Advent of Machine Production

The conditions in the United States have always been favorable to the use of farm machines. There never has been a great surplus of labor in the country. This resulted in comparatively high wages, and provided the most important incentive for using methods of saving labor. During a great period of the nation's history, new land was being brought under cultivation and large areas were available for extensive methods. The topography, the soil, and other physical conditions were favorable to the introduction of machines. Compared with the farmers of other countries, American farmers have consistently had the money with which to purchase new equipment. Thus the development of the American plow, the invention of the seeding machines, and particularly the invention and manufacture of reaping and threshing machines, were stimulated by the favorable conditions for their use.

The shortage of labor following the Civil War encouraged in a most definite way the use of machines. A review of the development of farm machines indicates that the farmers of America used primitive implements for many decades, like the farmers of other parts of the world. An extremely

rapid change to machines was underway in the United States during the middle of the nineteenth century. This change is substantiated by the following statement which appeared in the twelfth census report. "The year 1850 practically marks the close of the period in which the only farm implements and machinery other than the wagon, cart and cotton gin were those which, for want of a better designation, may be called implements of hand production."

The United States census further emphasized the mid-century as the time of the general introduction of machines by the inclusion of information pertaining to the value of farm machines manufactured during the census years. In 1849, the first year in which the census included this data, the value of machines manufactured was $6,842,611, but in 1859, the value of manufactured machinery increased to $20,831,904. On Iowa farms, in 1850, there was $1,172,869 worth of machinery while in 1860 this figure had increased to $5,327,033. The reports for the later census years indicate a rapidly continuing increase in the value of machines manufactured.

The pioneer settlers of Iowa, as they drove their covered wagons over the early trails into the state from the East, had a few of the basic implements of farming in their outfits. The plow was often tied onto the side of the wagon, and elsewhere were to be found such hand implements as hoes,

scythes, grain cradles, flails, forks, and axes. These simple tools, together with a supply of seed, were essential to getting started with crop production in the Black Hawk Purchase, where settlement was largely concentrated prior to statehood in 1846.

The flat or gently rolling, fertile land of Iowa was particularly well adapted to the use of farm machines, but the first breaking of the native sod was found to be too difficult for the ordinary plow used in turning the old ground of the East. It was also found that the native grass could be killed by cutting a thin furrow slice like a giant ribbon and completely inverting it. The grass was thus killed and the tough sod rotted quickly. A most satisfactory crop of corn could be grown without cultivation by planting corn in each third or fourth furrow. After the first year the sod, if laid evenly and smoothly, was sufficiently rotted to be plowed and sown to wheat.

Special large plows were developed for the breaking of the raw prairie sod, and breaking for the most part became a contract job carried out by those with special equipment. In Iowa the cost of prairie breaking varied. In the 1840's from $1.50 to $2.00 was charged, while in 1855 the usual price in the more settled eastern counties was $2.25 per acre. By 1870 farmers in western Iowa paid as high as $3.00 to $4.00 per acre. It is reported that a large breaking plow, often with a

beam ten feet long and with a thin sharp share, a long landside, and long rods to receive and turn the furrow slice, did most excellent work with little attention from the plowman. Often as many as ten yoke of oxen were used, since these big plows required a great deal of power. After the breaking of the sod, the broad fields offered ideal conditions for the use of machines which made hand labor more effective.

The deep interest in farm machines in the early days of the state of Iowa is indicated by the fact that the Iowa State Agricultural Society of 1867 had a standing committee on the "Implements of Husbandry." An extended report of the committee is to be found in the annual report of the society for 1867 which for the most part is a description of the machines exhibited at the State Fair of that year, together with other particulars, such as the number of machines sold in the state, the capacity of the machines, and the cost of each.

The committee report revealed that there were 379 entries at the Fair in the several classes allotted to farm tools and machinery. It is stated: "These afforded an exhibition of great interest. Several acres were covered with labor-saving machines, which were the admiration of all beholders." Incidentally, the committee reported that the price of farm products, much to its surprise, had been maintained.

The report concluded: "The great mass of the

people would be delighted to enjoy the sight of the spectacle, presented to only twenty-five thousand of our people at the State Fair." In order to gratify them, the committee requested the exhibitor to supply information about each machine in the following particulars:

1. The name, style, and date of patent of the machine.
2. Can it be bought in Iowa; if not, where?
3. What can the machine do?
4. Its claim of superiority.
5. Amount of sales in Iowa in 1867.
6. Price and terms of payment.

The report covers some 55 pages of the *Report of the State Agricultural Society* for 1867 and includes ninety illustrations of machines. It is very clear that the Iowa farmer was interested in machines operated by horses rather than by hand. This author does not know of a better source of information pertaining to the farm machines of that period.

In 1934 Ray Murray, Secretary of Agriculture for Iowa, requested this author and C. H. Chase, Secretary of the Iowa Retail Farm Equipment Association, to prepare an article comparing the machines of 1867 with those used in Iowa in 1934, two-thirds of a century later. This article was published in the *Iowa Yearbook of Agriculture* for 1934.

Steam traction engines came into general use

following the Civil War. It is estimated that there were 24,000 on the farms of the United States in 1880, the number increasing to 40,000 in 1890, and continuing at about this number until 1910 when the number in use began to decline rapidly, as the gas tractor came into use. It is generally agreed that the use of steam power in agriculture represented a desire to provide a larger unit of power than was practicable with animals. These large units were needed to drive threshing machines and to some extent for the breaking of prairie land in the newer states. The main objection to the steam traction engine was its weight; also, the need of a fireman and often a water tender in addition to the engineer made it an expensive plant to operate.

In England it is reported that David Ramsay and Thomas Wildgoose attempted to build a steam plow as early as 1618 but gave up the effort because the steam engines experimented with were too heavy. More than two centuries later, equipment for a successful system of plowing with steam power came into general use in England and many steam plows were exported. This equipment, manufactured by the Fowler Company of England, consisted of two steam traction engines, each of which had winches mounted on them. These engines were placed at opposite ends of the field and pulled a double plow with two gangs back and forth by means of a cable. The gang not in use was carried high in the air.

However, it was proved that steam engines were not well adapted for agricultural uses, and mechanical power made little headway until the internal combustion engine became available. A liquid fuel, readily available from petroleum, made the gasoline engine particularly well suited to the farm. Stationary gasoline engines were introduced in a limited number before 1900 and increased in number until a few years before 1930 when tractors took over much of the work performed by the larger gasoline engines.

The internal combustion engine, on account of its automatic stoking and its lighter weight, was recognized as well adapted for a traction engine, or the tractor, a name now generally accepted. Two young Iowa farm men should be credited for much of the early development of the gas tractor. C. W. Hart, of Charles City, after attending Iowa State College for a year, changed to the University of Wisconsin where he met C. H. Parr of Iowa City. Both were interested in designing a tractor powered with a gas engine, and they became close friends.

Hart and Parr established a factory at Madison, Wisconsin, upon graduation in 1896. In 1898 they produced their first oil cooled engine which was later incorporated in their first tractor which was made in a factory at Charles City, Iowa, to which place they had moved. This early tractor was essentially a stationary engine mounted on a

chassis of structural steel carried on steel wheels.

The introduction of the gas tractor was one of the most significant events in the history of American agriculture, as the productive output of workers in doing field work was greatly increased.

The use of the gas tractor grew at a phenomenal rate after it was once accepted by the farmer. The United States census indicates that there were about 10,000 gas tractors in use on farms in 1910 and 246,000 ten years later. The number continued to grow rapidly until in July, 1949, it was estimated that the number of gas tractors in use on farms was 3,375,919 of which 232,344 or about 7 per cent were in Iowa.

There were a number of reasons why the gas tractor met with such favor. The internal combustion engine was a light motor; petroleum fuel became universally available at a low cost; and its machine equipment was made more universal in its application. It should be recognized that the rapid development of the automobile helped with the refinement of the tractor.

The gas tractor not only reduced the labor of crop production but made many millions of acres, then used for growing horse feed, available for growing food crops. The early attempts to substitute mechanical power for animal power consisted, in a sense, of making a mechanical horse with wheels for propulsion and guiding, instead of legs. This effort continued for many years.

Horses and oxen could be organized conveniently into various sizes of power units, a single horse could be worked alone, or a two-three-four or even a larger team could be used if desired. The tractor, on the other hand, was a power plant of a fixed size.

It was soon found that machines, such as the plow, the cultivator, and the planter, could be mounted on or carried by the tractor which enabled the tractor and machines to be controlled as a unit. Also, power for certain parts of the machine could be supplied directly from the motor through a suitable transmission called the power take-off. Such an arrangement made for efficiency in the application of power.

It is generally recognized that the development of the automobile was largely dependent upon rubber tires whose shock-absorbing capacity made higher road speeds practicable. The high road speeds for the self-propelled vehicles would be entirely impractical without the cushioning effect of rubber tires. A few pneumatic tires were tried on farm tractors about 1932, and the results were so satisfactory that immediately there was a rapidly increasing demand for such tires for tractor and farm machines. These tires made it possible to operate at higher field speeds and with greater comfort to the operator. There was also a reduction in the rolling resistance of the tractor and machines over the comparatively soft ground sur-

faces. The higher field speeds made it possible for a tractor of a given weight to do more work in a given time. In the short period of eight years, or by 1940, 90 per cent of the farm tractors were equipped with pneumatic tires.

The incentive to develop and use machines in agricultural production is clearly understood when the relationships between the various items of cost are established. Briefly this can be explained by the use of an equation in which the cost items for a unit of area, an acre for instance, are included viz:

$$C = L + P + M + Ld + S + Misc.$$

Where C = Cost of crop production per acre
L = Cost of labor per acre
P = Cost of power
M = Cost of machinery
Ld = Cost of use of land
S = Cost of seed
Misc. = Other miscellaneous items of expense such as storage, hauling, fertilizer, etc.

In some instances, the amount of the miscellaneous items may be considerable, such as expense for fertilizer, when used. In fertile areas well adapted to crop production the cost of the use of land, either by ownership or by rental, is the largest item. The next largest item is usually labor. A typical situation for corn production follows:

Labor — 6 hours @ $1.00	$ 6.00
Power — 35 horsepower-hours @ 8 cents	2.80
Machinery — Annual cost — 12½ per cent of a $16.00 investment per acre	2.00
Use of land — two-fifths of crop or $12.00 per acre	12.00
Seed — per acre	1.20
Other expenses	6.00
Total cost	$30.00

In contrast, in 1848 John Bangs of Henry County estimated the cost of an acre of corn, including plowing, marking off and planting, cultivating, and harvesting at $2.87½. On the basis of 40 bushels per acre, the corn cost 7 cents per bushel to raise. It was sold at 12½ cents, making a profit for the farmer of 5½ cents on each bushel.

This outline of costs is intended to emphasize the relationship and magnitude of the various items entering into the cost of producing corn in the central part of the Corn Belt. These are the items which concern the person interested in the engineering or managerial aspect of growing corn and in no way minimizes the importance of following a good agronomic practice.

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