

The Development of Mechanization in English Farming

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ENGLISH farming is probably the most highly mechanized in the world. Accountancy studies show that even without farm motor-cars, vans, and lorries, most systems nowadays require more than £10 capital per acre in tractors and general tenant's equipment—almost one-third of the total working capital.¹ To equip a farm with these implements new would cost considerably more.

It is interesting to trace the development of this aspect of farming since the days of hand tools and ox labour. The plough has, of course, a very ancient origin; it was a common implement of cultivation in biblical times. Fitzherbert tells us that by the sixteenth century special types of plough were to be found in different parts of this country, but apart from harrows no other cultivating implements are referred to. In the seventeenth century attempts were made to improve the plough and to invent a seed-drill; Tull's is the best-known example. Tull also invented a horse hoe, and there are references to seed harrows and rollers in this century. But few of these inventions were adopted commercially, and by the time of the Hanoverian enclosures virtually all the implements on farms were hand tools, with the exception of ploughs and harrows, and waggons, wains, carts, or coups. This is made abundantly clear from the inventories which many peasants left behind them with their wills. An examination of a sample referring to the county of Yorkshire in 1688 and 1689 shows that most farms had ploughs, except in the dales where the land was almost all under grass. Similarly, harrows were almost universal in those districts which had any arable land. Frequently it is stated if they were ox harrows or horse harrows, and it seems probable from the numbers of each that horses and oxen were used about equally for harrowing.

There were very few waggons at this time in Yorkshire, but most farms had at least one cart, coup, or wain. In the Plain of York, Holderness, and on the Wolds, wains were more popular than coups or carts, but in the hillier districts the reverse was true, though many farms in the Dales had no vehicle

¹ See e.g. 'Types of Farming in Yorkshire', University of Leeds, Economics Section, Dept. of Agriculture, Farmers' Report No. 143, Table V, p. 34, and *Farm Incomes in England & Wales 1957/58*, H.M.S.O., Table 36, p. 55.

at all, unless it was a sled. The inventories make it clear that these implements were frequently dismantled on the farm, and there is a strong suggestion that they were commonly home-made. Thus, it is usual to find parts of the plough valued separately, such as the beam, the irons, handle, or stilts. On one farm, "plow timber" was valued individually.

It is not likely that harrows were ever taken to pieces: certainly no valuation of a part of a harrow has been found.

It was unusual to describe the wains, carts, or coupes. All were two-wheeled vehicles.¹ One seldom met a waggon and then only in the East Riding. A certain amount of specialization seems to have occurred, however, for one or two inventories mention hay carts, and less frequently a dung cart and a turf cart. Similarly, a muck coupe (with iron-bound wheels) appears once, and in another inventory a wain coupe. Most sleds are not described, but single examples of an ox sled, a great sledge, a hay sled, and a long sled occur. More interesting is the frequency with which parts of these vehicles crop up in the valuations. There are several entries of "pair of wheels," and sometimes these are entered as cart wheels, coupe wheels, wain wheels, and even sled wheels. Axle trees are often valued separately, and there are frequent references to "a gang of ffelkes," "a gang of spoakes," and to naves (naths or neffs), which suggest that many wheels were made on the farm. Occasionally a cart body or wain body was valued without its wheels and with the wain blads (shafts) as a distinct item. Most carts and wains had raves or shelvings to make possible a larger load at hay time and harvest; these were always valued separately, as were the shackles and bolts which went with them. Sometimes an entry "waine timber" appears, suggesting that the body as well as the wheels was to be built at home.

Beyond this very short list of implements, the seventeenth-century farmer relied on hand tools for cultivating, harvesting, and barn and yard work. These are usually entered in considerable detail. There was a variety of forks, described as hay, pike, half-pike, pitch, dung, dock, iron forks, and gripes. Other tools were shovels, spades, hacks, and gavelocks. The work which is now usually performed by the roller when the seed bed is being prepared had to be done by hand with the help of a moll (mell, maul, or mall). Hoeing was done with a hack, and the crops were bound to the wain or cart at harvest time

¹ According to Wright's *Dialect Dictionary* a wain was a long, narrow two-wheeled waggon; "an ox-cart without sides. The veritable wain, now never seen, was a narrow, long-bodied vehicle, with two wheels only, and these at the hinder end. The front or foremost end trailed along the ground (N. Yorks). A large ox-cart with an open body and furnished with shelvings (Marshall Yorks)." Constable's painting of a wain (in the National Gallery) shows a vehicle with two small wheels in front and two large wheels at the rear.

with ropes which were usually noted separately in the inventory. The grain after threshing was dressed with the help of what was usually described as a "window cloath," but sometimes as a "winding" or "winnow" cloth; a few inventories also included a "hand ffan." The grain was finally bagged up into sacks or pokes. (It is interesting to notice that in spite of the detail with which many of these small tools were entered in the inventories, scarcely once does a flail appear.) Sieves and riddles occur fairly frequently; there is some indication that each class of corn had its own size of riddle. "Sithes" appear more frequently than sickles, and ladders, grindstones, and wheelbarrows were sometimes mentioned. Scuttles, baskets, metts (which held variously 1, 2, or 3 bushels), maunds, skepps, and buckets were all in use, and, for other purposes, gavelocks (crowbars), hammers, wedges, axes, bills, and chisels.

Corn was sown from a seed hopper and hay was made with the help of a "sweath" rake in addition to the hayforks. The usual way of feeding fodder to livestock was by putting it into standhecks which stood in the yards.

Dairy equipment was usually valued in considerable detail. Most farms had either a churn or a cheese press, and many had both. Kitts, sayes or milk cans, siles or kiln hairs, kivers and kimblins, skeels and bowls and cheese fatts all played their part in the production of butter and cheese, and many inventories include cheese (as well as bacon and beef) in their total.

The work of the farm was shared by horses and oxen. Generally the harness worn in the plough teams was valued separately as "yokes" and "teames." Saddles appeared in addition and were sometimes identified as cart saddles, pack saddles, hackney saddles, load saddles, side saddles, and pillion seats. Other bits of harness which were each valued separately in some inventories were bridles, haimes, traces, back band, back haimes, and the girth. The swingle trees (sometimes described as "thorough trees" or "work trees") made the attachment to the plough or harrows.

As one might expect, the values at which these items were entered in the inventories were by no means uniform from farm to farm, but an approximate valuation is as follows:

Wains, waggons	40s. to 60s.
Carts, coups	20s. to 50s.
Sled	2s.
Plough	5s. to 6s.
Harrows	2s. to 5s.
Horse hoe (one entry only)	6s.
Standhecks	2s. to 3s.
Wheelbarrows	2s.

Ladders	1s.
Saddles & Bridles	2s. to 5s.
Wheels	2s.
Sacks, pokes	6d.

It was usual to refer to implements and equipment as "gear." The amount of the valuation depended on the size of the farm and, to some extent, on the system of farming. On the grassland farms of the dales and moors, gear often consisted of only a cart, or perhaps a sled, in addition to hand tools, dairy utensils, and harness. It was unlikely to exceed £3 in value and might easily be no more than £1. Elsewhere one or two ploughs, an ox harrow and a horse harrow, and a wain, besides hand tools and harness, were commonly found, with a range in value of from £3 to £8. The valuation of gear ranged from 3 per cent of the total of £45 in the Dales to nearly 8 per cent of £50 in the Industrial West Riding district and nearly 5½ per cent of £119 on the Wolds.

There was little incentive to introduce machines into farming when most of the land was held in strips in the open field, and when Young made his Northern tour in 1770 he found that waggons, carts, ploughs, and harrows were the only field implements used in Yorkshire.

The popularity of carts in some parts of Yorkshire and wains in others, which the inventories reveal, persisted one hundred years later. But in Holderness waggons appear to have superseded wains, though according to Arthur Young they were very paltry vehicles. Whereas in some parts of England the narrow-wheeled waggon, capable of transporting 90 to 100 bushels of corn, was giving way to a broad-wheeled waggon, the Holderness waggon would hold only 40 bushels, or at the most 50 bushels of corn. Leatham described the East Riding waggons as clumsy and heavy running. They needed 2 to 4 horses to pull them. The width of waggons was confined by statute to not more than 4 ft 6 in. between the wheels, inside measurement. This was too narrow for the size of the carriages, and there was a big danger of their overturning. Other disadvantages of these dimensions were their heavy draught and high rate of wear and tear. According to Young, waggons cost £15-£17, carts £10, ploughs 17s., and harrows 12s. Oak and ash timber was valued at 1s. 4d. to 1s. 6d. a foot, and a run of wheels of ash, £3 15s., which suggests that it was still usual to make some farm implements, or assemble them, on the farm.

The eighteenth century saw the introduction of some new machines as well as the improvement of others. Early in the century a winnowing machine was designed, and by 1770 one was made that cleaned and sorted grain. Before the end of the century, winnowing machines were in general use and cost £4

to £6 new. Experiments were being made with threshing machines in the 1780's. Some rubbed out the grain, others beat it out. A portable threshing machine was exhibited at the Woburn Agricultural Meeting in about 1800. The early models were all operated by horse labour, and it was not until the half-century that steam replaced horse threshers. The earlier types threshed only about 7 quarters of wheat a day compared with 60 quarters by a steam thresher. However, they needed a crew of only 5 men and boys, and 4 horses, compared with a dozen or more men with steam. And they worked much more quickly than a man with a flail, who would thresh no more than a quarter of wheat in a day. By 1841 threshing machines included most of their modern features, but it was only then that they replaced the flail on the majority of farms. By 1867 the advantages of the steam over the horse thresher were so great that the judges at the Royal Show recommended that prizes for horse-drawn threshing machines should be discontinued; in the 1880's a high degree of perfection had already been reached, so that for the last 80 years little change has occurred in their design.

Primitive kinds of seed-drill had been experimented with from time immemorial, and in the seventeenth century several drills had been designed or constructed. The most famous was Tull's which he built about 1700 on the principle of the organ. But throughout the eighteenth century drills were regarded with suspicion by most farmers. The reporter on agriculture in the East Riding in 1794 found that drills were very little used, and in 1800 in the North Riding they were employed only for sowing turnips and beans. However, the first decade of the nineteenth century found a big change in farming practice, and many firms consequently put drills on the market for the first time. By 1830 the two types, cup feed and force feed, had become established, and drills had already been designed which would sow seed in combination with manure. By 1860 most of the features of the modern drill had already been incorporated.

The plough has probably the longest history of any implement in Britain. By the end of the seventeenth century it had already evolved into its present form and, as the inventories show, it had acquired all the main features that we know it to have. During the last three hundred years its development has, in fact, been mainly in variations on the same theme, generally by increasing the number of furrows, or sometimes changing its application, as in the sub-soil plough, its type, as in the turn-wrest plough, or in the material from which it is made when iron superseded wood. The stimulus for double-furrow ploughs came through the shortage of labour, especially skilled ploughmen, in the middle of the nineteenth century.

The nineteenth century was notable for the steam plough as the twentieth

century is for the tractor plough. A system of ploughing with an endless steel rope moved by a windlass was patented in 1832 and by the middle of the century it was being used commercially; in 1867 it was estimated that 200,000 acres out of 12 million acres of arable were steam tilled. The subsequent depression in arable farming went against the development of steam ploughing, and during the 1914-18 war the advantages which tractors driven by internal-combustion engines had over it became apparent. It was not, however, until the 1939-45 war that the tractor became the almost undisputed source of motive power on the farms of Britain. Since then numbers of tractors have continued to increase so that there are now more than 400,000 in England and Wales. This represents considerably more than one per holding. Similarly, in 20 years the number of farm horses has fallen from 856,713 in 1938 to 167,000 in 1958.¹

Harrows have not developed greatly since the seventeenth century, though some specialized forms, such as Parmiter harrows for grass land, and spring tine harrows have been introduced. The scruffier, or cultivator, has emerged out of the harrow, and is an alternative implement to the heavy harrow for cleaning the land. One had been designed by 1808.

In the seventeenth century any working down of the soil which could not be accomplished by ploughing and harrowing had to be done by breaking the clods by hand with a beetle or moll. The first rollers were brought into use about 1800 and were made of wood, stone, or iron. Since then, wood and stone rollers have largely disappeared and the design has taken two forms, viz.: flat rollers, for consolidating land that is already in a fine state, and Cambridge or Crosskill rollers, for breaking down clods.

Although haymaking requires much human labour compared with most other enterprises, it was not until the middle of the nineteenth century that machines began to be used instead of manual labour on a wide scale. In the eighteenth century even the use of forks was regarded as a sign of indolence in the North Riding. From the beginning of the nineteenth century some progress had been made in inventing and introducing tedders and horse rakes, but the difficulties of using machines satisfactorily in grass fields which still showed the high ridges and deep furrows of their arable past for a long time militated against the introduction of haymaking machines in many districts. Moreover, although it was estimated that a horse rake would do the work of up to 20 men with "dew" rakes or sweath rakes, there was little point in investing capital that might be used elsewhere to save labour, which, for much of the earlier part of the century, was to be had in abundance. Labour

¹ The diminishing importance of horses is illustrated by the fact that 1958 was the last year for which official returns of their numbers were published.

had become scarcer when the grass mower was introduced about 1850, but the swathe turner did not appear till the latter part of the century, and the side-delivery rake in the first decade of the present century. Hay and straw elevators made lighter work of stacking in the latter part of the eighteenth century if conditions were favourable for using them, and in the 1920's hay loaders increased the rate at which hay was loaded (though they did not lighten the work).

Attempts to produce a machine to cut corn go back to the eighteenth century, and early in the nineteenth century various designs were tried out, but, with little demand, progress was slow. Bell's reaping machine, with reciprocating cutters and side delivery, was designed in 1828, and this, with others used in the U.S.A., became the prototypes of the modern binder, but the sickle and scythe were not finally replaced by it until the beginning of the present century.

By this time the idea of a machine to cut and thresh the corn simultaneously had already been conceived. Combine harvesters were not uncommon in California in 1890, but they made little appeal to British farmers until the 1939-45 war. At its outbreak, there were probably fewer than 100 in the country, but numbers rose rapidly and by 1958 had reached 40,000. A self-propelled combine represents one of the most expensive items of agricultural machinery, often exceeding £2,000 in cost.

Potato sorters date from the 'sixties of the last century, a potato digger from 1852, and a prototype of the spinner from 1855. Baird's potato planter was put on the market in 1857. But the problem of lifting potatoes without employing large amounts of hand labour still awaits solution. Mechanizing the sugar beet crop, which was introduced into the farming systems of this country only in the middle 'twenties of this century, has been more successful. Simple ploughs for lifting the roots have now largely been superseded by complete harvesters which top the crop, lift and clean it, and deposit it in loaders.

Machines for crushing cake were necessary when oilcake was bought in slabs three or four feet long. Since compound cakes in nut form, brought on to the farm in bags, have taken the place of straight cakes, cake breakers have fallen into disuse. The prototype of the chaff cutter appeared at the end of the sixteenth century, and early in the nineteenth turnip cutters and grain and cake mills were introduced. During the nineteenth century the larger farms installed steam or oil engines which were connected by shafting to the barn machinery. Early in the present century these gave way to the internal-combustion engine. As tractors replaced horses, they were often used for barn work too.

Towards the end of the century, cream separators came into use, and a milking machine was patented. It was not, however, until comparatively recently that machine milking became almost universal in all except the smallest dairy herds.

In the eighteenth and nineteenth centuries the produce of British farms for the first time was grown mainly for market rather than for the subsistence of the growers. At the same time, industrial machinery of all kinds was being introduced, and it was natural that thought should be given to inventing machines for agricultural purposes too. Until the middle of the nineteenth century mechanization made less headway than it might have done because of the surplus of agricultural labour for which employment had to be found, and many machines that could have saved labour were roughly handled by farm workers who feared that they might be displaced.¹ By the middle of the nineteenth century farm labour was becoming scarce, and the high price of horses gave an additional reason for introducing labour-saving machines. For nearly a hundred years from the middle of the eighteenth century farms became well equipped to make use of what horses and steam could do for agriculture. The design of many implements, such as horse ploughs, rollers, and threshing machines, during that time reached such a standard of perfection that little improvement has taken place in them since then. There was unfortunately little to encourage farmers to bring in new implements during the last quarter of the nineteenth century or the first years of the present century, for agriculture was either in a very depressed state, or was still suffering from the effects of depression. Moreover, labour was still cheap and plentiful. At the beginning of the 1914-18 war many able farm workers were still earning no more than 16 shillings a week in wages. The war and the Agricultural Wages Boards caused wages to rise by approximately double, but post-war depression induced farmers to follow those systems which would involve least expense, and there was no real change in the machinery situation up to the beginning of the Second War.

In 1937 the amount of capital tied up in implements and machinery, including farm tractors and motor-cars, on typical Yorkshire farms, was about £2 an acre. It varied with the type of holding. On cash roots farms in the Vale of York, whose system was both intensive and diversified, it was nearly £2 15s. an acre; on the large sheep and corn farms of the Wolds it was scarcely more than £1 15s. an acre.

The present-day implement valuation of all farms is very much higher. This is due partly to the higher degree of mechanization and partly to higher

¹ But in Yorkshire threshing by flail had become so unpopular that the introduction of threshing machines was welcomed by the workers.

prices. More farmers own cars now than in 1937, and although this is a tendency by no means confined to farmers, the fact that cars are used for personal as well as business purposes makes it wiser to exclude them from the post-war valuations for the purposes of this study. (It was not possible to do so before the war.) The valuation of implements and machinery, including tractors, on a group of cash roots farms in the Vale of York in 1957 averaged £14 15s. an acre; on the Wolds it was nearly 10 guineas an acre. Even if it is assumed that prices have risen threefold since before the war, the increase in real terms represents quite double.

What this amounts to in terms of machinery can be seen from the analysis of the purchases during the twenty-year period on one cash roots farm of rather under 200 acres. In 1937 this farm had the following equipment:

Cultivating equipment	5 ploughs, 3 sets of harrows, pitch pole harrows, Cambridge roll, scrufflers, one-row horse hoe, two-row horse hoe.
Drills	Corn drill, turnip drill, fiddle drill.
Haymaking equipment	Sweep, horse rake, turner, mower.
Harvesting equipment	Binder, potato sorter, and baskets.
Carts, etc.	2 waggons, 4 carts, motor lorry, trailer, shelvings and racks.
Barn machinery	Chaff cutter, mill, turnip cutter, weigh and weights sack lifter, cake crusher, winnowing machine, sack barrow.
Sheep equipment	Turnip cutter, racks, troughs, nets, and stakes.
Pig equipment	Huts and troughs.
Poultry equipment	Hen houses, huts, incubators.
Cattle equipment	Tumbrils.
Sundry equipment	Ladders, hay forks, muck forks, shovels, waggon ropes, scythes, hand hoes, push hoes, hoppers, wheelbarrow.
Horse equipment	Gearing for 4 horses.

The total valuation, including a motor-car valued at £45, was £459.

Twenty-two years later, in 1959, the valuation of machinery and equipment on this farm was £3,890, excluding the motor-car. Details are available of the purchases and sales of equipment in each year. They give a vivid picture of the growth of mechanization:

1937-38	New equipment	Cultivator, manure drill.
	Replacement	Trailer.

1938-39	Replacement	Sugar beet plough attachment, potato hand riddle.
1939-40	New equipment	Tractor, with plough, cultivator, and 3-row ridger.
	Replacement	Harrows.
1940-41	New equipment	Scruffler, 4-row root drill.
	Replacement	Horse hoe, harrows.
1941-42	New equipment	Potato lifter.
	Replacement	Harrows, binder, weigh.
1942-43	New equipment	Tractor, sheep rack, potato steamer.
	Replacement	Potato sorter.
1943-44	New equipment	Tractor lift unit.
	Replacement	Cart, mower, hay turner.
1944-45	New equipment	Cultivator.
1945-46	New equipment	Potato lifter.
	Replacement	Fertilizer drill, 3 carts.
1946-47	New equipment	Motor truck, tractor.
	Replacement	Tractor harrows.
1947-48	New equipment	Petrol pump and tank, cultivator.
1948-49	New equipment	Disc harrows, tractor plough, sack lift, potato row splitter.
	Replacement	Tractor.
1949-50	New equipment	Beet harvester, tractor equipment, weeder.
	Replacement	Tractor, manure drill.
1950-51	New equipment	Side-delivery rake, engine (for potato sorter).
	Replacement	Potato sorter.
1951-52	New equipment	Tractor, elevator, potato digger, fire extinguisher.
	Replacement	Trailer (replacing cart).
1952-53	New equipment	T.V.O. tank, weeders.
	Replacement	Hammer mill, trailer (for cart), 2 tractors, weigh.
1953-54	New equipment	Manure loader and bucket, 3-furrow plough, corn drill, fire extinguisher.
	Replacement	Tractor.
1954-55	New equipment	Fertilizer distributor, electric drill.
1955-56	New equipment	Beet thinner, beet topper, potato sorter, poultry troughs, nest boxes.
	Replacement	Fertilizer distributor, potato harvester
1956-57	New equipment	Tipping gear for lorry, motor pick-up, truck, rotovator, irrigation equipment.

- 1956-57 Replacement Sugar beet harvester.
1957-58 New equipment Rota hoe ($\frac{1}{2}$ share), buck rake, beet-top saver,
farrowing rails.
1958-59 New equipment Hay baler ($\frac{1}{2}$ share), irrigation equipment.

This farm has eight main enterprises, and because of the complexity of the system, a greater number of machines is required than would usually be necessary on a simpler system. On the other hand, nothing has been spent on grain storage or on a combine harvester, both items which represent high capital expenditure on many farms. It has not always been possible to distinguish between new equipment and replacements, but this distinction is significant only with the larger machines, like tractors, which could be followed through accurately. Sometimes a replacement has been by tractor-drawn for horse-drawn implement. The main features are the substitution of 4 tractors for 5 horses, for all the horses were disposed of during the period, and an increase in the total machinery inventory from £414 to £3,710 (exclusive of cars). How much of this can be regarded as the result of the rise in prices cannot be estimated accurately because so many of the implements valued at the end of the period were not in general use before the war, but the list of new purchases gives an indication of the high degree of mechanization which took place.

This is typical of the trend during the full period of this study. Once holdings were suitable by their size and layout for a higher degree of mechanization than the seventeenth-century farmer enjoyed, machines began to be used. It was fortunate that large-scale businesses were growing up at the same time, so that the advantages of factory production could be enjoyed in the manufacture of the more complicated farm machines. Two things were needed, however, before they were universally adopted: sufficient prosperity to induce farmers to sink the capital which the purchase of machinery involved, and alternative employment for workers who had under the old Poor Law regarded work on the land as their right—if their place of settlement offered nothing else. Both these conditions were fulfilled in the 1860's, and soon after it is probable that with the exception of harvesting machines and internal-combustion engines, most farms were as well equipped with as good machinery and implements as at the beginning of the First War.

Thereafter progress was comparatively insignificant until 1939. Apart from the four years of war, farming was depressed almost throughout the period, from the 1870's to the 1940's, and farm wages remained low. Moreover, arable farming, in which the effects of mechanization are most pronounced, was losing ground to grass land and livestock, and cheap imported

feeding stuffs lessened the advantage of reducing the costs of growing fodder at home by improved methods. The outbreak of war in 1939 changed all this. Arable farming returned to favour, horses were slow workers and expensive to keep, and there was no certainty that the armed forces would not take away a considerable proportion of the staffs. The money soon became available to buy tractors and numbers increased very rapidly. The disadvantages of using horse machinery behind tractors were soon apparent, and it became necessary to change all the field machinery to tractor-drawn types.

It may not be altogether easy to explain why the metamorphosis in this country has been so much more complete than in other countries. The larger size of most English farms has certainly been an important reason, and the increased prosperity of farming has made mechanization possible to a degree which could not have been thought of when farming was depressed. The need to equip labour with the tools for increasing its output in order to offset wage increases and shorter hours of work had its influence, too, though the number of workmen (unlike the farm horses) has not fallen significantly. This list of reasons would not be complete without mentioning the security which a high degree of mechanization gives to the farmer who fears lest he may be denuded of his workers. This was a real threat during the war, and many farmers insured against it by buying machinery. The effect has been to increase the tenant's investment to such an extent that capital is now a worthy partner with land and labour as a factor of production.