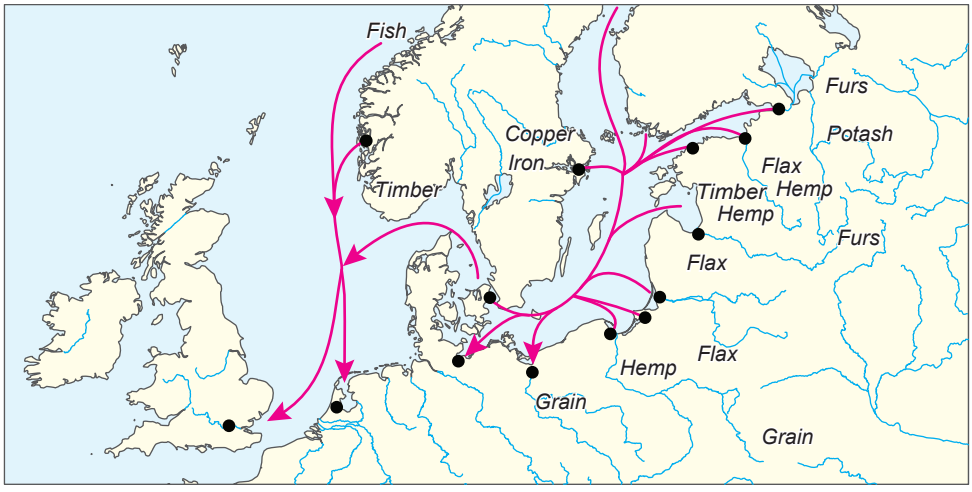
The exploitation of these extra resources began as a windfall, rather like collecting booty. Initially, most of them came 'for free'. But increasingly systems of exploitation had to be developed in which the production of certain commodities became organised by Westerners and guaranteed on behalf of Western markets. The hard, basic work

Figure 3-1 Europe's Great Frontier



Based on information in Webb, *Great Frontier*.

Map 3-4 The main products and routes of the Baltic and Northern trade



Pounds, *Historical geography of Europe, 1500-1840,* 279. Based mainly on J. Jepson Oddy, *European commerce* (London 1805).

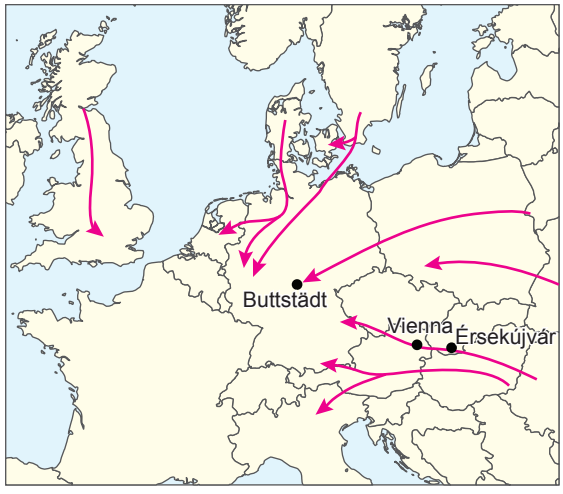
this required as a rule was done by unfree labour that was found locally or, in particular in certain regions of the Americas, increasingly imported from other parts of the world.

In discussions of 'peripheries' of Western Europe's economies, the focus has always been on the peripheries in other continents. But a lot of the peripheries of the most advanced economies in early modern Europe and of the economies where industrialisation took off were actually *in* Europe. This in particular applies to Central, Eastern and South-eastern Europe and to a lesser extent also to parts of Northern Europe, regions that often functioned as Europe's 'internal Americas'. To all intents and purposes, they were real peripheries. They specialised in the production of primary products and raw materials for export, using coerced and badly paid labour, in Central and Eastern Europe serfs, and they all had weak states. Map 3-4 shows the products that core-regions in Western Europe received from the Baltic regions and Northern Europe. From South-eastern Europe and Eastern Europe, they received grain, cattle and forest products; from Ireland wool and flax and from Scotland cattle.

Great Britain's trade with Northern Europe and the Baltic region was quite substantial. In 1750 it amounted to £6.5 million (only England and Wales); in 1791 to almost £10 million and 1800 to over £21 million. Many ships were involved in it. At the beginning of the 1770s, no less than twenty per cent of British shipping, in terms of tonnage, was engaged in Scandinavian and Baltic trade. That trade became even more important in absolute terms later on, although its relative importance declined. In the second half of the eighteenth century the British took over from the Dutch as the main trade partner of the Baltic regions and Scandinavia. For the Dutch the trade with the Baltic region was with good reason called "the Mother of all trades". Their Golden Age would have been unthinkable without the imports of wheat and rye and all sorts of naval stores from that region. Peasants in the Baltic could work on the fields producing grain in summer and wood in winter. The Baltic regions had the space and the forests to produce these goods. The production of potash required enormous amounts of wood. It too came from the Baltic regions, from Archangelsk on the White Sea, and in the last decades of the eighteenth century increasingly from North America. In the nineteenth century exports of naval stores and potash from Eastern to Western Europe began to decrease. With the Napoleonic Wars with France and with the Continental System, timber imports that had become increasingly important shifted from the Baltic to British Northern America.

Less discussed but certainly not irrelevant was the trade in cattle from Northern, Eastern and South-eastern Europe to the urbanised Northwest of the Continent. Map 3-5 shows the main droves in the sixteenth century.

Map 3-5 Cattle droves in Europe in the sixteenth century



Pounds, *Historical geography of Europe, 1500-1840*, 39. The map shows current borders. Based on Wiese and Bölts, *Rinderhandel und Rinderhaltung*.

A couple of examples must suffice. From what are now Schleswig-Holstein, Denmark and Skane (in Southern Sweden) alone, at its height, i.e. in

the first two decades of the seventeenth century, some fifty thousand oxen at least were imported into the Netherlands, i.e. basically Holland; some forty thousand over land and some ten thousand over water. Total annual exports of the regions referred to may even have been as high as 70,000 to 80,000 oxen. In 1542, over twenty-seven thousand oxen were exported from Hungary to Austria and Moravia, from where they often went further westward. Exports would reach even higher levels. In the period from 1549 to 1551, Hungarian traders sold more than 180,000 oxen on the markets that were held weekly in Vienna. In the 1560s and 1570s, they exported about 150,000 oxen annually. In 1588, more than 84,000 oxen passed over the bridge of Érsekújvár in modern Slovakia on their way to markets in Western Europe. Exports from Red Ruthenia and the Ukraine, at their height - also in the seventeenth century - could be as high as 40,000 per year. At fairs in Buttstädt near Weimar, in the second half of the sixteenth century, 16,000 to 20,000 cattle coming from Eastern Europe could change hands. Overall, after 1700 cattle exports from Northern, Eastern and Central Europe to Western Europe decreased sharply. The cattle droves from Scotland southwards to England continued to be substantial. In the first decades of the eighteenth century they still amounted to 40,000 cattle per year.

For certain products and regions, we have actual calculations of their ghost acreage contribution. The first one relates to the trade with the Baltic. Over 200,000 ships entered and exited the Sound between 1497 and 1660. They transported amongst many other things some 60,000 tons of cereals per year. In the period from 1661 to 1787, their number was some 560,000, and they transported more than 95,000 tons of grain annually. To produce such amounts of grain in the importing countries would have required 5,000 sq. km to 7,000 sq. km of land. Most of this grain went to the Dutch Republic, whose total size was just some 33,000 sq. km A varying percentage was transported further afield. As a rule, not to Great Britain, that in any case was a net exporter of grain until the 1770s. When it comes to timber, however, Great Britain was a major importer. The ghost acreage of its timber imports at the end of the eighteenth century was some 2,600 sq. km (from the Baltic) and, at the beginning of the nineteenth century, some 4,000 sq. km (then mainly from British North America, i.e. what we now call Canada).

Surprisingly enough, the product that for a long time had the biggest ghost acreage of all products imported from a periphery into North-western Europe, was potash. Table 3-29 gives the ghost acreage for Great Britain, the country for which we have the best data. The Dutch Republic was also a major importer for quite some time. During the seventeenth century, its imports are assumed to have been even larger than those of Great Britain.

Table 3-29 Potash imports into Britain and their ghost acreage

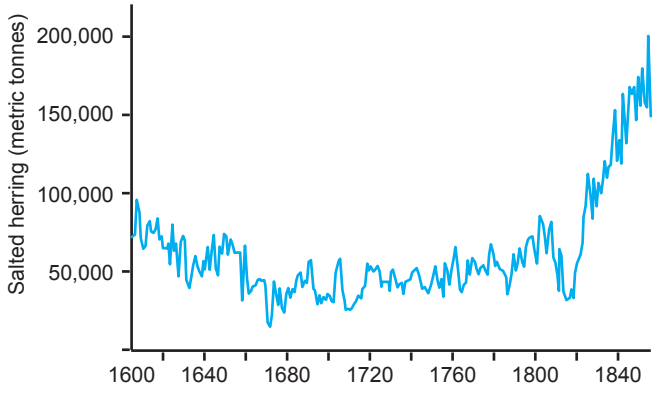
	Potash imports in million lbs	Wood needed to produce those imports in millions of m3	Ghost acreage for Britain in sq. km
1700-1730		3	
1770	5		
1792	14.2	10	30,000
1810	36	26	60,000
1819		14	
1832			50,000 to 62,000

Figures based on information in Warde, 'Trees, trade and textiles' and in Theodoridis, Warde and Kander, 'Trade and overcoming land constraints'.

Some comments are in order about Western Europe's 'marine ghost acreage'. Let us start 'nearby' and briefly discuss a fish that contributed substantially to Western European consumption, salted herring from Northern Europe. Graph 3-3 gives

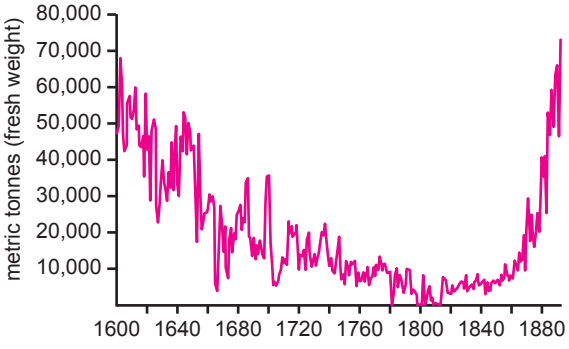
figures for its production in Northern Europe. Graph 3-4 deals specifically with the Dutch Republic.

Graph 3-3 Production of salted herring in Northern Europe in metric tons, 1600-1840



Poulsen, *Dutch herring*, Figure 4.12

Graph 3-4 Total estimated production of salted herring in 'the Netherlands' in metric tons, 1600-1892



Poulsen, *Dutch herring,* Figure 4.1.

The average production over the eighteenth century was about 75,000 metric tons. As one kg of salted herring is some 4,000 calories, 75,000 metric tons equals 150 million rations of herring of 2,000 calories. That, in strictly calorific terms, would suffice to provide more than 400,000 adult males with bare subsistence for a year. A large part of this herring was caught by the Dutch. Surprisingly enough, in the Dutch case herring fishery seems to have been hardly profitable, in contrast to whaling. But whalers were increasingly confronted with the exhausting of their fishing grounds. After the late 1640s, herring became a declining industry and output and employment began a fall that continued into the second half of the eighteenth century. In the first half of the seventeenth century on average some 800 vessels had been involved in Dutch herring fishing. In the first half of the next century that number had decreased to some 200 to 300. At the same time whaling became a relatively large source of employment. Total employment in fisheries thus remained more or less stable at circa three per cent of the total labour force of Holland between the 1620s and the 1750s. It was only during the second half of the eighteenth century that the industry as a whole showed a decline. One has to realise that fishing as such was usually a seasonal affair that, moreover, could be severely disrupted by warfare. In the short term, employment thus could fluctuate wildly from one year to another. During the Second Anglo-Dutch War, to provide an extreme example, estimated employment fell from about 14,000 in 1663 to 1,000 in 1665 and even less in the next year. It was not a small-scale endeavour. To catch herring, the Dutch used ships of between eighty and a hundred tons with crews of about fifteen men that could stay at sea for several months and often functioned as fish-preparing factories. At its highpoint in the 1780s, more than 25,000 people were employed in the Swedish herring industry. Marine ghost acreage for North-western Europe *outside* Europe will be discussed on pages 101-103, where some extra comments will also be made on whaling.

Europe's *external* peripheries, its Great Frontier, consisted of a vast body of wealth that was considered freely available. The rights or the claims

of those people who to all intents and purposes *de facto* (had) owned it were simply ignored. In principle it provided the western European economy with an abnormal windfall of land and capital, the latter mainly in the form of gold and silver. Europe as a whole, including Russia west of the Urals, measures some ten million sq. km. Excluding 'Russia' west of the Urals, it measures some five million sq. km and had some seventy million (in 1500) to some 150 million (in 1800) inhabitants. Adding the entire Great Frontier to Europe (again excluding Russia) made almost twelve times as much land available per non-Russian European. Large parts of Austria-Hungary, Poland as well as what is now Sweden, Finland and Iceland and the Ottoman Balkans were actually not or only marginally involved in exploiting the Great Frontier. The part of Europe that directly profited from the Great Frontier was only close to three million sq. km, which made the actual ghost acreage 'windfall' even bigger. The biggest windfalls, consisting of land and bullion, went to the early comers. After the initial looting, more investment and work were required. But still, in particular in the case of land, Western Europeans at the Great Frontier hardly ever paid for it. The importance of Africa and Asia as providers of primary products, that became substantial with industrialisation, will be discussed in the chapter on the great divergence. The importance and impact of (mainly) American bullion and African slaves for the economies described in this text will be discussed separately in the chapter on exchanges.

For Europeans, the New World consisted of an incredible amount of land, water and wildlife which they had to share with only very few people, insofar as they shared it at all. Again, the most important examples of the way in which they profited from this windfall must suffice. When it comes to food imports from the Great Frontier, sugar from the Americas was the biggest provider of ghost acreage for Western Europe. For Great Britain the following calculation has been made. If the country had wanted to produce the calorie-equivalent of its sugar imports at home, that would have required roughly 3,800 sq. km to 5,500 sq. km in 1811 and 5,100 sq. km to 7,100 sq. km in 1831. In 1800, Britain's population got four per cent of its calorie intake from sugar.

Extra calories were also provided by fishing. In an average year in the seventeenth century, 47,000 metric tons of codfish, caught in the waters near Newfoundland, Nova Scotia and Southern Labrador by crews from England, New England and France, arrived on European markets, dried and wet. Over the period from 1701 to 1789, the average was even higher at about 55,000 tons. The harvest of crews from the Basque Country is not included in these averages. In the period from 1785 to 1790, about 100,000 metric tons of American codfish entered the European market, most of it ending up in France, Spain and Italy. One ton of codfish, three quarters dried and one quarter wet, made available 2.9 million calories, enough to feed, in strictly caloric terms, some 1,500 adult males for a day, assuming that one such adult needed 2,000 calories as a daily ration. That would mean that the 100,000 tons consumed in the second half of the 1780s could have provided 150 million adults males with a bare subsistence ration for a day. The life-catch of the fishermen was much higher. For the seventeenth and eighteenth century, it has been estimated at, on average, 200,000 to even 250,000 tons. Dried and salted cod became an important element in the Mediterranean diet but it was also exported to the sugar islands of the West Indies, the Canary Islands and Madeira, and to settler colonies along the North American coast.

The contribution of open seas fishing to total calorie intake in early modern Europe can easily be overestimated. It may have been impressive in absolute figures, but it nevertheless was rather marginal to total food provision. The number of calories provided by herring and cod fishing together at their height were not enough to provide one million adult men with bare subsistence in strictly caloric

terms. That means that they contributed less than one per cent to total European food provision.
Whaling was another example of marine ghost acreage outside Europe. In the Dutch Republic even more people were employed in whaling than in herring fisheries. In the second half of the seventeenth century, no fewer than 9,000. Whales, however, in contrast to herring, were not hunted by the Dutch for food but for their 'oil' that was used to make soap and lamp-oil. It was not just crews from the Dutch Republic that were involved. Britain, the Germans lands and the Basque Countries were also important whaling countries. Table 3-30 can provide a sense of orders of magnitude.

Table 3-30 Number of whales caught by European fishermen, 1530-1850

Basques, Labrador whaling,	1530-1620	22,000-32,000
Dutch and Germans, drift ice whaling,	1661-171	±50,000
British Northern whaling	1733-1800	12,000
	1817-1850	22,000
Greenland bowhead whales	1530-1850	>160,000

Richards, *Unending frontier*, 588, 600 and 607.

A final example of European exploitation of the Great Frontier in terms of 'wildlife' is the hunt for skins and furs. According to a conservative estimate, British, French and Spanish traders at the beginning of the eighteenth century exported 50,000 deerskins per year from North America. At the peak of exports in the 1760s and 1770s, that number had increased to 250,000 or even 300,000. As Table 3-31 shows the export of all kinds of furs was even larger.

The Russian frontier too was turned into a big hunting ground. Throughout the seventeenth century between 200,000 and 300,000 sable pelts were harvested per year in Siberia. In the period from 1743 to 1798 the total number of sea otters caught near the Aleutian Islands, the Commander Islands and Alaska was 187,000. Interestingly enough, the Chinese were avid buyers of sea otter pelts from the American west coast.

Table 3-31 Furs harvested for export alone in North America, annual averages, 1760-1849

	1760-1763	1780-1799	1830-1849
Beaver	179,268	263,976	77,654
Raccoon	91,637	225,115	322,759
Marten	51,315	88,856	130,283
Fox	18,411	20,360	79,056
Bear	16,033	26,833	13,229
Mink	15,730	20,680	144,719
Otter	11,525	36,326	20,169
Muskrat	10,432	177,736	849,865
Lynx/Bobcat	10,179	17,277	35,443
Fisher	3,373	8,480	10,412
Wolf	1,830	16,461	8,899
Wolverine	608	1,430	1,318
Total	410,341	903,530	1,693,806

Richards, *Unending frontier*, 511.

The most famous import ghost acreage, famous because it was for a product at the heart of the Industrial Revolution, though, was not of food but of raw cotton. It was quite large. If Great Britain had wanted to produce the wool-equivalent of its cotton imports, that would have required some 36,000 sq. km of land for sheep to graze in 1815 and over 93,000 sq. km in 1830.

For Western Europe as a whole, effective import ghost acreages in the Great Frontier area during the preindustrial period were still relatively small, as shows in the relatively small amounts of goods exported from 'Great Frontier regions' to the 'mother countries', and in a way also in the relatively small number of people who went to the frontier. In the nineteenth century, the incorporation of

frontier lands in the economies of the core lands acquired completely new dimensions. In a way this incorporation closed the frontier as Western European economies ran out of 'new' land to distribute. Acquiring the Great Frontier represented an unprecedented and unrepeatable windfall for what became the wealthiest part of the world.

In the existing literature the idea of 'ghost acreage' has been preferably associated with 'the West' exploiting 'the rest'. But it of course can also be applied, as has been done, to other exchange relations. The highest-developed regions of Qing China e.g. imported many goods that required large tracts of land for their production from other parts of the country. These imports too could be described in terms of 'ghost acreages'. By about 1750, at least three macro-regions of China, Lingnan, the Southeast Coast, and above all the Lower Yangtze region, imported significant amounts of food. For the Lower Yangtze region imports were thirteen to eighteen per cent of total supply. All three of them imported timber, and at least the Lower Yangtze region also imported large amounts of bean-cake fertiliser from Manchuria. Lingnan imported most of its cotton and also increasingly began to import bean-cake in the nineteenth century. Imports of grain and bean-cake from other parts of China were of fundamental importance for the economy of Jiangnan. The economy of the Pearl River Delta region in Southern China was not sustainable without inputs that kept on increasing over time. During the late eighteenth century, the food imports of the province of Shandong alone, with some twenty-three million inhabitants, which is almost as many as France at the time, could feed some 700,000 to 1,000,000 people. China's economic heartlands in fact appear to have been more dependent on the country's 'internal periphery' than Britain was on its overseas periphery, in any case for the period we are discussing here. Long-distance grain trade in eighteenth-century China actually dwarfed the Baltic grain trade, the biggest example of such trade in Europe. In a conservative estimate for the eighteenth century, that trade was enough to feed some fourteen million Chinese. In a more optimistic estimate, for the 1790s when this trade was at its peak, the amount of rice traded inter-regionally could feed almost thirty million people.

China's core regions actually could have imported much more, especially from those regions that in the West are usually called 'Manchuria' - a word that the Chinese tend to associate with Japanese and Western imperialism and thus avoid - which enjoyed extra-ordinary natural endowments. Qing 'Manchuria' in its entirety, until the Russians took over part of it in the 1850s, measured about two million sq. km. (For further explanation and a map see pages 270-280.) The breath of its farmland and its woodlands was enormous. The region had plenty of fur-bearing animals, fish and oysters. Its soil contained gold and, as one discovered late in the nineteenth century, copper, lead, and tin. It was famous for its ginseng. But the Qing elite apparently did not really care. The emperors and their imperial households received all sorts of food and furs from the region which also provided China Proper with soybeans. But the country as a whole could have done so much more and much earlier. After its 'opening', it was soon turned into the biggest soybean producer in the world. It could also have become a major grain supplier for Beijing. It had excellent soil and enough water for farming. Its grain prices were substantially lower than they were in China Proper. People knew all this as early as the middle of the eighteenth century and made suggestions about how to use the region's potential. They were not very successful. In economic terms the region remained somewhat neglected. The Qing rulers did not promote trade in or with the new territories they acquired. There are various examples of the fact that they discouraged or even prohibited the mining of precious metals and minerals in Xinjiang, or the starting of various projects that might have helped in developing the

region. Tibet was known, in any case in the West, to be rich in minerals. The Qing state did not take it upon itself to exploit them, nor did it encourage or help others to do so. During the eighteenth century, it not only tried to strictly regulate migration to Taiwan, it also frequently restricted its trade. Overall, government was often reluctant to let Han Chinese settle in zones outside China Proper.

China's core regions not only imported land-intensive goods from the rest of China - which they could have done much more in the case of regions outside China Proper - they also imported such goods from abroad. Between 1785 and 1833, the province of Guangdong alone each year imported, on average, six times as much raw cotton from India as the whole of Britain used to do annually in the 1770s when its industry began to take off. In 1805, 55.3 million lbs of cotton were shipped from British India into Canton. That cotton was and continued to be substantially cheaper than Chinese cotton. At that time, the imports of 'wool cotton' into Great Britain for processing there stood at 58.9 million lbs. As late as 1815, China's imports of cotton via Canton roughly equalled Britain's cotton imports at the time. China at that time did also import food, i.e. mainly rice from other parts of Asia. In absolute numbers that import was huge, certainly feeding hundreds of thousands of people. In relative terms, i.e. as a percentage of total population, it was rather small. In total, i.e. as compared to the national economy, trade with the West, that was never actively promoted, was never large.

Tokugawa Japan may be known as a 'closed country' but it too had some ghost acreage. Its increasing exploitation of parts of Hokkaido might be considered as such but the type of ghost acreage that really mattered here was marine ghost acreage in the form of fishing, whaling and collecting other seafood. Commercial fishing and whaling expanded significantly over the Tokugawa period, as the number of fishing grounds increased and fishery technology developed. Sardines fishing became very important. It did not so much provide food directly but indirectly, as these fish were used for fertilising. Fishing boats could have work crews of up to fifty persons. Hokkaido whaling became big business with fleets of numerous ships with hundreds of men. It provided fresh and salted whale meat. Much of Japan's populated area is close to the sea or to rivers from which fish and shellfish could be gathered for home use. Villagers caught freshwater fish for their own consumption, while also processing it for sale in local towns. In coastal villages a large variety of sea fish and shellfish (especially oysters) was also available. Fish were raised in ponds. The total number of calories from fish may not have been impressive. (See page 113.) But it was important as a provider of proteins and vitamins. It has become even more important as such in contemporary Japan, where sixty to seventy kg of fish are consumed per year per capita.