The story of an agricultural revolution introduced by aristocratic heroes in the century after 1750 has proved a surprisingly enduring myth. Like early accounts of the industrial revolution it is a late Victorian tale that captured the popular imagination with its emphasis on particular innovations (turnips, the Norfolk four-course rotation, and mechanical gadgets such as the seed drill), and the Great Men associated with them (‘Turnip’ Townshend, Coke of Holkham, and Jethro Tull). Although subsequent research in agrarian history has shown this traditional account to be a grossly misleading caricature there is no consensus among agricultural historians about an alternative view of the nature or timing of a decisive transformation in agriculture.

Agricultural revolutions

The phrase ‘agricultural revolution’ is now used to refer to a multitude of events and processes taking place at some point during the three centuries after 1550. Using work published in the 1960s it is possible to identify three distinct periods during which it has been claimed that an ‘agricultural revolution’ took place. This essay will outline each of these in turn, and then comment on them in the light of some of the most recent research in agrarian history. This research shows that the process of agricultural change is too continuous and too varied to enable any one episode in a long history of development to be identified as the agricultural revolution. The essay also includes a brief discussion of the concept of an ‘agricultural revolution’ since the existence of such a phenomenon is not something that can be determined by examining the facts of history alone.

Period 1: 1750-1850

Over the years research has diminished the reputations of the ‘Great Men’. It has been shown that ‘Turnip’ Townshend was a boy when turnips were first grown on his estate and Jethro Tull was something of a crank and not the first person to invent a seed drill. Coke of Holkham was a great publicist (especially of his own achievements) but some of these innovations (turnips, the Norfolk four-course rotation, and mechanical gadgets such as the seed drill), and the Great Men associated with them have been positively harmful. More generally it is acknowledged that the traditional picture of a sudden and rapid transformation in the eighteenth century is mistaken, and that some improvements had long antecedents. Nevertheless a revisionist view of the traditional story, which owed much to the work of G. E. Mingay, still firmly located an agricultural revolution in the century after 1750. According to this interpretation, progress came through technological innovation which raised land productivity (output per acre), and was facilitated by parliamentary enclosure.

The major technological innovations emphasised by this account were two fodder crops, turnips and clover, which gradually became integrated into arable rotations. They increased livestock carrying capacity and therefore supplies of manure - the main fertilizer of arable land. This raised soil fertility and hence yields per acre. The new crops were grown in a rotation in which grain crops alternated with fodder crops, replacing the old rotations in which several grain crops were taken in succession and followed by a bare fallow. The fallow had been necessary to allow nitrogen (an essential plant nutrient) to be restored to the soil from the atmosphere, and also to control perennial weeds by repeated ploughing. Most fallows could be eliminated since weeds could be suppressed by growing turnips provided they were hoed, while clover converted atmospheric nitrogen into nitrates in the soil. A third of the increase in arable productivity in northern Europe between 1750 and 1850 has been attributed to legumes such as clover. Turnips were also instrumental in reclaiming light land that had not previously been cultivated for arable crops. The new crops were often cultivated in a rotation where clover was undersown with barley, and turnips grown as a break between two grain crops. The ultimate expression of these principles was in the Norfolk four-course rotation of wheat, turnips, barley and clover, although the rotation was rarely practised in this pure form. Not all environments were appropriate for it, and even where soils and climate were suitable farmers usually wanted to grow other crops, such as oats to feed their horses.

Table 1 Estimates of wheat yields, 1520-1851 (ten year averages in bushels per acre)

<table>
<thead>
<tr>
<th>Year</th>
<th>Norfolk &amp; Suffolk</th>
<th>England</th>
</tr>
</thead>
<tbody>
<tr>
<td>1520</td>
<td>9-11</td>
<td>1750</td>
</tr>
<tr>
<td>1600</td>
<td>11-13</td>
<td>1801</td>
</tr>
<tr>
<td>1630</td>
<td>12-14</td>
<td>1831</td>
</tr>
<tr>
<td>1670</td>
<td>14-16</td>
<td>1851</td>
</tr>
<tr>
<td>1700</td>
<td>14-17</td>
<td>32</td>
</tr>
</tbody>
</table>

New Research

Most research into agrarian history published during the last 20 years or so contributes in some way to the discussion of these three ‘agricultural revolutions’ but most scholars have avoided direct entanglement with the debate. Taken as a whole, the conclusions of this research are equivocal; no single period emerges as the most likely candidate for the revolutionary label. Space precludes detailed discussion of the individual contributions but some examples may be given.

There is general agreement that Kerridge exaggerates his case for the period 1540-1673. More particularly it has been shown that while convertible husbandry did spread in midland England before the mid-seventeenth century, there was a reversion to permanent pasture after that date. This suggests that part of Kerridge’s agricultural revolution may not have been an enduring phenomenon. It has also been...
Other eighteenth-century improvements included the selective breeding of livestock, which changed the size and shape of animals, but more importantly improved the rate at which feed was converted into meat. The widespread introduction of machinery dated from the 1830s and 1840s, although earlier in the century the scythe replaced the sickle as the tool with which wheat was harvested. This change could double labour productivity (output per man) at harvest. Two other nineteenth-century ‘agricultural revolutions’ have also been proposed: the first dating from the 1830s when the import of feedstuffs and artificial fertilizers from abroad became common, and the second dating from mid-century when the heavy claylands of the country were underdrained using tile-drains.

Chambers and Mingay justified these post-1750 changes as ‘revolutionary’ because they estimated that an additional 6.5 million more people were being fed by home production in 1850 compared with 1750. (Population grew by 11 million, but the country switched from being a net exporter of food to a net importer). Although more land was cultivated, much of this extra food was the result of increased output per acre. Only by increasing land productivity could the country have escaped a ‘Malthusian check’ in which population growth outstripped the supply of food [Chambers and Mingay (1)].

Period 2 : 1650-1750

In a series of articles published in the 1960s A. H. John and E. L. Jones argued independently that rapid technological change in the form of cropping innovations took place in the century after 1650 [Jones (3)]. Although Jones was careful to avoid the phrase, subsequent authors have described these innovations as amounting to an ‘agricultural revolution’. In contrast with the following century population growth remained roughly static after 1650, so that the importance of the period lay in a rapid ‘transformation in techniques’. These led to increases in grain output per acre, and a rise in total output evidenced by rising grain exports. The processes by which output was increased were virtually the same as for the Chambers and Mingay post-1750 revolution: a rise in the fertility of the soil through turnips and clover and their associated crop rotations. The stimulus for change was seen as a run of sluggish grain prices which squeezed farmers’ profits. This caused them to keep more livestock, and more important, to lower unit costs of production by raising yields through the innovation of fodder crops. Landlords supported their tenant farmers and encouraged them to make improvements during this period. If tenant farmers went out of business and no replacements could be found for them, landlords would have been forced to farm the land themselves in order to maintain its condition. Jones also argued for a change in the regional geography of farming, since these new methods were most readily adopted on lightlands - principally the chalk downlands of southern England.

Period 3: 1560-1767 most before 1673.

These precise dates come from E. Kerridge whose Agricultural Revolution announced, ‘This book argues that the agricultural revolution took place in England in the sixteenth and seventeenth centuries and not in the eighteenth and nineteenth’ [Kerridge (4)]. Kerridge attempted to establish his claim by dismissing the significance of agricultural change after 1750, and by stressing the importance of technological innovation in the earlier period. He had three lines of attack on the significant features of the traditional post-1750 agricultural revolution. First, he argued that some of them did not occur at all - the mechanisation of farming in the eighteenth century for example. Second, he considered some features to be ‘irrelevant’ (including parliamentary enclosure, the replacement of bare fallows, the Norfolk four-course, and selective breeding). Third, he maintained that some technological innovations occurred much earlier, such as the introduction of fodder crops, new crop rotations, and field drainage. While some of these points are accepted (farming was not mechanised in the eighteenth century for example), few historians accept his cavalier dismissal of so many features as ‘irrelevant’.

After this demolition Kerridge then constructed an argument for an agricultural revolution in this period on the basis of seven criteria which form chapter headings for his book: up and down husbandry, fen drainage, fertilizers, floating the watermeadows, new crops, new systems, and new stock. Most emphasis was placed on up and down husbandry (also called convertible or ley husbandry), in which the distinction between permanent grass and permanent tillage was broken and grass was rotated round the farm, so increasing fertility. Once again the criteria are technological and Kerridge justified his claim for an agricultural revolution by pointing to the fact that domestic agricultural production coped with a doubling of the English population between 1550 and 1750.
shown that population growth ceased about 1650 [Wrigley (6)], and it has been suggested that this amounts to a Malthusian ‘preventive check’ in that food output was not keeping up with the increase in population.

The most recent verdict on the following period (1640-1750) in The Agrarian History of England and Wales Volume V is that a depression in grain prices prompted innovation and enterprise, but that the full harvest of this ingenuity in the form of an agricultural revolution was not to be reaped until after 1750. The view that this period witnessed the most significant changes is supported by recent work by historical demographers. This has shown that from the 1540s onwards there was a positive relationship between the rate of population growth and the rate of growth in food prices: when population grew food prices rose, and when population fell food prices fell. But then, during the 25-year period after 1781, this crucial relationship changed: the rate of population growth remained unprecedentedly high, but the rate of growth in food prices fell. This change indicates that there was some significant increase in agricultural production in this period. Dr Turner presents some corroboratory evidence in this issue of ReFRESH, in so far as he shows how increases in land productivity could be a consequence of parliamentary enclosure taking place after 1750. On the other hand, this is still a matter of controversy given that recent work by Crafts (see below) contradicts this, and suggests that growth in agricultural output was more rapid in the first half of the eighteenth century than afterwards.

Measuring agricultural change

These contradictory findings arise in part because of difficulties in measuring the phenomena under discussion. None of the arguments for the three agricultural revolutions outlined above is backed up by comprehensive statistics of innovation, yields, or output. Such estimates may be made in two ways; from the ‘top down’ and from the ‘bottom up’.

The former involve calculating rates of growth in agricultural output at a national level by the application of some basic economic assumptions. Agricultural prices are assumed to be determined by the interaction of the demand and supply of agricultural products. Thus the unknown supply (or output) can then be inferred from the available information on demand (represented by population growth) and on prices. Using such methods Crafts finds that progress was more rapid from 1700 to 1760 than in the latter part of the century, He calculates that agricultural output was growing at 6.2 per cent per decade between 1700 and 1760, but only at 4.5 per cent per decade from 1760 to 1800 [Crafts (2)].

‘Bottom up’ methods involve the systematic analysis of conventional historical sources (such as probate inventories) at the local or regional level. An example of this approach includes the calculation of crop yields per acre for two counties, Norfolk and Suffolk, together with estimates of the area and output of grain, for the period 1580-1740 [Overton (5)].

Table 1 shows these yield figures, as well as some national estimates for the nineteenth century. The most reliable estimates are those for 1801 and after, and unfortunately the figure for 1750 is little more than a guess. Nevertheless these figures are of considerable interest since all three agricultural revolutions place such strong emphasis on output increases brought about by yield changes. The Table suggests that until 1801 increases in yields were steady rather than spectacular; and the most striking feature is the apparent slowdown in the rate of growth in output per acre between 1750 and 1830. This is not to say that total output was not increasing. On the contrary it was probably growing rapidly as the arable acreage was increased, but average yields did not rise because more and more physically marginal land was brought into cultivation.

Statistics of innovation have also been produced, although again they refer to just two counties. Turnips and clover spread very rapidly amongst the farmers of Norfolk and Suffolk in the century after 1660; by 1720 half the farmers in the two counties were growing root crops, lending considerable support to the argument for an agricultural revolution during that period. Yet appearances can be deceptive. Although turnips were widely grown they were not being cultivated in such a way as to have much impact on grain yields -only some 9 per cent of the cropped acreage of the two counties was under turnips and 3.5 per cent under clover in the 1720s, whereas by the 1850s the percentage for both crops had risen to 20 [Overton (5)]. It is unlikely therefore, that the crops were introduced with the intention of cutting costs through raising grain yields as Jones argues; it is after 1750 that fodder crops become important in this way.

Processes of agrarian change

This evidence from Norfolk and Suffolk emphasises that the presence of new fodder crops is not in itself sufficient evidence for major technological change; much depends on how they were grown and in what quantities. In fact new rotations involving fodder crops were only one mechanism by which output could have risen. So it is important to distinguish four methods by which the supply of food could have increased:

(i) The area under cultivation could be extended so that more grain was grown. This does not necessarily involve any technological change, and it can only be a short-term solution for eventually the supply of land runs out. Although output increases, yields per acre need not rise and could even fall if lower quality land was brought into cultivation.

(ii) Agricultural inputs (such as seed, fertilizer and labour) could be increased so that existing methods of production are intensified. This need not involve any technological innovation, but would result in a rise in yields. In the long run, however, diminishing returns would mean that an
increase in inputs would result in a less than proportionate increase in output.

(iii) Through regional and local specialisation overall output could increase; farmers grew the crops that were most suited to the physical environment of their farm. Neither technological change nor an increase in the area cultivated need take place but the overall national output of food could rise.

(iv) Technological innovations of the sort already discussed could open the door to unconstrained increases in total output by raising yields per acre.

It should be evident that all four of these mechanisms were in operation, frequently in conjunction, during the centuries under review. For example, the introduction of the Norfolk four-course rotation to raise grain yields is unlikely to have taken place without an extension to the cultivated area. This is because a switch from a three-course rotation (wheat, barley, and fallow) to a four-course (wheat, turnips, barley, and clover) would reduce the grain area from two thirds to one half of the cropped area and it is unlikely that farmers would have introduced a new rotation to raise grain output if it involved a reduction in the grain area.

The concept of an agricultural revolution

All three agricultural revolutions under discussion lay strong emphasis on increases in agricultural output, and in two cases on its relationship to a growing population. It is clear, therefore, that this concept of an ‘agricultural revolution’ needs to take proper account of the mechanisms by which that increase is achieved, since it could be argued that some are more ‘revolutionary’ than others. Taking a long-term view for example, technological change (method (iv) above) that allows a continued upward spiral in yields is of more significance than an increase in output brought about by an extension to the cultivated area (method (i)). But given that the phrase ‘agricultural revolution’ is used simply to refer to a series of events and processes in a particular period which are held to be significant in some sense, there is no reason why the concept should not be applied to other facets of agricultural change: Two of these will be briefly mentioned here.

First, while the productivity of land has been much discussed, comparatively little explicit attention has been paid to the productivity of labour. Yet this is important because an increase in output per man is one of the means by which the post-1750 agricultural revolution contributed to the industrial revolution. If output per worker in agriculture rose, a greater proportion of the population could be fed by the agricultural sector, and so be able to work in the non-agricultural sector of the economy. No direct figures of labour productivity are available but some indirect estimates can be made. These suggest that output per man in agriculture may have increased by rather more than a third in the century before 1750 and that the pace then accelerated strongly in the following century.

A second theme is the change in the institutional structure of farming. In so far as this is considered at all, it tends to be through the agency of parliamentary enclosure, yet in some ways this may be a red herring. Not only could land be enclosed without act of parliament, but many important processes may well have been independent of parliamentary enclosure. This would apply, for example, to the increase in the size of farms, the concentration of land ownership, the replacement of owner occupiers by tenant farmers, the decline of farm servants, and the establishment of daylabouring as the normal mode of employment.

By the 1830s the three-tiered system of relationships between landlord, tenant farmer, and farm labourer had been established in much of southern England. Figure 1 shows the ratio of agricultural labourers to farmers not employing labour (i.e. family farmers). It therefore indicates the very considerable extent to which the agricultural labour force had been proletarianized in many areas in the sense that people were working on the land for somebody else rather than for themselves. As a commentator on nineteenth-century Norfolk agriculture put it, ‘There is nothing between master and man except work on the one hand and cash on the other’. This change may be regarded as revolutionary. Although it has been discussed in the literature it has received little prominence except in the writings of R. H. Tawney on the sixteenth century, and in the context of the debate on the social consequences of parliamentary enclosure in the eighteenth and nineteenth centuries.

A revolutionary era?

These new findings can form a basis for speculation about agricultural development in the three periods under discussion.

Before 1650 there seem to have been increases both in the area under cultivation and in grain yields, but output per worker did not rise significantly until the 1630s and 1640s. The productivity increase may have been due to the spread of convertible husbandry but it may well have resulted from increased inputs of labour under pressure of population.

During the century after 1650 new crops made a widespread appearance, but probably not in sufficient quantities to have made much impact on yields per acre. Output increases were probably due more to increased regional and local specialisation than to massive technological change.

After 1750 it appears that innovation may have slowed, and the rate of growth in output fallen, as land was converted to pasture with early parliamentary enclosure. After the turn of the nineteenth century more enclosure was for arable farming and, as Dr Turner points out, yields may not have risen because more marginal land was being brought into cultivation. On the other hand, output per agricultural worker was growing rapidly perhaps because of changes in hand tool technology (the scythe) and in the way agricultural labourers were employed.

From 1830 onwards yields per acre increased dramatically, giving a relatively rapid transition to the period of the mid-nineteenth century known as ‘high farming’. Innovation continued apace so that for the 18 English counties with data, the proportion of cropland under root crops almost doubled between 1801 and c.1850, from 11 per cent to just under 20 per cent.

which was the truly revolutionary era? The answer depends on how the concept of an ‘agricultural revolution’ is defined. In terms of output per acre the most rapid surge seems to have come after 1831; labour productivity showed a decisive rise after 1801; by 1831 English agriculture was capitalist in structure though sufficient data are not available to enable that particular transition to be charted in detail. The search for an ‘agricultural revolution’ is as much an exploration of alternative concepts of agrarian change as it is an exploration of the historical record.

References

(2) N.E.R. Crafts, British economic growth during the industrial revolution (Oxford, 1985)
(3) E. L. Jones, Agriculture and the industrial revolution (Oxford, 1974)