The early settler furnished the energy for production under hand methods. Now the farmer directs machine labor, and boosts production accordingly.

21. The Role of Machinery in Iowa Farming

J. B. DAVIDSON, *Agricultural Engineering*

THE COVERED WAGONS THAT FOLLOWED THE GRASSY trails from the East into the Territory of Iowa carried precious cargoes. Besides food, clothing, and shelter that were to last until the soil could be made to produce, they also brought the basic tools of husbandry by means of which production could be started. The simple plows, hoes, scythes, cradles, flails, and axes, together with seeds for the various crops to be grown on the rich soil, represented the basic elements of the agriculture which was to make Iowa the leading agricultural state of the Union.

IMPLEMENTS

Farm implements used in Iowa in 1846 were for the most part simple ones. The plow tied to the outside of the settler's wagon was his most highly-developed implement. With such simple tools it has

TABLE 10

LABOR REQUIREMENTS FOR PRODUCTION OF ONE ACRE OF CORN—HAND METHODS, 1855
(Yield About 40 bushels*)

Operation	Equipment Used	Man Hours Labor
Plowing	Walking plow	5.
Harrowing	Harrow	1.2
Marking rows	Shovel plow	2.5
Planting	Bucket	1.2
Covering seed	Hoe	2.5
Harrowing	Harrow	1.2
Cultivating	Shovel plow	10.
Husking and hauling	Pegs and wagon	10.
Total		33.6

* *Power and Machinery in Agriculture*, U.S.D.A., Misc. Pub. 157, 1933.

been estimated that as late as 1855, it took a farmer thirty-three hours to grow one acre of corn. Today, using modern machines, the Iowa farmer can grow and harvest the same acre of corn in less than four hours (Tables 10 and 11).

The revolution in farming methods caused by the adoption of power-driven machinery has taken place within the one hundred years

TABLE 11
LABOR REQUIREMENTS FOR PRODUCTION OF ONE ACRE OF CORN—MACHINE METHODS, 1940
(Yield 60 bushels*†)

Operation	Equipment Used	Man Hours Labor
Breaking stalks	30-foot harrow	0.08
Plow	two 16-inch plows	.88
Disking and harrowing	8-foot disk and 10-foot spike tooth harrow	.34
Planting	4-row planter	.25
Cultivation	2-row, 3 cultivations	1.22
Picking	2-row picker	.83
	servicing equipment	.36
Total		3.96

* *Machinery for Growing Corn*, U.S.D.A., Cir. 592, 1940.
† *Mechanizing the Corn Harvest*, U.S.D.A., Farm Bul. 1816, 1938.

of Iowa's history. Not until 1850, four years after Iowa became a state, did the general movement begin to substitute machines for hand labor of the farm. The period from 1850 until World War I saw the replacement of simple hand tools by horse-drawn machines. As machines became larger and more complex, more and more horses were needed to pull them, and breeders began to produce heavier types of horses. Eventually, however, a limit was reached. Dependence on horse power limited both the size of the machines and the speed with which farm operations could be performed. With the invention of the gasoline tractor, these limits were broken down. Machinery, and the farmer, entered into a new phase of history.

Iowa's flat and fertile acres have so well adapted its farms to the use of machinery that today Iowa is the most extensive user of farm machinery in the nation. Its farmers have invested in farm machinery nearly one and a half times as much as farmers of any other state.

PLOWS

The prairie sod was so thick and tough that ordinary plows could not break it, and for a time it seemed that the riches of the soil were locked up. It took a plow with a long, sloping moldboard to do the

job. A thin, sharp share for cutting roots was welded to a low, long landside and attached to a beam by a combination wood and steel standard. The furrow was turned by a series of rods attached to the share, but curved in such a manner that the furrow slice could be slowly turned without breaking. A writer of the period described the machine thus:

> It is . . . like other plows but much larger, being 10 feet long and cutting a furrow some 22 to 24 inches in width. The fore-end of the beam rests upon an axle, with wheels, one of which runs in the furrow and gauges the width, acting like the wheel of the locomotive upon the rail. A level is attached to the fore-end of the beam, running back to the handles, which regulates the depth of furrow and throws the plow out when desired. When the plow is once set in, it needs no further attention in good prairie, as it runs alone, and the driver has only to attend to his team, which consists of some five yoke of oxen. . . It is considered best to break the ground as shallow as possible . . . the thinner the sod, the sooner it will rot. Often the farmer sends his boys to drop corn along every third or fourth furrow and corn is thus produced, with no further care, yielding 30 bushels to the acre. . . The next season the sod is well-rotted and the ground in prime order for wheat. In the meantime the immigrant incloses his fields . . . and erects his dwelling.

Since few farmers had breaking plows or the animals to draw them, the job was performed by contractors who charged about $2.25 an acre.

After the prairie was broken, farmers used to the iron plow of the East had trouble in Iowa's black soils. Farmers in Illinois had learned that a cast iron plow such as was used in the eastern states would not scour in the black soils of the Midwest. The manufacture of steel plows which would scour had been started in a small way as early as 1837 by John Deere and others. Such plows were made the principal product of a factory established by Deere in 1847 at Moline, Illinois, across the Mississippi River from Davenport. The location was intended to be a strategic one for supplying plows to the newly-settled Iowa farmers.

Cyrus Hall McCormick made a reaper in 1831 in Virginia, but by 1846 little progress had been made in the manufacture of reapers for general farm use. In 1836 there was an "almost unprecedented" devastation of the wheat crop by the Hessian fly in the middle states and Virginia and in 1837 a financial crisis seized the land. As a result development of the reaper had to wait. McCormick sold only six machines in 1842 and in 1848 it is reported that the "whole western output for the season did not exceed 50 machines." That same year, however, McCormick established a factory in Chicago, and the years following witnessed the formation of the McCormick Harvesting Machine Company, which became a part of one of the largest manufacturing concerns of the country.

Conditions in Iowa in 1846 were favorable to the rapid develop-

ment of farm machines which would substitute the energy of work animals for the muscular effort of the farm laborer or, in other words, "save labor." There were wide areas of fertile soil available for cultivation with little effort for preparation except breaking. Furthermore, labor was scarce. When the war between the states came, the demand for grain and its high price furnished a most effective incentive to grow grain in any suitable area from which the grain could be transported to market.

The first comprehensive record of the early machines used in Iowa during the early days of statehood is found in a report of the "standing committee on the Implements of Husbandry of the Iowa State Agricultural Society," published in the annual report of the society for 1867. The report indicates that there was much interest in farm machines on the part of farmers. The exhibit of farm machines was an important feature of the State Fair of that year, of which the committee had the following to say:

> At the recent State Fair, there were 379 entries in the several classes allotted to farm tools and machinery. This afforded an exhibition of great interest. Several acres were covered with labor-saving machines, which were the admiration of all beholders. At first it was the design of your committee to present, in a connected form, the various implements in general use by Iowa farmers, the amount paid for them, their advantages, etc., but it was found impracticable.

CORN PLANTERS

A heavy hoe was first used to plant corn by driving the blade of the hoe into the soil by a forceful swing, so that a quantity of soil could be lifted, leaving a pocket in the soil into which the desired number of kernels of grain could be dropped while the soil was held on the soil blade. A quick downward movement of the hoe placed the soil over the corn in the pocket. The final operation was that of pressing the soil over the hill of corn with the foot.

Hand corn planters were shown at the state fairs in the sixties. These planters consisted of a tube from two to three feet long with a wedge-shaped point which could be jabbed into the soil and then opened, leaving a hill of corn in the soil. Such planters saved little labor and the transition in corn planter development proceeded for the most part from the hoe to the horse-drawn machine.

One of the early successful horse-drawn corn planters was the Brown, named after its inventor, George W. Brown, of Galesburg, Illinois. This machine had two furrow openers into which hills of corn were dropped by a hand-operated mechanism. Two operators were needed, one to drive the team and manage the raising and lower-

ing of the furrow openers, and one to operate the dropping mechanism. The hills were spaced and placed in checked or cross rows by marking off the field by shallow furrows across the row, indicating where the hills should be placed. This machine was popular as soon as it was placed upon the market. Four hundred sixteen machines were sold in Iowa in 1867 for $70 each. By 1880, the wire-operated check rower was available and quickly came into general use.

Now, with four-row corn planters, more than four acres can be planted in an hour. On level fields the hills of corn can be checkrowed by a device using a wire with "buttons" to locate the hills. In some instances tillage equipment such as a cultivator may be used in combination with the planter, thus combining the operation of the completion of the seedbed with planting.

CULTIVATORS

The first horse-drawn cultivators were single or double shovel, one-horse implements. In 1867 two-horse straddle row cultivators were being manufactured with runners to give the implement stability. Later the runners were replaced with wheels, and soon provision was made for the operator to ride.

Today, on level fields four-row cultivators may be used. There is also a tendency to increase the number of cultivating units—shovels, sweeps, or disks—thus raising the effectiveness of the machine. With the higher field speeds of the tractor it is necessary to use cultivating devices that will not clog with trash or vines and which will not throw the soil into the corn plants.

HANDLING THE CORN CROP

The harvesting of ear corn with a machine was one of the last operations to be mechanized. The corn picker was an expensive machine and the early machines left too large a percentage of the crop in the field. Due not only to the improvement of the machines but also to the breeding of corn hybrids which were better adapted to mechanical harvesting, the corn picker has replaced hand picking except on very small areas. The conventional machine now harvests two rows and is either drawn by the tractor or is mounted on it.

The storage of the corn crop as ensilage became a recognized practice before 1900. In the making of ensilage the entire corn plant is reduced by cutting into short lengths and stored as a succulent feed in an air-tight silo. In early practice corn fodder was harvested in the field with a hand corn knife, and after hauling to the silo was chopped

with a stationary cutter. A first step forward in saving labor came with the corn binder which bound the fodder into bundles, thus reducing the labor and facilitating the handling of the fodder. The most advanced method now practiced is to chop the fodder as it is harvested in the field with a silage harvester. This machine is usually operated by power from the tractor engine transmitted through the power take-off shaft and delivers the silage to a vehicle—trailer or truck—drawn beside the harvester. The chopped silage is placed in a silo with a blower or pneumatic elevator; thus much of the arduous labor is eliminated. At the present time silage harvesting can be accomplished with less than one-half man hours of labor per ton while formerly about three to five hours were required.

HAYMAKING

In the early days of Iowa, haymaking was an operation performed entirely by hand. The grass was mowed with a scythe, raked by hand, and handled from the windrow with the pitchfork. One of the first machines to gain universal adoption was the mower. The report of the State Agricultural Society for 1867 indicated that the mower was one of the machines then being sold in large numbers. The price ranged from $110 to $195. The next machine added for haymaking was the dump rake, a comparatively simple and reasonably priced machine.

Following the dump rake came the hay loader and with the development of barn equipment for unloading, haymaking equipment became standardized about 1900. The small acreage of hay grown on the average farm made a large investment in this equipment unprofitable. During the past quarter of a century, only about three million acres of hay were harvested annually in Iowa, or an average of about fifteen acres for each of two hundred thousand farms. During the settlement period much prairie hay was harvested and stacked in the field, with sweep rakes to gather the hay from the windrow and stackers to lift the hay onto the stack.

With the labor shortage that became acute during the World Wars I and II new methods of conserving labor were introduced. Chopping hay in the field has come into general use. The reduction of long hay to the chopped form makes it possible to blow it into storage with a pneumatic elevator.

Another method coming into use and competing for favor with chopped hay is that of baling the hay in the field with a windrow pickup baler. This makes handling easier and requires less storage space.

A better knowledge of the nutritional value of feeds has led to greater appreciation of quality in hay. This has created a desire to be free from the weather hazards of curing hay by natural means in the field where frequent rains often result in low grade hay. Artificial drying is now being used. In one method green grass is converted into dry forage with a furnace type of dryer. In another form partially-cured hay from the field is cured by forced mechanical ventilation after it has been placed in the mow.

A popular machine with the early Iowa farmer was the self-rake, reaper, and mower combined. When used as a reaper the grain fell behind the cutter bar on a table from which the grain was raked at intervals and deposited in even gavels on the stubble. The self-rake and platform were removed when mowing grass.

HARVESTING GRAIN

The thresher at first was a stationary machine. Later it was mounted on a truck for transportation to the grain to be threshed. About 270 of these threshers were sold in Iowa in 1867. The machine was said to have the capacity to thresh three bushels of wheat per minute. The combined harvester-thresher saves about one-half the labor required by the binder and stationary thresher, thus reducing the labor per acre from six hours to about three hours under normal conditions. Other factors, such as the saving of the straw, may lead farmers to prefer the stationary thresher, however.

MILKING

Growing and harvesting crops is not, of course, the only farm operation in which the farmer uses machinery. The milking machine has come into wide use on dairy farms with herds of more than eight to ten cows. The machines, crude at first and difficult to clean, are now perfected so that with proper management the quality of milk they turn out exceeds that of hand milking. Although the saving of labor has not been more than about 7 per cent during the past thirty-five years, a much better product is obtained. Even more important changes have come in the handling of milk. Refrigeration which makes it possible to cool the milk, and pasteurization which reduces the bacterial content, extend the period that milk may be kept without souring.

POWER

The function of farm machines is primarily that of applying energy to farm operations. When hand methods prevailed, the worker

supplied the energy from his muscles. As a source of power, man is hopelessly outclassed. The amount of energy which a sturdy worker can supply is limited to about one-tenth of a horse power, and the cost of the energy supplied is excessive. The accomplishment of a farm worker is in direct proportion to the amount of energy directed. Thus a four horse plow will enable a farm worker to plow an acre in half the time of a two horse plow. The early settler in Iowa used work animals, mostly horses. Oxen were used to some extent in the early days of the state for breaking the native prairie, a type of work for which they were particularly fitted, when used in large teams. Oxen, however, were never used to the same extent in Iowa as in the eastern states. When the immigrant came to the state he wanted to travel faster than he could with oxen whose gait is about one-half that of horses. Since oxen are controlled by lash and command rather than by reins they were not so well adapted to the cultivation of a row crop such as corn. And since a man's output is determined by the amount of energy he can direct, the number of animals in the teams were increased with more extended use of machines. Thus Iowa became the leading horse-raising state. A survey of power used on the farms made in 1933 credited Iowa with more power than any other state. These sources of power are shown in Table 12.

TABLE 12

APPROXIMATE AVAILABLE PRIMARY HORSE POWER IN IOWA, 1930

Horses and mules	1,169,240
Gas tractors	1,523,934
Stationary gas engines	287,442
Trucks	816,725
Electric motors	55,602
Electric light plants	62,679
Combined harvester-threshers	8,750
Total primary horse power	3,924,372

The tractor has continued to grow in favor. The principal reason for this may be the advantage of the tractor in supplying the farm worker a larger power unit. Early tractors did not make as rapid an advance in Iowa as in small-grain states. These early power plants were not adapted to the growing of corn. They were more or less satisfactory for plowing but not suitable for other operations, such as planting and cultivating. In time a more versatile tractor was developed suitable for all the operations. During recent years the number of tractors has increased rapidly until Iowa today has a larger number

than any other state. This trend shows in the listing of the number of tractors in Iowa year by year, as follows:

1920	20,270	
1930	66,258	
1940	124,487	
1944	160,557	
1946	175,000	(estimated)

There have been many important advances in the agricultural practices of the state during the past century but none has been of more significance or has had a greater effect upon Iowa's agriculture than the extensive use of farm machines and power. The influence has been expended in many ways but one of the most noticeable has been in the increased productivity of labor.

For example, the labor of producing an acre of corn has been reduced to about one-eighth of the time required in 1855. The reduction of labor in the producing of other staple crops has been of a similar nature. Although the reduction of labor is of fundamental importance, there have been many other changes more or less dependent upon labor efficiency. The character of farm labor has changed. The laborer now directs the machine and its power, while under hand methods he furnished the energy. Farming is now "more a matter of brain and less of brawn." The length of the working days has grown less. Wages have increased and the living conditions surrounding the laborer have improved. The labor of women in the field is no longer needed.

Observers who have made a careful study of the influence of farm machinery on farm labor during the past century declare it to be significantly beneficial. The farmer is no longer "the man with the hoe" but a worker whose equipment not only relieves him of drudgery but stimulates his mental faculties, enables him to be a better citizen, and permits him to enjoy the larger measure of well-being which should come through increased productive efficiency.