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U. S. DEPARTMENT OF AGRICULTURE.

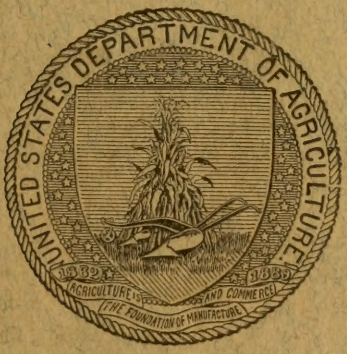
OFFICE OF EXPERIMENT STATIONS—BULLETIN 173.

A. C. TRUE, Director.

# CORN-HARVESTING MACHINERY.

BY

C. J. ZINTHEO,
EXPERT IN FARM MECHANICS.

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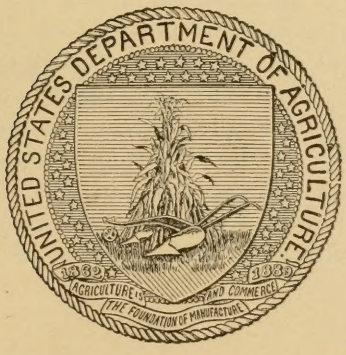


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**THE OFFICE OF EXPERIMENT STATIONS.**

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Elwood Mead, D. E.—*Chief of Irrigation and Drainage Investigations.*

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# LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Office of Experiment Stations,
*Washington, D. C., September 25, 1906.*

Sir: I have the honor to transmit herewith a report on Corn-harvesting Machinery, by C. J. Zintheo, of this Office. This report briefly sketches the history of corn-harvesting machinery in this country, describing in more or less detail the various implements and machines which have been used and are now in use, and discusses the economy of using such labor-saving devices.

On a large part of the corn land of this country the grain only is harvested, leaving the stalks in the field to be consumed by cattle to some extent, but principally to go to waste, and remain in the way of subsequent cultivation. In this way a large part of the food value of the corn plant is lost. The great object of the introduction of corn-harvesting machinery is to prevent this loss.

The report gives figures as to the value of corn fodder, and the cost of gathering it with the various machines described.

Such a report should be of value to the farmers in the corn-growing sections, and its publication as a bulletin of this Office is recommended.

Respectfully,

A. C. True, *Director.*

Hon. James Wilson,
*Secretary of Agriculture.*

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# CORN-HARVESTING MACHINERY.

## INTRODUCTION.

Corn was the earliest as it is the most important cultivated crop on the American farm. When the first colonists settled on American soil they found the Indians producing corn, and also preparing various foods from it. The first corn grown by white men was that of the Virginia Colony, at Jamestown, in 1608, and it is claimed that two Indians taught them how to plant and cultivate the crop. The product of this harvest served almost as the sole food supply of the colony. The early Massachusetts colonists, too, received their first lessons in corn cultivation from the Indians. The first fields cultivated by the settlers there were those which had been left vacant by the Indians.

The United States census of 1840 gives the corn yield for that year as 377,518,875 bushels. The following census (1850) places the yield at 592,000,000 bushels, with a corn acreage of 31,000,000. During the civil war little advance was made in the production of corn. In the year 1900 the United States alone produced 2,105,102,516 bushels, or about 75 per cent of the total crop of the world. In 1904 the yield of corn reached 2,467,480,934 bushels, and the acreage 92,231,581.[a]

It is only when compared with the production of other cereals that the importance of this crop is fully appreciated. At the present time one-fifth of the area in improved land in the United States, one-third the area in crops of all kinds except pasture, and one-half the area in cereal crops is devoted to corn. In 1899, while 35 per cent of the farmers of the United States raised wheat, 82 per cent raised corn. The total combined yield of wheat, oats, barley, rye, and buckwheat in the United States amounted in 1904 to 1,673,995,336 bushels, and the acreage was 79,649,720—these figures equaling two-thirds of the yield and four-fifths of the acreage of the corn crop. The farm value of the corn crop for 1904 was $1,087,461,440, while the combined value of the other crops mentioned for the same year was $877,120,785 or only 80 per cent of the value of the corn crop.[b] In 1905 the

[a] U. S. Dept. Agr. Yearbook 1904, p. 628. [b] Ibid., p. 629.

yield of the corn crop was 2,708,000,000 bushels and the value $1,116,700,000.

There may be, moreover, a double harvest from every field of corn—that of the grain and that of the fodder. There are thousands of farmers in the United States who in the last few years have doubled the profit they used to make on their corn crop, by harvesting the whole plant—stalks, leaves, and all—yet there are tens of thousands of other farmers who still "snap" or husk their corn in the field, letting the stalks and blades go largely to waste. It has been demonstrated beyond a doubt that when properly harvested corn fodder is as nutritious as good hay. The farmer who would receive the full value of his crop should secure this fodder with as much care as he gives his hay, taking care that it is harvested at the proper period, and not allowed to have the nutrients it contains leached out by rains or injured by frost.

The composition of the dry matter of the fodder corn varies greatly with the season. The yield of food material increases with the advancing age of the corn, the largest amount being obtained when the corn is well ripened. Feeding experiments have been conducted with corn fodder by which it has been determined that at least 45 per cent of the food value of the corn plant is in the stalk, and that the stalk can be cut at the time the ear is dented without material loss to the kernel. A mine of wealth is thus opened to those farmers who are in position to make use of this fodder.

For years we have had machines which successfully harvest, thrash, and clean the small grains, so that every part of the plants may serve some useful purpose. The machinery for the care of the corn crop has been much more difficult to develop than any other line of farm implements. Altho there has been considerable progress in the harvesting of corn, no such profound changes have been made as those in the harvesting of small grain. The larger part of the crop is still husked by hand from the standing plant, and the crop is but partially utilized. In large sections of the country only the ears are gathered, while the leaves and stalks are almost a total loss.

After the success of mowing and reaping machines, inventors tried to develop a corn harvester along the lines followed in the construction of those machines. The old methods of harvesting corn fodder were slow, expensive, and laborious, and the manufacturers have long sought to solve the problem. Their success is not as yet complete, but the labor-saving devices so far perfected have largely changed conditions. The corn may now be cut, husked, and shredded with less labor than the cutting alone formerly required.

## SIMPLE METHODS OF HARVESTING CORN.

### TOPPING.

As a stock food, both the ears and the stalk of the corn plant have been used from the earliest times. The Aztecs and the Peruvian Indian tribes practised topping corn for this purpose at the time they were conquered by the Spaniards. This method of securing fodder was followed by the early colonists and continued to be the common method until late in the nineteenth century. It is largely followed in Italy, and is still practised in many parts of the South.

Before topping corn it is necessary to allow the ears to pass the silking period in order to secure fertilization. If done before this the grain fails to develop. Soon after fertilization has been accomplished the silk rapidly turns brown, and when the kernels have past the milky state the corn plant is ready to top.

The topping was formerly done by a man who, with a sharp knife, past along the row of corn and cut off the top just above the ear, and also stript the leaves from that part of the stalk left standing in the field. The parts cut off were laid in small piles to dry and were afterwards tied into bundles. The bundles were set up in little shocks and left until the fodder was sufficiently cured, when they were hauled away and stacked near the feeding place. This feed was considered very valuable and was used for feeding the horses and oxen in the spring before the grass came, when the work animals had the hardest labor of the year to perform.

In regard to the advisability of topping corn, the Pennsylvania Station[a] found that, by topping, 1,050 pounds of fodder was obtained, at a loss of 540 pounds of ear corn, as compared with allowing the corn to ripen and merely gathering the ears. The Mississippi Station,[b] as a result of a three years' trial, found the net loss in feeding value more than 20 per cent. Seven other stations show an average loss which was "more than the feeding value of the fodder secured."

At the Arkansas Station[c] neither topping nor pulling reduced the yield so much as cutting and shocking the whole plant when the ears were just past the roasting-ear stage, as shown in the following table:

*Effect of method of harvesting corn on the yield of grain.*

| Method of treatment. | Yield per acre. | | Loss per acre. |
|---|---|---|---|
| | *Pounds.* | *Bushels.* | *Pounds.* |
| Left standing till ripe | 1,241 | 22¼ | ..... |
| Topt above ear | 1,224 | 21⅝ | 17 |
| Leaves stript | 1,102 | 19⅝ | 139 |
| Stalks cut and shocked | 1,075 | 19⅛ | 166 |

[a] Pennsylvania Sta. Rpt. 1891, pp. 55–60.

[b] Mississippi Sta. Bul. 33, p. 64.

[c] Arkansas Sta. Bul. 24, p. 120.

### PULLING OR STRIPPING THE LEAVES.

Thruout the Southern States the leaves of the corn plant dry up before the ears are mature, and the custom prevails of stripping the leaves from the stalk while they are still green and the ears immature. At least 8 experiment stations in the Southern States have investigated the influence of this practise on the yield of corn and in general report a decrease of 10 to 20 per cent. The earlier the work was done the greater the loss. Redding, of Georgia,[a] concluded that "pulling fodder" is only expedient under the most favorable circumstances; but where it is done the best practise is to strip the blades, from and including the ear blade downward, at about the usual time of pulling, and in a week or ten days to cut off the stalks above the ear. Besides adding largely to the yield of stover this method is believed to be more expeditious.

The Florida Station[b] reports that "pulling fodder" has the effect of loosening the husks on the ear before the grain becomes hard, thus promoting the ravages of the weevil.

### CORN CUTTING WITH KNIVES.

The unsatisfactory results which followed when corn was topt or stript, together with the extension of corn growing, led the farmers to seek a better way of securing fodder. This was found in the method, continued to our own time, of cutting the stalk close to the ground at a time when no damage is done to the ripening grain and while, at the same time, considerable of the saccharine juices still remain in the stalk.

The implement first used for corn cutting was the hoe, or something akin to it, and it continued to be used as late as the beginning of the nineteenth century. This was rather heavy and awkward to handle and the work of harvesting was slow and exhausting. The more progressive farmers discarded this crude implement and substituted the corn knife.

The diary of one early planter near Philadelphia tells the way in which the corn knife was first used on his farm. "The use of a sharpened blade for cutting corn was first begun by a negro who was rather lazier than the rest and always sought to escape the harder labors of the farm. He wrapt one end of a broken sithe blade with a cloth and, using this for a handle, was able to cut three times as much corn as he had cut with the hoe, and that with less fatigue."

Many kinds of blades were used for the purpose, but among them the sithe blade was most largely employed. It was customary to cut these blades in two parts. The knife made from the point of the sithe was considered the better. It was somewhat lighter in weight

[a] Georgia Sta. Bul. 23, pp. 81–82. [b] Florida Sta. Bul. 16, p. 8.

than that made from the shank end, and of better shape. Sometimes a shank was made by beating and hammering the upper end of the blade into proper shape, and sometimes by cutting away the thin part of the blade for a few inches. By many these old homemade knives are much preferred to the factory-made knife now almost universally used. The factory-made knives are of all sizes and shapes. The corn hook (fig. 1) now extensively used is generally considered even more convenient than the corn knife.

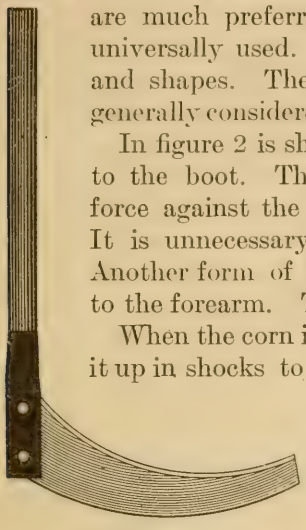


FIG. 1.—Corn hook.

In figure 2 is shown a form of corncutter which is fastened to the boot. This implement is pushed with considerable force against the stalks, severing them close to the ground. It is unnecessary to stoop over the work when using it. Another form of this implement is made so as to be fastened to the forearm. This form is very convenient for topping.

When the corn is cut with a corn knife, it is customary to set it up in shocks to cure. Shocks vary greatly in size, ranging from 6 hills square (36 hills to the shock) to 16 hills square (256 hills); a very common size is 12 hills square (144 hills). Shocks of the smaller sizes are common in the North Atlantic States, where, according to the Connecticut Station, it is more difficult to preserve flint-corn stover; while 10 hills square and 12 hills square are common sizes in the North Central States. A common method is to tie the tops of 4 hills together as they stand, and then to cut and shock the rest of the plants around these. This form is called a four-saddle shock. Another method of making the shock is to use a wooden horse as a temporary support. In either case the shock is built around the support with great care to prevent it from being blown over by heavy winds or damaged by rain. In some cases the corn is tied into small bundles which are set together to form the shock; more commonly the stalks are gathered as cut and set up an armful at a time. Where the wooden horse is used, the shock is built about the horse by leaning the first bundles or armfuls against a pair of projecting arms formed by inserting a pole thru a hole bored at right angles to the horse (fig. 3). When the shock has been set up the pole is withdrawn and the horse removed. When completed, the shock is tightly tied near the top. In the past shocks have been tied with bark or

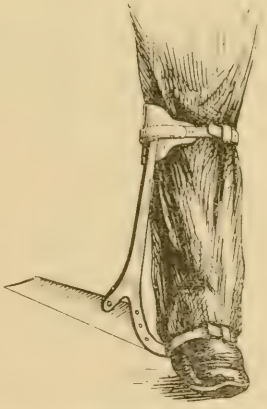


FIG. 2.—Foot device for cutting corn.

grass, or more commonly by means of a stalk of corn or two stalks twisted together; but now since twine has become cheaper it is extensively used. A rope with a hook at one end is sometimes used to draw the tops together before tying. Sometimes shocks are allowed to stand without being tied.

After the fodder has become cured, which usually takes about a month, the shocks are generally husked by hand in the field, and the stover is commonly tied into bundles, tho this is by no means a universal practise. The stover is then shocked up again. Frequently the stover from two or more shocks of corn is put up in a single shock. For convenience in husking a movable table is sometimes used, on which the stalks are laid while being husked. The ears are thrown in piles on the ground near the shocks, and afterwards hauled to the crib. The stover is sometimes hauled to the barn and stored but often it is left standing in the field till needed for feeding during the winter.

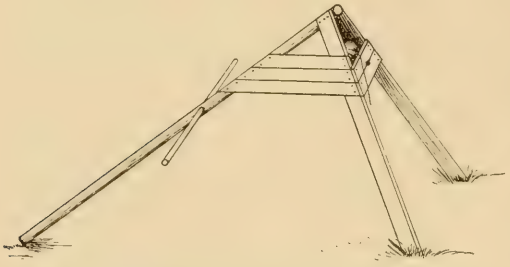


FIG. 3.—Wooden horse used to support shock.

It is important to choose suitable weather conditions for husking, since if the plants are too dry the stalks will break and blades will fall off and be lost. On the other hand extremely wet weather makes the ground too soft for hauling in the corn.

The cost of these methods of caring for the corn crop varies with the locality and the year. Taking the average of the replies to 200 inquiries, it has been learned that one man is able to cut and shock by hand about 34 shocks 12 hills square, or nearly 1½ acres of corn per day. The average cost per shock for cutting by hand is 6.5 cents, or $1.50 per acre.

The advantage of cutting the cornstalks and allowing them to cure in the field is strikingly illustrated in an experiment conducted at the Georgia Experiment Station.[a] One acre of land was laid off into 52 4-foot rows, and planted in corn. From 20 of these rows the leaves were pulled and carefully cured and weighed. This required the labor of four men during two hours, the cost being 40 cents, or $1.04 per acre. On the same day 16 rows were cut and shocked, which required the time of four men one hour, the cost being only 20 cents, or $0.65 per acre. The remaining 16 rows were left untouched until the ears were fully matured, when they were husked and the

[a] Georgia Sta. Bul. 51, pp. 280–281.

stalks were cut and weighed. On the same day the ears of the other lots were husked and weighed, and all the fodder was cut, weighed, and shredded. The following table gives the result of the experiment:

*Results of harvesting corn by different methods.*

| How harvested. | Shelled corn. | Blade fodder. | Stover. | Total value of product per acre. |
|---|---|---|---|---|
| | *Bushels.* | *Pounds.* | *Pounds.* | |
| 1. Blades pulled; stalks harvested | 47.24 | 585 | 2,012 | $35.18 |
| 2. Blades pulled; stalks not harvested | 47.24 | 585 | ..... | 27.13 |
| 3. Stalks cut and shocked | [a] 48.74 | ..... | 3,037 | 39.55 |
| 4. Ears husked and stalks cut when dry | 45.43 | ..... | 2,195 | 31.49 |

The total values are based on the following prices: Shelled corn, 50 cents per bushel; naked, weather-beaten stalks and husks shredded, 40 cents per hundredweight; the stover, including stalks, blades, and shucks from the shocks, 50 cents per hundredweight; cured corn blades, 60 cents per hundredweight.

The plats on which the stalks were cut and shocked yielded 1.5 bushels more than plats on which blades were pulled, and 3.31 [a] bushels per acre more than the plats on which the stalks were left untouched.

In discussing the experiment, Professor Redding says:

> The economic results are so strikingly in favor of the cutting and shocking method of harvesting the corn crop that there can be no further doubt of its great economy.
>
> The results of the foregoing experiment confirm the experience gained in the last five years in regard to methods of harvesting corn, and strengthen the conclusion already reached, that it is much more economical to cut the stalks down and shock them than to pull the fodder in August or to husk the ears in September or October.

## MACHINES FOR HARVESTING CORN.

### SLED HARVESTERS AND SIMILAR DEVICES.

As early as the year 1820 attempts were made to construct a mechanical corn harvester. From that year until 1892 all attempts to perfect such a machine were unsuccessful. The machines invented

[a] The larger yield of shelled corn from the plat that was cut and shocked should not be counted in favor of that method of harvesting. It is explained as follows in the Georgia bulletin just cited: "The increased weight of grain for the plats on which the stalks were cut and shocked can be credited to the fact that the ears left on both the other series of plats were drier, because fully exposed to the sun and wind. The cause of difference was overlooked at the time and until too late to remedy. * * * No gain in the weight of grain from the cut and shocked plats was expected, and the results would have been entirely satisfactory had there been a small loss as the result of cutting down the stalks."—EDITOR.

were patterned after the mower and the reaper, but owing to the size of the corn plant these machines either would not cut at all or were soon broken under the heavy strain. Some of the machines, however, had commendable mechanical features which were embodied in machines invented later.

Many homemade harvesting devices of the sled pattern have been made from time to time, some of which are illustrated in figures 4, 5, and 6. The first harvester of this class was patented by J. C. Peterson, of West Mansfield, Ohio, who put one in the field in 1886. Others followed and added improvements until eight or ten harvesters of this kind were in the field.

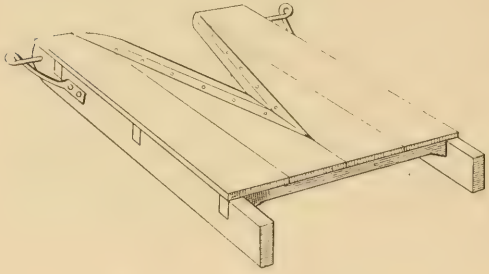


FIG. 4.—One-row sled harvester.

With most of the sled harvesters the driver rode on the platform, and it was necessary for him to gather the stalks in his arms in advance of the cutting edge, so as to prevent them from falling in various directions. This method of harvesting was very exhausting. The harvester shown in figure 6 was an improvement, in that the guiding arm collected the stalks on the platform and it was only necessary for the driver to pick the stalks from the sled at intervals and throw them on the ground. As an improvement, in order to reduce the draft, the sled was mounted on wheels (fig. 7). This machine cuts two rows at a time, and two men sit on the platform, one facing each row, to guide the corn against the cutting edge with one hand, and with the other hand and arm to collect the cut corn on the tilting-side part or wing of the platform, drawing it back against the leg, where it is assembled until enough has been collected to form a shock. The stalks are then tied together into a small shock, and the side platform is so tilted as to deposit it upon the ground in an upright position. This form of corn harvester is still used quite extensively. It has automatic knife guards by which the cutting edge of the knife is covered with a plate of steel when the machine is not in use. This lessens the danger of injury to men and animals, which often happens when the cutting blades are left exposed. The tilting parts or wings of the platform

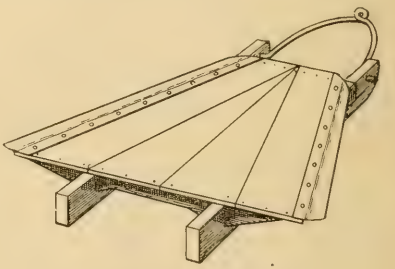


FIG. 5.—Two-row sled harvester.

may be raised into a vertical position to pass obstructions, or may be folded back against the seat standard. The wheels can be adjusted to cut corn high or low.

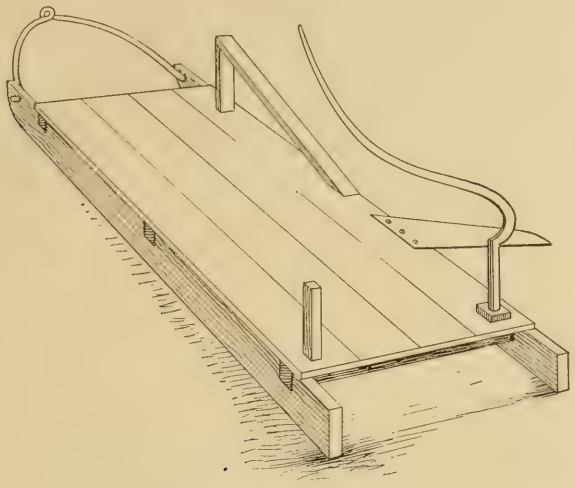


FIG. 6.—Improved one-row harvester.

To reduce the labor involved in cutting corn with the machines described, another form of corn harvester was invented, as shown in figures 8 and 9. This machine consists of two driving wheels, between which is mounted the frame for the driving mechanism and platform. It is drawn by one horse, which walks between the two rows that are cut at the same time. The dividers pick up the lodged corn, except

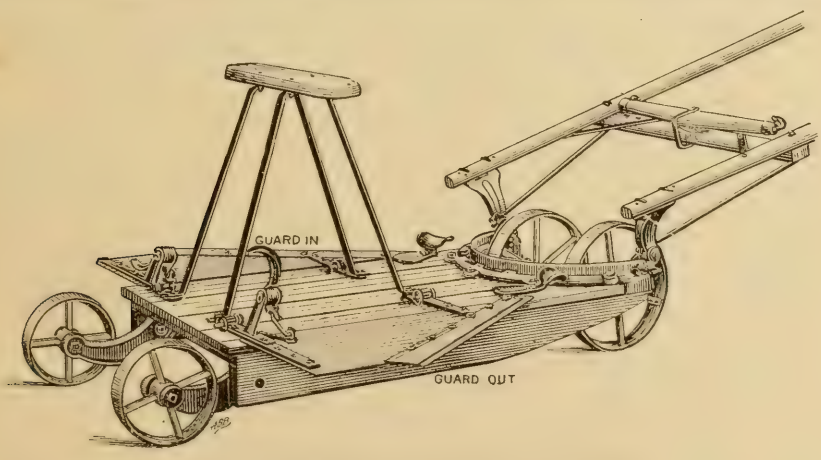



FIG. 7.—Corn harvester with automatic knife guards.

such as lies in the row of corn away from the machine, and guide it to the cutting apparatus, which consists of two stationary side blades, above which is a movable sickle, which cuts the corn and deposits it

horizontally on a platform that is elevated about 6 inches above the cutting apparatus. On the inner side is a guide chain, which assists in directing the stalks of corn to the knife and the platform. The rear part of the machine is provided with a small wheel, above which is a tilting lever, by means of which the dividers in front can be raised or lowered to gather up the lodged corn until it comes in contact with the endless chain, which carries it backward until it is cut and deposited on the platform, as shown in figure 9. The machine shown in figure 8 has low wheels and stationary cut, while the one shown in figure 9 can, by means of side levers, be adjusted to cut the corn from 2 to 15 inches from the ground.

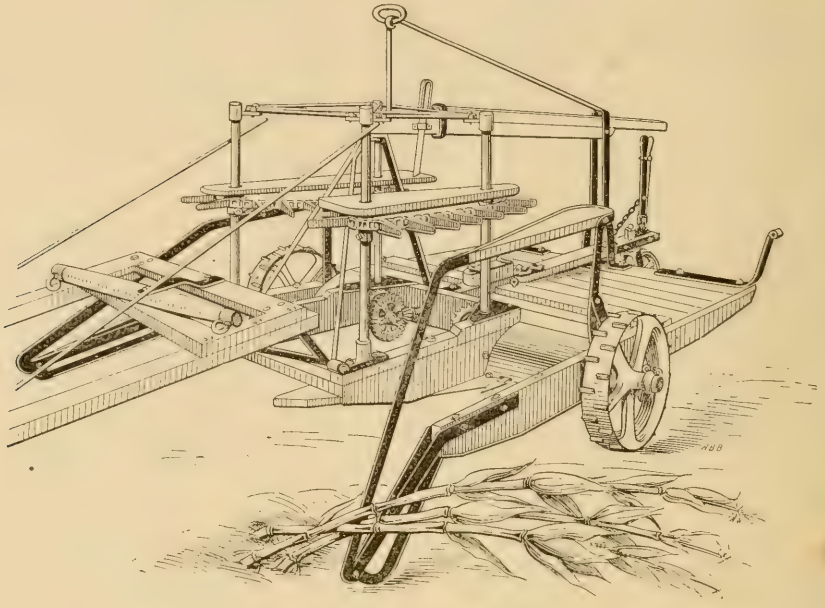


FIG. 8.—Two-row corn harvester with stationary lift.

Machines of this type gather and cut the corn and drop it on the platform. When there is enough to start a shock the horse is stopt and the two men who follow the machine gather the corn from the platform and set it up around the shock pole and tie it. They then start the horse again, and when returning across the field the horse is stopt opposite the shock, to which more corn is added, and this is continued until the shock is of the desired size. When the shock row has been started the shock pole is pushed in so as to be out of the way (fig. 8) while the balance of the corn is being cut. This will save carrying the corn around the pole. The machine may also be backed up to the shock instead of the corn being carried to it from the machine.

The sled harvesters and corn harvesters of the same type vary in price from $5 for the simpler forms, which are made at home by the farmer, to $55 for the more elaborate machines as shown in figures 8 and 9. These harvesters have one great advantage over the more complicated machines in that the first cost is low. For this reason every farmer, even with only a few acres of corn to cut, can afford to have one. It requires but one horse for motive power, and very little if any twine is used to tie the shocks. However, if the corn is tangled or lodged the cruder forms of these harvesters can not be used, as the corn must stand straight and the horse walk rather fast in order that the harvester may do perfect work. It is also rather hard work for the men to gather and shock the corn. The work of har-

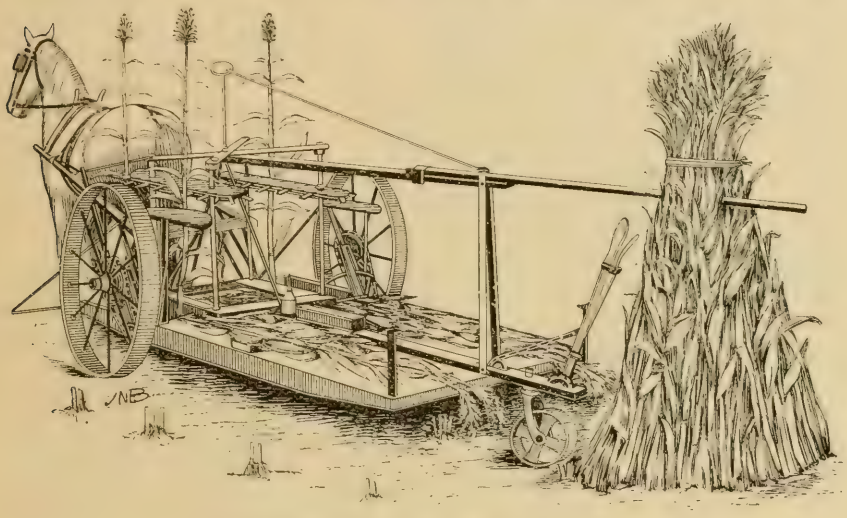


FIG. 9.—Rear view of two-row corn harvester.

vesting corn is such that only the best construction can withstand the strain for any great while, and hence these machines are being used less than formerly, even in those sections of the country where they were once extensively introduced.

In regard to the cost of harvesting corn with these machines the following questions were sent out to numerous farmers in various sections of the country where corn is raised:

1. With a sled harvester, how many acres of corn can be cut per day?
2. How much does it cost per acre to harvest corn with a sled harvester? (*a*) Cost of machine——. (*b*) Driver and team ——. (*c*) Twine ——. (*d*) Extra shocker ——.

From the 90 replies received in answer to these questions, it was learned that the minimum in acreage of corn cut per day is 2 acres, and the maximum 10 acres. The average from all the replies

received equals 4.67 acres of corn which can be cut per day by two men and one horse using the sled harvester.

In reply to the question as to cost per acre for harvesting corn, the minimum price reported was 55 cents per acre and the maximum $2. Taking the average of all the replies received, the cost of harvesting corn with a sled harvester is $1.18 per acre. This is estimated on a basis of 18 cents per acre, or 84 cents per day for the use of the machine and repairs; 4 cents per acre, or 19 cents per day for twine; 58.5 cents per acre, or $2.75 per day for one horse and a man who does part of the shocking; and 37.5 cents per acre, or $1.75 per day for the other shocker. Comparing this cost per acre with that of hand cutting (p. 46), it will be noted that there is a saving of 32 cents per acre in favor of the machines. It will also be noticed that two men and a horse, with a sled harvester, can cut and shock 4.67 acres per day as against 1.47 acres per day for one man with a knife, which gives a credit of 1.73 acres per day for the work of the horse, or a considerable saving in favor of the machine. The work may thus be done quicker than by hand, which is of importance, as the corn plant should be cut promptly just when it is ripe in order to obtain full benefit of all its nutrients.

## CORN BINDERS.

### HISTORICAL.

The credit of inventing corn-harvesting machinery belongs to Edmund W. Quincy, of Illinois, as he obtained the first patent on a corn-harvesting machine in October, 1850. "Old Father Quincy," as he became well known thruout the country, spent more than forty years of his life in efforts to produce a machine to pick corn, and during most of that time he lived in abject poverty, wandering from place to place pursuing the will-o'-the-wisp of promised assistance, using the money tossed to him as alms to construct his crude machines or to remedy their defects, going for days without food or shelter, faithful to his cherished plan until the end. His machine was essentially a field picker. Many other inventors worked like Quincy, on the idea of a machine to pass over the row and pick the ears from the stalks.

Another form of corn harvester (fig. 10) was invented in the "eighties." This machine cut the cornstalks and elevated them into a wagon, which was very convenient when the fodder was to be used for ensilage. The elevator could be removed and a binder attachment put on by which the corn was bound into bundles, these being left in the field to cure.

One of the earliest forms of corn harvesters and binders was constructed as a modified form of the grain binder. This machine also

was so constructed that for the binder attachment a device might be substituted to elevate the corn into a wagon.

The principle in corn harvesters and binders which was destined to prevail was invented by A. S. Peck, of Geneva, Ill., and patented January 5, 1892. It consisted of a corn harvester with the two dividers passing one on each side of a row of corn, which was cut and carried back in a vertical position to the binder attachment by means of chains and gathering arms. A standard twine binder was used, set in a vertical position so as to receive the stalks and keep them in this position until the bundle was discharged. The horses were hitched behind the machine the same as they are on the header or

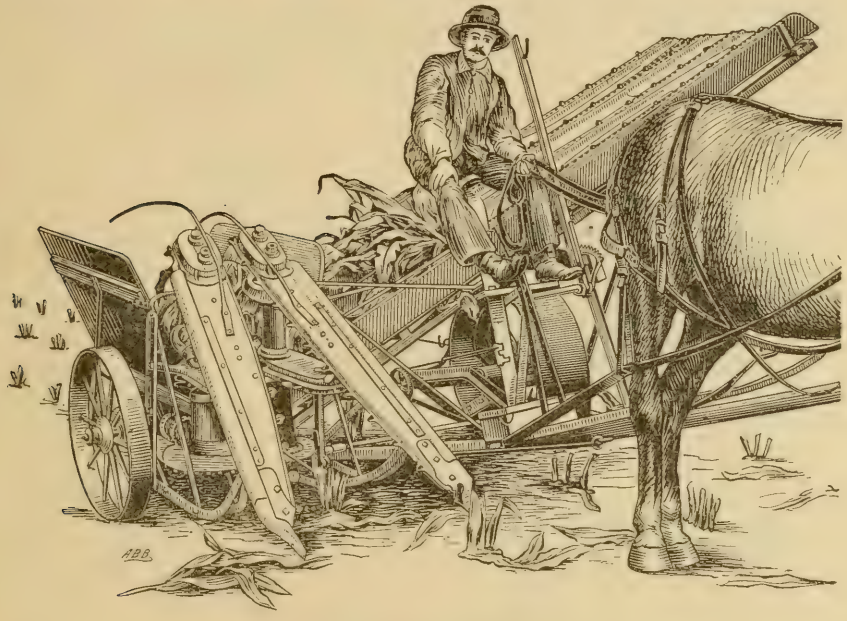


FIG. 10.—An early corn harvester.

push binder. The machine is shown in figure 11, in operation in the field.

The Peck patent received very little attention at first. It showed very few elements that were new, as the vertical principle of cutting grain had been tried and failed to give satisfaction. It was rather a rearrangement of well-known principles used in harvesting machinery than a new departure. Still it was the collection of these principles in proper form which produced a successful machine. After two years' use by the inventor and a few other persons, its merit was recognized by one of the prominent harvester manufacturers.

In the perfection of farm implements there are usually two stages of development. The first covers the conception of the idea and the

making of an implement that does its work satisfactorily in the hands of the inventor. The second stage covers the pioneer efforts to manufacture it and to introduce it into general use. The period from the first invention of the corn-harvesting machine by "Father Quincy" in 1850, until 1895, may be considered as covering the first stage of the development of corn-harvesting machinery, in which many machines were made that would work well in the hands of inventors; but almost half a century was required for the designing and perfecting of these machines so that they might be manufactured for general use. During this time much capital was lost in fruitless efforts.

Since 1895 the self-binding corn harvester has had a considerable sale. In practically all of the corn binders now built the features of the Peck type predominate. Even the most divergent forms still retain the general organization of parts used in the Peck machine.

FIG. 11.—Vertical corn harvester in the field.

Among the practical and successful corn binders in the market the widest divergence from the Peck type is probably to be found in the machine invented by John A. Stone, of Chicago. In this machine the binder is in an almost horizontal position, instead of vertical. When the corn is cut the stalks move a little rearward in an upright position, and then they are tripped so that the tops fall rearward onto an inclined deck, being guided in their fall toward the binder by curved guide arms. The butts are pushed out of the way of the incoming cornstalks, and are evened for a bundle by means of a butt adjuster.

A type of corn binder, which comes about halfway between those already described, was invented by Tarrall and Maul, of Batavia, N. Y. It is designed to occupy an inclined position over the deck for the purpose of binding the stalks in a semiprostrate position.

There are, therefore, three different forms of corn binder, namely, the vertical, the horizontal, and the inclined, the latter being rather a blending of the two preceding types. These machines differ only in the relative position of their elements, being composed of the same essential parts. Binders consist essentially of the dividers, of which previous mention has been made, and of cutting and binding devices. (See figs. 12, 13, and 14.) A bundle carrier is usually also attached, but this is not essential to the smooth operation of the machine.

DIVIDERS.

The dividers consist of two diverging jaws opening at the front of the machine. The jaws begin in two points at the front, but gradually widen vertically to where they join the frame of the machine,

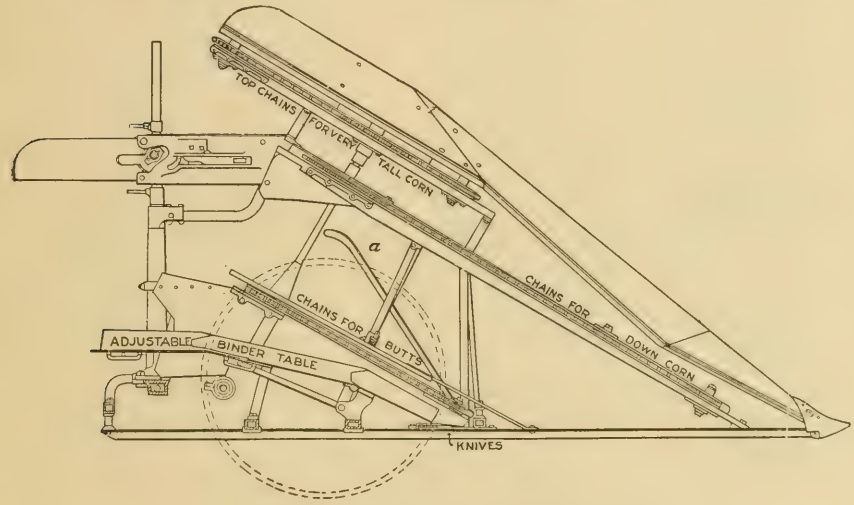



FIG. 12.—Skeleton frame of corn binder, showing chains.

when they have a width, or rather a height, of 4 feet or more. By an arrangement of levers the points may be raised or lowered. Attached to each jaw are two or three traveling chains, whose purpose it is to bring the stalks to a vertical position and carry them back to the binding deck. The chains are placed one above the other (fig. 12). The lower one is known as the short-corn chain, the middle one is the conveyor chain, and the upper one is the tall-corn chain. The middle chain passes around a sprocket wheel close to the point of the jaws, and extends back almost to the binding deck. The upper chain begins farther back and extends some distance over the binding deck. This chain is meant to carry the tops of tall corn. The lower chain is of about the same length as the upper one, begins nearer the point of the jaw, and does not extend so far back. These chains are

supplied with fingers, which take hold of the stalks and lift them to a vertical position as the machine advances. The jaws have such a position relative to each other as will bring the fingers of the opposite chains almost in touch with each other at or near the cutting blades. The chains receive their motion from the main driving mechanism, and are driven at such speed as will bring the stalks to the proper position for cutting without shaking them too severely.

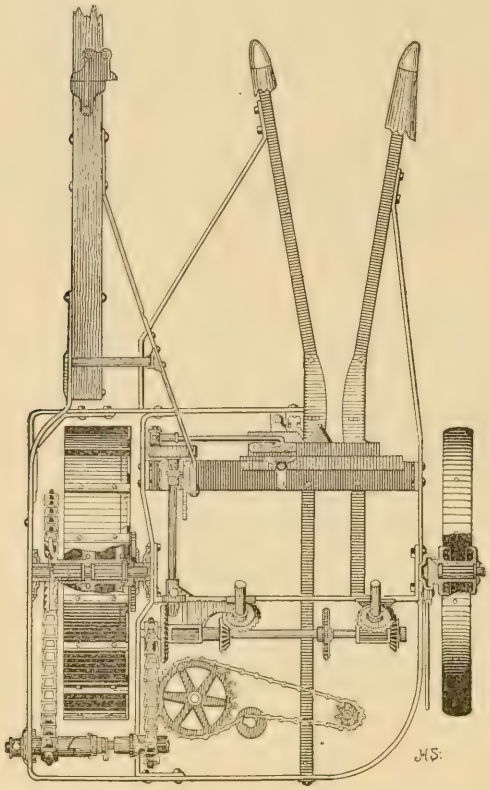


FIG. 13.—Frame of corn binder, showing mechanism for driving cutter knife, gear shaft for driving chains and binding device, and roller bearings.

CUTTERS.

The cutting arrangement consists of a serrated knife which passes to and fro across two stationary blades, one of these being attached to each jaw. This serrated knife is driven by a pitman attached to a weighted wheel called a "fly wheel." The added weight gives enough stored energy to sever the toughest stalks without shock to the small gear wheels (fig. 13).

Attached to the rear of the dividers and extending around the binding deck are several guide springs (fig. 11) which keep the tall corn from bending over and becoming entangled in the binding gear.

BINDING APPARATUS.

Just behind the knife and thence extending back to the bundle carrier, is the butt shoe, or butt carrier (fig. 12). This device carries the weight of the stalks after they are cut. It is fastened to the frame just behind the knife, but thru the rest of its length it is adjustable vertically, so that the binding twine may be placed at the proper place on both tall and short corn.

As the stalks are cut they are carried back by the conveyor chain, with their butts resting in the butt carrier until they reach the binding deck, where they are pushed backward by the packers, which have such a motion as will carry them perpendicularly thru the binding deck and parallel to it while conveying the stalks to the knotter. Their motion is more rapid than that of the chains, but

they have the advantage of yielding slightly while a bundle is being tied. This is important, as many ears would otherwise be knocked from the stalks by jamming the stalks behind the needle.

The needle and the knotter form the binding attachments. They are in nearly all cases of the same pattern as are those of the grain binders of the same makes, but are made heavier to meet the requirements of the work.

The packers on these machines (fig. 14) must have such a motion as to travel toward the back of the machine as long as they project above the binding deck, their travel thru the deck being fast and of short duration. There is one machine on the market which does not use packers at all, but has instead several chains with collapsing fingers. While the bundle is being formed, these fingers assume a position perpendicular to their chains, being held so by the guides over which they travel. As soon, however, as the needle moves, these guides no longer bear against the fingers, which collapse when pressure is brought to bear against them. This prevents their jamming the incoming corn against the rib of the needle while a bundle is being tied and avoids the breaking off of ears that would often occur otherwise.

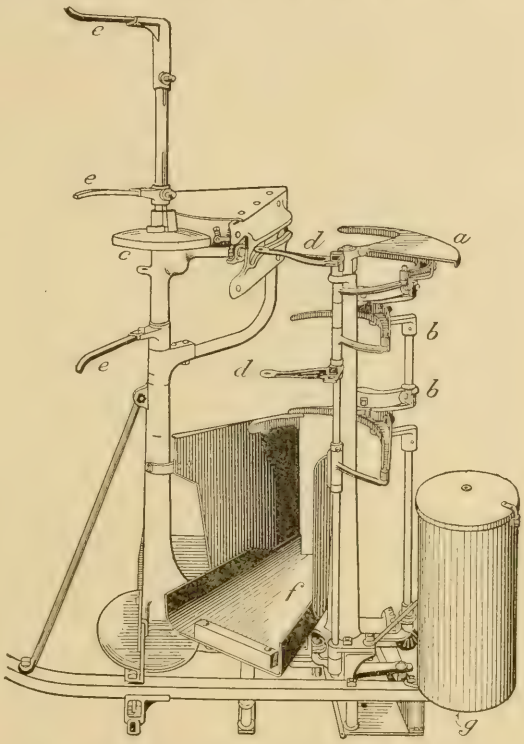



FIG. 14.—Binder attachment: *a*, needle; *bb*, packers; *c*, knotter cam; *dd*, compressor hook; *eee*, discharge arms; *f*, Butt table or butt shoe; *g*, twine cam.

When the bundle has been bound the two or three discharge arms on the binding shaft have reached the back side of the bundle, and by the continuous motion of the shaft the arms force the bundle off the deck and discharge it, after which the compressor hook returns automatically to its place and the binding shaft stops until another bundle is formed, when the operation is repeated. Figure 14 shows the binding mechanism and the general arrangement of the several parts referred to.

The parts that are adjustable by lever are the butt shoe, the dividers, and in some machines, the binding deck and knotter and needle. The whole frame of the machine may be raised or lowered by means of the two worm-and-pinion arrangements, one on the grain wheel and one attached to the main drive wheel.

In the vertical machine the binding mechanism has a vertical position; in the horizontal machine it sits horizontally on the frame, and in the inclined machine it is inclined.

In the horizontal machine it is necessary to extend a conveyor chain farther back than in either of the other types, so as to bring the tops of the stalks into a horizontal position. In this type, too, the bundle carrier extends in a direction parallel to the length of the machine. This arrangement is very apt to give trouble from the butts of stalks becoming lodged in stubble or soft earth and spreading the bundles in disorder upon the ground. This might be avoided more or less by giving the bundle a sharp toss, thus freeing the carrier before any part of it touches the ground. The fingers of the carrier are sometimes made free to move backward and forward so as to prevent the drag above referred to. On the vertical and inclined machines there is less danger of trouble from this source, as the bundle carriers extend across the path of the machine. The smooth operation of the carriers depends greatly on the skill of the operator. Too many bundles crowd the carrier and prevent the binding attachment from properly freeing itself, causing the leaves of the stalks in one bundle to become wrapt about the stalks in another.

The tall-corn chains may be removed where the corn is short or of medium height, and in clean fields of tall corn the short-corn chains are unnecessary. In short corn the lower chain has sometimes proven inadequate alone to properly convey the stalks to the binding deck. By the addition of a small iron rod or spring (shown at *a*, figure 12, p. 19) on each of the dividers, the choking of the binding gear is prevented and a more nearly perfect bundle is made. A short iron bar has also been added on many machines to serve the same purpose. This is usually placed in a horizontal position between the lower and middle chains. The dividers are adjustable vertically, allowing them to pick up corn that is lying flat upon the ground, the lever being in reach of the driver.

To protect the mechanism from the stalks of the uncut rows, a guide rod of hickory or other tough wood is usually attached to the dividers and extended as far back as is necessary. It may be raised or lowered independently of the dividers, however, so as to give protection against either tall or short corn. This bar is shown at the left in figure 15, and the tilting lever on the right.

Badly tangled fields make the progress of one of these machines slow, but it is remarkable with what precision the chain conveyors right the stalks. The adjustment is accomplished by tilting the machine forward or backward by the tilting lever, according to whether it is desired to lower or raise the points of the dividers. As the weight is almost evenly distributed on either side of the main shaft, it takes but a very little power to bring the dividers into the desired position.

There are two types of these dividers—the vertical (see fig. 11, p. 18) and the inclined (fig. 15). For the vertical it is claimed that little jostling is given the corn, decreasing the danger of knocking off ears, while advocates of the inclined pattern claim to accomplish the

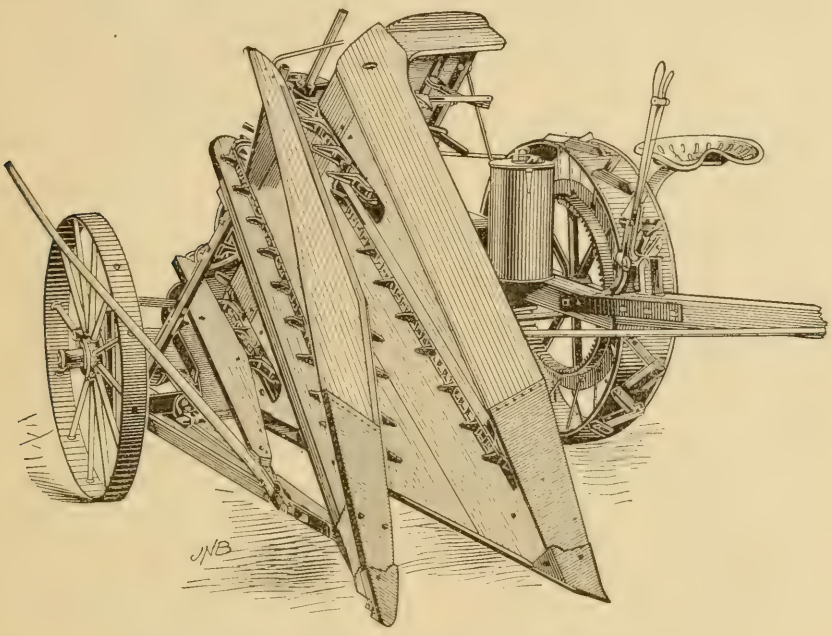


FIG. 15.—Inclined corn binder, showing tilting lever and guide rod.

same result by allowing the stalks to recline against the inner jaw and be carried backward between the fingers of the conveyor chain on that side.

Owing to the great variation in height of corn, even in the same field, the binding attachments are given great range of operation. In some machines they are placed as high as 32 inches. On machines of this range it is customary to have two needles, each covering half of the variation in the position of the knotter. With such a large range as this it is possible to tie the bundles sufficiently low without raising the stalks any great distance, thereby reducing the work required of the machine. In most machines the motion is taken

from the inside; in some, however, it is taken from the outside hub of the main driver (see fig. 13, p. 20). The arrangements for reducing friction and excluding dust from the bearings receive careful attention, as may be noted from the numerous roller bearings and brass-bearing boxes. Gears are also protected wherever possible, to prevent wear from dirt and grit. Where gears are not properly protected and oiled there is apt to be a great loss of power, to say nothing of the wear. When they receive careful attention, however, the power required to move them is reduced considerably below that required for chain and sprocket. The driving power is increased by means of lugs cast or riveted on the rim of the main drive (fig. 15). They are made of various shapes, the object of all being to sink into the earth in such a way as to prevent slipping. Tubing, angle iron, and bar iron are used almost exclusively in the construction of the frames. These give strength and lightness, features which are most essential to a perfect machine. The attendant, from his seat on the machine, has perfect control over all parts. The levers at his side operate all adjustments, and the position of the bundle carrier is controlled by a foot-lever attachment.

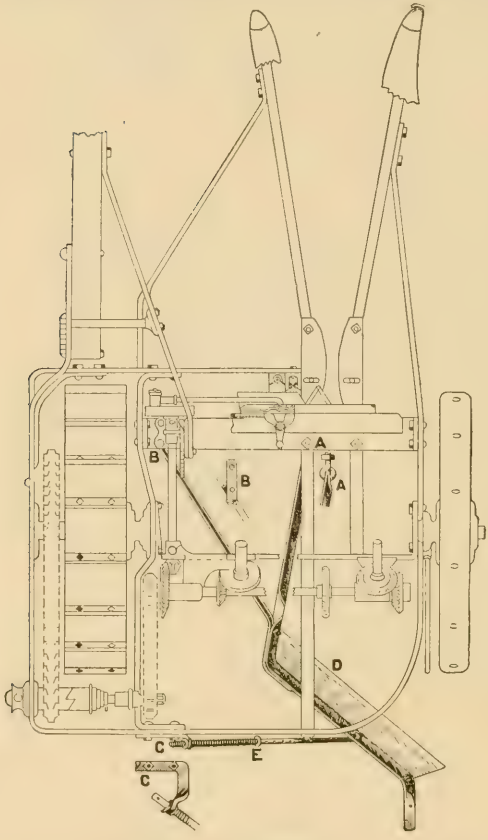



FIG. 16.—Corn-stubble cutter, attached to corn harvester.

These machines weigh, complete, from 1,400 to 1,800 pounds. Generally speaking, those weighing in the neighborhood of 1,500 pounds have been most successful, this weight seeming to give the proper relation between driving power and durability.

The corn binder is used to greatest advantage in fields where the corn is check-rowed, as it is possible to cut around a block, keeping the machine constantly in operation.

When the corn is cut high with a corn binder the farmer experiences considerable difficulty in getting rid of the corn stubble. In order

to obtain a clear field and to have the cornstalks cut close to the ground, an attachment has been invented as shown in figure 16. This knife is attached to the underside of the machine and floats on the ground, cutting the stalks even with the surface. The cutter (D) has a drawing, slanting cut against spring resistance (E), making a clean cut. When this attachment is used the binder is usually set to cut higher. The stubs, if cut when sappy, will decay quickly, and are left on the ground to form humus in the soil; and the ground may be prepared for the next crop with greater thoroness.

### DRAFT.

The following results were obtained in draft tests of corn binders made by the author at the Iowa State College:

*Draft tests of corn binders.*

| Binder. | Condition of soil. | Empty, out of gear. | Empty, in gear. | Cutting, not binding. | Cutting and binding. | Cutting and binding with rows as cultivated. |
|---|---|---|---|---|---|---|
| | | *Pounds.* | *Pounds.* | *Pounds.* | *Pounds.* | *Pounds.* |
| 1 | Medium soft | 351 | 328 | 465 | 480 | 496 |
| 2 | Dry | 372 | 415 | 575 | 600 | 592 |
| 3 | do | 290 | 332 | 492 | 496 | |
| 4 | do | 235 | 352 | 463 | 500 | 473 |
| 5 | do | 267 | 298 | 451 | 468 | 448 |
| | Average draft | 283 | 345 | 489 | 509 | 502 |

The average draft on corn binders is about the same as that of a 6-foot grain binder. The corn binder should, therefore, be propelled by three horses, the same as are required for grain binders. Draft tests of the corn binder, with a stubble-cutter attachment, shows the following results:

*Draft of corn binder with and without stubble cutter.*

| | Pounds. |
|---|---|
| Draft with stubble cutter | 437 |
| Draft without stubble cutter | 420 |
| Draft of stubble cutter | 17 |

### COST AND EFFICIENCY.

In order to obtain full information regarding the efficiency of corn binders, the following questions were sent out to numerous farmers using corn binders in different sections of the country:

1. How many acres of corn can one man and three horses cut per ten-hour day with a corn binder?
2. How many acres can one man shock per day after a corn binder?
3. How many pounds of twine per acre of corn is used when using a corn binder?
4. What is the life, in years or acres cut, of a corn binder?
5. What is the total cost per acre for harvesting corn with a corn binder? (*a*) Cost of machine ——. (*b*) Driver and team ——. (*c*) Twine ——. (*d*) Shockers ——.

The average results, taken from the several hundred replies received to this letter of inquiry, indicate that for all conditions of corn, the average number of acres of corn cut per day with a corn binder using three horses, is 7.73 acres. The average number of acres which one man can shock per day after a corn binder is 3.31 acres. The average number of pounds of twine used per acre of corn cut is 2.44. The average life in years of corn binders is 8.17, and in acres of corn cut, 668.77. The average first cost of corn binders is $125. The average cost of machine per acre cut, which includes price of machine, repairs, and interest on the investment, is 29 cents per acre; the cost of driver and team per acre cut is 46 cents, or $3.55 per day; the cost of twine is 30.5 cents per acre. The cost of shocking the corn after a corn binder is 44.8 cents per acre. This gives the total cost per acre of harvesting corn with a corn binder, $1.50.

The cost of cutting corn with the corn harvester and binder is, therefore, the same as the cost for cutting corn by hand, and 32 cents per acre higher than the cost of cutting with a sled harvester. This extra cost of cutting with the corn binder over the cost of cutting with a sled harvester may be attributed to the cost of the twine and the interest on the investment in the higher first cost of the corn binder. The corn binder has, however, proved a useful implement, the advantage over the other methods mentioned being the amount of work which can be accomplished per day and the general ease with which the work can be done.

One disadvantage which may be credited to the corn binder is that it knocks off more or less ears of corn, which either have to be picked up by hand, at a cost of about 10 cents per acre, or left to waste or to be found by the cattle after the field is cleared.

Farmers who have not sufficient corn to cut to make it profitable to purchase machines sometimes hire the work done at a rate of 75 cents to $1 per acre for the use of the machine, the driver, and the team. The average cost of cutting given above was 29 cents per acre for the use of the machine, and 46 cents per acre for the driver and team, or 75 cents per acre. The charge for hiring the work done is only slightly above this.

### THE CORN SHOCKER.

It is a curious fact that altho earlier efforts were centered upon the construction of the corn shocker, the perfection of this machine was delayed until after the introduction of the corn binder. In the first machines the inventor attempted to engage the stalks by extending rods or springs in advance of the cutting knives, but this did not prove as successful as did the dividers of the corn binder. With these the corn could readily be brought to an erect position and thus made into a perfect shock.

DESCRIPTION.

The present corn shocker was invented in 1888, and a machine was constructed that year by A. N. Hadley. It was built with a frame mounted on two wheels the same as the corn binder, and consisted of a corn-gathering device—revolving reels on vertical standards, the upper bearings of which were arranged for adjustment laterally, and fore and aft. It had as a cutting device two circular rotating cutters operating against each other and cutting the corn as the machine advanced toward it. Behind the cutting device was a circular rotating table 5 feet in diameter, upon which the corn was collected vertically to form a shock. On this table were several radial ribs, which aided in revolving the standing corn. In the center of this table was a rotating shock-forming standard having radial arms, around which the corn was collected. A revolving crane was mounted on the frame and a rope and pulley attached above the shock by which it could be lifted from the platform and deposited on the ground.

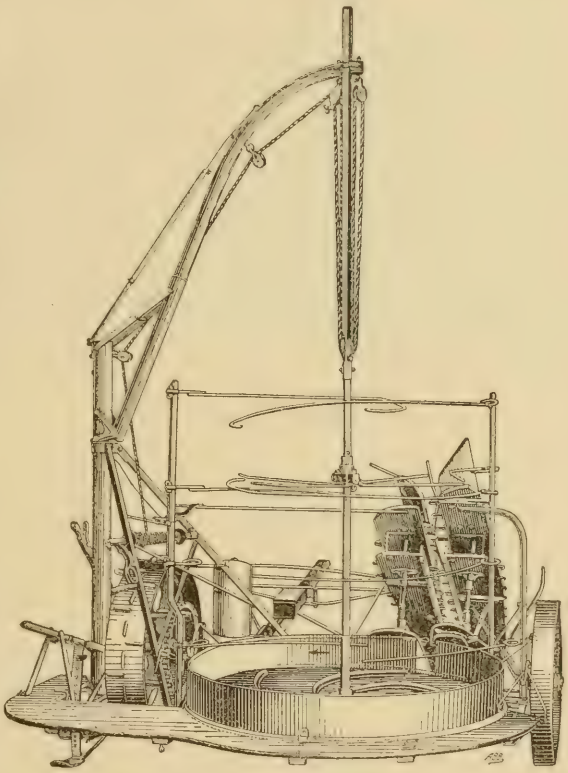


FIG. 17.—Corn harvester and shocker.

In 1893 a shocker was constructed by J. M. Shively, similar in principle but somewhat departing in its construction from the Hadley shocker in that the cutting apparatus and the dividers were like those of the corn harvester, and the retaining wall surrounding the shock-forming table was somewhat higher than that on the Hadley shocker.

The present form of shocker (fig. 17) consists essentially of the dividers already described in connection with the corn binder, a revolving table for assembling the shock, and a crane for removing it. The knives and fly-wheel attachment for cutting the stalks, and the

arrangements for raising or lowering the dividers, and the frame are similar to those used on the corn binder. The table revolves in the direction indicated by the arrow, and receives its motion from a bevel gear driven from the main drive and meshing into a rack on the outer edge of the table. As the machine advances the stalks are carried thru the opening in the guard band. They are then caught by the spiral plates and the arms and forced around the central post. The arms also revolve, receiving their motion thru the central pin from a gear located just beneath the table. Their motion is somewhat slower than that of the table. The guard or tension springs keep the stalks firmly compressed about the central post. Sometimes the twine is tied to one of the arms and allowed to assist in bringing the stalks toward the center by being wound about them as the arms revolve. This practise adds to the expense of operating the machine and does not materially improve the character of the work. At the outer edge are posts which support the tension springs.

When the shock is fully assembled on the table it must be tied by hand. The shock may then be raised from the table by turning the crank, and winding the rope about a spool. The shock must be lifted high enough to clear the retaining wall. The tension springs are swung aside and the crank acting on a sector gear swings the shock free from the machine, as shown in Plate I.

The arms (fig. 17), which are held in a horizontal position by the weight of the shock, are released the instant the rope is given slack. This release of the arms is brought about by a unique arrangement of a cam and pawls. When the rope is tight owing to the weight of the shock, the pawls are held in the grooves of the cam because the weight is carried from the pulley. When the rope is given slack the pawls are no longer kept from slipping out of the grooves in the cam, the shock moves thru a small arc of a circle and drops to the ground. The central supporting post is raised to its position on the machine, as shown in Plate I, figure 2. The whole operation of forming, tying, and setting a shock can be done in five minutes. The shocks are somewhat smaller than those ordinarily made where corn is cut by hand or with a binder, averaging about 100 hills per shock, but the smaller size is necessary and makes it possible to reduce the weight of the machine. The smaller shocks also tend to cure more rapidly. The adjustment of the frame admits of the low cutting of the stalks. This results in a greater weight of fodder per acre and leaves a short stubble that is easily turned under at the spring plowing.

### COST AND EFFICIENCY.

Corn shockers cost about as much as corn binders and weigh approximately the same. The wear and tear on the shocker is probably not so great as on the binder, and the former has the added advantage of

FIG. 1.—CORN SHOCKER UNLOADING THE SHOCK.

FIG. 2.—CORN SHOCKER RETURNING THE CENTRAL CORE.

requiring the work of but one man, whereas the binder requires, besides the driver, two or three men to follow and set up the shocks. The use of a corn shocker removes much of the hard labor of farming. Shocking corn is generally considered hard work and farm hands employed only for that purpose demand a good price for their services.

In order to obtain a comparison between the merits of corn binders and corn shockers for harvesting corn, the following questions were asked numerous users of corn shockers:

1. How many acres per ten-hour day can be harvested with a corn shocker?
2. What does it cost per acre to harvest corn with a corn shocker? (*a*) Cost of machine ———; (*b*) cost of man and team ———; (*c*) cost of twine ———.

From the replies to these questions and from personal knowledge acquired in the field, it has been learned that the corn shocker seems to be the machine that meets the requirements of owners of small farms who do most of their own work. It requires a man of more ability to run a corn shocker than is required in operating a corn binder, on account of the numerous movements that the operator has to go thru, all at the proper time, in removing the shock from the machine. The time of five minutes is about the average required for making the shock, half of this time being occupied in stopping the team, tying the top, lifting the shock, swinging the crane, releasing the core from the shock, and returning it to the table.

Recently patents have been issued for a horsepower lifting attachment for shockers, which consists of a folding tongue, to the top portion of which the whiffletrees are attached. To these is attached a cable, which is wound around a drum, the other end being attached to the lifting device. When the shock is ready to be lifted, a spring catch is released and the horses started forward. The machine remains stationary, but the forward movement of the horses lifts the shock by means of the cable, from the table. When the core has been returned to the table the horses are backed up to their former position, and the spring catch fastens the tongue in place ready for the forward movement of the machine. The addition of such a device will greatly reduce the work of the operator.

In the replies to the questions it is found that the average number of acres of corn which can be cut per day with a corn shocker, three horses, and one man, is 4.7 acres. The life of the corn shocker, in years and acres cut, has not been ascertained, but as the wear and tear is less than on a corn binder, the life of the machine ought to be greater. Assuming that the allowance for first cost, life of machine, and interest on investment is the same as that for the corn binder—i. e., 29 cents per acre; allowing $3.55 per day for driver and team, or 75 cents per acre; and estimating that the twine required per acre cut with the shocker will not cost over 2 cents, we have a total cost of harvesting corn with a corn shocker of $1.06 per acre. This com-

pared with the cost of $1.18 per acre for harvesting with a sled harvester, and $1.50 per acre for corn binders or by hand, gives quite an advantage in favor of the corn shocker.

The manual labor in harvesting corn is the least when using the shocker.

The shock made by the corn shocker is not so easily loaded on a wagon as is that made by a corn binder, as the individual bundles may be loaded with a pitchfork, whereas the whole shock made with a shocker can best be loaded at once, and this requires some form of loading device or horsepower derrick.

The corn binder is well adapted for cutting corn for the silo, as the bundles are bound into convenient size to be loaded on a wagon, thus saving considerable of the work necessitated by handling loose stalks in the field and at the cutter. However, this saving of labor is accomplished at the cost of twine, which remains around the bundles for less than an hour and is a total waste when cut. A corn shocker arranged to load the shocks on a wagon would no doubt prove the cheapest method of harvesting corn for the silo.

The general verdict of farmers who have used both the corn binder and the shocker is that the shocker is the preferable machine for harvesting corn.

### A CORN-SHOCK LOADER.

A loading device for handling corn shocks adds greatly to the value of the shocker, for with it the corn can be more cheaply handled than by the present methods. One of the first devices of this kind consisted of a long pole or pipe supported on a fulcrum at the rear end of the wagon in such a way as to give considerable leverage. The idea was much like that of the old well sweep with the semirotary motion added.

An improved loading device which can be carried along with the wagon or left in the field and driven about independently, has been invented (Pl. II). It is mounted on four wheels and consists of an adjustable vertical mast on which is a horizontal steel cross-arm. On this is mounted a traveling block fitted with pulleys, thru which a rope passes. To the end of this rope is attached a horse, which lifts the load. For loading corn shocks, a grapple fork is used, which is slipt under the shock. The grapple arms are closed and with the pull of the horse the shock is lifted up on the wagon and laid on its side or stood on end, the grapple arms being released by simply turning the handle of the fork. This machine was originally designed to load corn shocks, and it easily handles two shocks per minute, and will bear a stress of 2,000 pounds. It can also be applied to many other uses on the farm, as well as commercial uses,

FIG. 1.—CORN-SHOCK LOADER, LOADED.

FIG. 2.—CORN-SHOCK LOADER, EMPTY.

such as loading hay, manure, small grain, and other heavy objects on the farm; and for loading dirt, lumber, or telephone poles. Some form of loading device will greatly reduce the hard work on the farm and will be the means of rapidly introducing the corn shocker.

## CORN PICKERS.

In the so-called "corn belt," where corn is the principal crop raised, it has not been possible so far to utilize all of the cornstalks, as there is not enough live stock to eat them. The crop is raised for the ears, which are picked by hand at maturity. A wagon is driven along the rows of corn and one or two men walk along the rows, husk the ears from the stalks, and toss them into the wagon. It is estimated that 50,000,000 acres of corn are annually gathered in this way. This is somewhat tedious work. It is usually done after the other fall work on the farm has been finished, at a time of year when the weather is often cold and disagreeable. It is often difficult for the farmers to secure capable men to do this work at the time they are needed, even at good wages. To relieve them, inventors have been busy for over fifty years trying to build and perfect a machine to pick the corn from the stalks.

### DESCRIPTION.

The first machine for this purpose was invented by "Father Quincy" in 1850. The picking mechanism of his machine consisted of a revolving cylinder on which were placed four rows of projecting metallic fingers placed at such a distance apart as to permit of the passage of the stalks but not the ears; these were snapt off and were received on an inclined conveyor belt which discharged them into a spout, from which they slid into a wagon driven alongside of the machine.

Only a short time after the Quincy patent had been issued another one was given to William Watson, of Chicago. His machine was somewhat more elaborate than that of Quincy in that it was provided with a cylinder and concave designed to husk and shell the corn. Practically all of the corn pickers consisted of rollers inclining up, in such a way that the front end of the rollers would pass below the lowermost ears and rake the stalk from the bottom to the top. A great many devices were employed for removing the ears, such as cutters, gathering prongs, rotating toothed cylinders, roller and breaker devices, parallel vibrating bars, etc.

All of the early machines were designed to be pushed from the rear and were provided with some form of dividers to guide the corn to the snapping devices, as shown in figure 18. The snapping-roller type of corn picker received serious attention from manufacturers

about 1874, when the first machine of this type was invented, but it was ten years later that it was patented. The rollers were placed in the inclined position for the stalks of corn to pass between them. The end portions of the rollers where the stalks entered were provided with bars designed to aid in snapping off the ears as the stalks past down between the rollers during the advance of the machine. For the remainder of their length the rollers were so constructed as to tear the husks from the ears and continuously feed the ears along to be finally discharged, husked, onto a conveyor, and delivered into suitable receptacles. This particular machine was thought to promise success, but when the corn binders began to be developed and came into use the interest in corn pickers abated, as it was thought that with a successful corn binder there would be no need of corn pickers. However, the use of the corn binder and the shocker, while quite extensive, does not solve the corn-harvesting problem in the purely corn-raising regions, where a large share of the corn is still picked by hand from the stalks as they stand in the field.

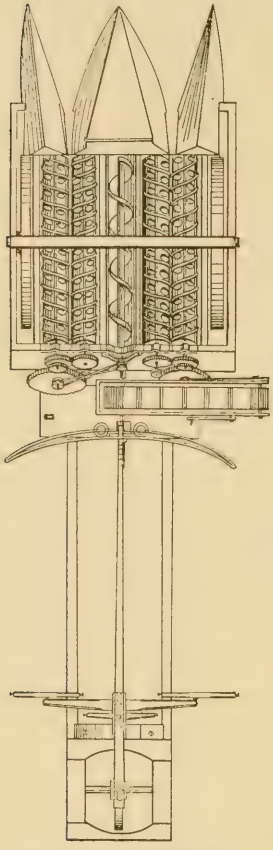


FIG. 18.—A corn-picking machine.

About 1902 the attention of manufacturers was again turned to corn pickers and several machines are now being introduced for picking corn. The corn picker as now constructed resembles the corn binder in the construction of the main frame, drive wheels, and dividers. It passes along the row of corn, which is straddled by the dividers, and the stalks after being righted by the points, chains, and other devices, pass between a pair of inclined, corrugated rollers that snap or strip off the ears. The rollers are positioned so that the ears fall naturally into a trough that extends along beside them. In order to provide snapping rollers to remove the ears and force them to fall always to the same side, yet permit free entrance of the upright stalks at the receiving end without the necessity of auxiliary means to bend the stalks laterally, James E. Goodhue arranged the snapping rollers in slightly skewed relation, by which the upright stalk may be gradually forced to one side as the picking rolls pass along, and the ears are broken off and directed to one side. The ears are carried back by a traveling conveyor and either delivered to a set of husking

MODERN CORN PICKER.

rolls or else, without being husked, carried by an elevator and delivered into a wagon which is driven alongside the machine.

Another form of modern practical corn picker has the guide chains with the usual prongs for straightening up the stalks. The chains form a stalk passage extending rearward thru the machine. A rapidly moving chain provided with fingers is located at one side and between the guide chains in such a position that as the machine passes over the row the fingers engage the ears on the stalks and snap them off. By means of a deflector the ears are directed to a receptacle from which they are carried to the husking rollers and thence to the wagon. The tops of the cornstalks are cut off, and by means of a conveyor this and other trash is carried to the rear and dropt on the ground. This machine is shown in Plate III.

### OBJECTIONS AND ADVANTAGES.

The corn picker is intended to remove the ears from the stalks, which are left in the field. Most of the machines are built on the assumption that the stalks are valueless, and therefore they are practically destroyed. It has not been possible to construct a picker that will not to some extent break down or tear down the stalks. This is somewhat objectionable because, where the corn is picked by hand, the dried corn leaves and stalks serve as roughage for cattle during the fall and winter. The machine has, however, this advantage, that the field can be picked quicker and the cattle turned in earlier to make use of the roughage before the snow falls.

Another objectionable feature of the corn picker as compared with the hand method of picking corn is that it shells considerable corn; and, if the corn is lodged and tangled, more or less ears are mist by the machine. The corn picker with the husker attachment requires considerable motive power, at least four horses being required to pull it. For this reason some manufacturers have dispensed with the husking attachment and depend upon the snapping rollers for removing most of the husks. Machines of this kind will remove from 25 to 75 per cent of the husks, depending upon the stage of maturity of the corn, the brittleness of the stalks, and the effects of freezing and damp weather. Where machines without the husker attachment are used, a stationary husker may be provided at the crib, in which the corn is husked and elevated into the corncrib.

There is a variance of opinion among the farmers as to the advisability of husking the ears clean. In the South the common practise is to leave the husks on the ears, and it is claimed that this practise tends to prevent injury by insects. In the North it is the common practise to husk the ears clean before they are cribbed.

The objections offered, in reply to inquiries, to using a corn picker which leaves the husks on the ears are that more crib room is required

for the ears; that they will serve to attract and harbor rats and mice; that the ears will not dry out, but will be liable to mold; that the husks interfere with the shelling; that, while for feeding cattle and hogs the husks will be advantageous as they will serve as a roughage, horses will toss the ears in trying to remove the husks, and thus lose ear and all. For selling purposes the corn needs to be husked clean in order to command the best market price.

The economic side of corn pickers may be profitably considered. The corn picker should last about as long as the corn binder, or 8.17 years, and pick about the same number of acres per day as can be harvested with a corn binder, or 7.73 acres. The first cost of the machine is, however, practically twice that of the corn binder, or on an average, $250. This makes the cost of machine, interest on the investment, and repairs equal to 58 cents per acre. The cost of driver and team is $3.55 per day, or 46 cents per acre. There is required two wagons with teams to remove the corn from the machine and deliver it into the crib, which, at $3 per day for each, costs $0.77 per acre, or a total cost of $1.81 per acre for picking corn with a corn picker.

To obtain a comparison between the machine and the hand methods of picking corn, the following questions were asked numerous farmers:

What is the average yield of corn per acre in your vicinity?

What does it cost per bushel, including board of men, to pick corn by hand from the field?

How many bushels of corn per day does the average man pick?

From the 300 replies received to these questions it has been learned that the average yield is 44 bushels per acre; that the average cost per bushel for picking corn by hand is 3½ cents, and that the average man picks 59 bushels of corn per day. This yield is considerably above the average given in the crop reports of the United States Department of Agriculture, but it represents the yield of corn in States where pickers are used. Considering now that the number of acres which the corn picker can cover per day is 7.73, this would, for the average yield, be 341 bushels of corn per day. It would require the time of 5.8 men to do the same work in the same time by hand as is done with the machine, at a cost of $11.93 for labor, but in addition to the wages of the men there is need of a team and wagon for every two men who pick corn by hand to haul the corn to the crib. These teams are worth at the very least $1 each per day, or three teams for the 7.73 acres would cost $3. The total cost for picking the same number of acres of corn by hand as can be picked with a corn picker, per day, would be $14.93, or $1.93 per acre, as compared with $1.81 per acre for machine picking. While the saving effected with the corn picker is not large, the use of a machine makes the farmer more

independent of the labor market, as the work may be done without hiring extra men at a time when they are hard to secure. But the advantage of hand over machine picking in the removal of the husks should not be overlooked.

The corn picker is still an experimental machine. There are a number of problems to solve before a wholly efficient picker will be produced. The advisability of a farmer purchasing a corn picker is a question which each farmer should decide for himself. He may safely follow this general rule in the purchase of farm machinery and implements of all kinds: A machine newly put on the market, no matter how promising, should not be purchased by a farmer on ordinary terms, because, even with the greatest care on the part of the manufacturer in designing and constructing the machine, weak points in operation and construction are bound to develop, which it will take the manufacturer several years to overcome. Not until the machine has been perfected should the farmer purchase it. It is best to allow the manufacturer to do his own experimenting. If special arrangement is made whereby the farmer is compensated for aiding the manufacturer in developing the machine, that is a different matter.

## ECONOMY OF CORN-HARVESTING MACHINERY.

The benefits to the farmer of using modern corn-harvesting machinery have been pointed out, but a question as to when these machines are really profitable should also be considered by the successful farmer, viz, how many acres of corn must a man have to harvest each year in order to make it a profitable investment for him to purchase a corn harvester or corn picker?

We have found that the average life of the corn binder is 8.17 years, and the cost $125. If a man has only 20 acres of corn to cut per year, the cost for the use of the binder for each year would be $15.30. To this should be added $7.20 for interest, making the total annual cost of the machine $22.50. Other expenses for cutting the 20 acres of corn, according to the previous averages derived, would be $9.20 for team and driver, $6.10 for twine, and $8.96 for shockers; or a total cost for cutting 20 acres of corn with a corn binder of $46.76, or $2.34 per acre. We have seen that the work may be done by hand for $1.50 per acre, and that by hiring a neighbor's team and binder at 75 cents per acre, the work may also be done for $1.50 per acre. We may then conclude that a farmer who has only 20 acres of corn to cut per year and does not intend to cut any for his neighbors would lose money by purchasing a corn binder.

If a farmer has 30 acres of corn to cut per year, the annual cost of the machine, including interest, would be 75 cents per acre. It will require a cut of at least 80 acres per year before the farmer can properly estimate the cost per acre for the use of the machine to be 29

cents, as already given. It may, therefore, be concluded as a general proposition that unless this number of acres is available for cutting each year, the investment in a corn binder is not profitable.

These estimates may not be exactly fair, because if the corn binder cuts but 20 acres per year, the life of the machine would probably be considerably longer than eight years. This would in a large measure depend upon the care the machine received. If left outdoors the wear and tear on the machine when not in use would be more than when used. However, with proper care it would last longer, and there is no doubt that in general half the money which our farmers spend for implements could be saved if they gave their implements better care when in use, and when not in use protected them in an implement shed from wind, rain, sunshine, and farm animals.

In the same way we may determine when it is advisable to use a corn picker. The price of these machines ranges from $200 to $325, but if we take $250 as the average price and the average life of the machine and acreage cut as previously noted, the cost per year for the use of the machine would be $30.59, and interest on the investment would be $15. To this should be added about $5 per year for repairs, or a total of $50.59 per year for the use of the machine. In order to make this machine a profitable investment it should husk at least 87 acres of corn each season. Circumstances may alter cases and different conditions change the problem, but in general it is better not to invest in expensive implements unless there is sufficient work in sight to make them profitable.

## CUTTING AND SHREDDING MACHINES.

The corn picker should be considered as a temporary machine for emergency use only until such a time as the American farmers will be able to utilize all of the food products grown on their farms. In many instances the great increase in the value of land has brought the farmers to realize that unless more scientific methods of agriculture are adopted and the wastes from the farms stopt, they are not going to realize proper interest on their investments in their farm land and equipment.

One of the serious wastes on the farm in the past has been the neglect of the use of the cornstalks. Thru the efforts of experiment stations the losses from this source have been determined and their enormity pointed out to the farmers. The best method of reducing these losses to a minimum has been found to be thru the use of the silo. It is not within the sphere of this bulletin to go into the details of the advantages of silos or of their methods of construction, but to describe some of the machines used in the preparation of the cornstalks for the silo.

The implements used for harvesting the corn plant have been described. An important matter to be decided in preserving the green-corn fodder in the silo is whether the corn plants are to be put into the silo whole or cut up into fine particles. The advocates of whole-corn silage claim that there will be smaller losses from fermentation with whole than with cut silage. No direct proof is, however, at hand, and the practise followed must be decided by the greater ease of handling the fodder as silage and the relative economy of one system or the other in the opinion of each farmer. The majority of farmers follow the practise of running the corn thru a cutting or shredding machine.

The feed and ensilage cutters used for cutting or shredding corn fodder for the silo and feed for other purposes are of various sizes, from the small hand machine shown in figure 19 to the large power-driven machine provided with self-feeder and blower attachment, as shown in figure 20. The term "fodder shredder" is sometimes erroneously applied to the husker and shredder. There is considerable difference between the two machines. The fodder shredder is similar to the ensilage cutter, being provided with feed rollers of large diameter between which the entire corn plant, ears and all, may pass to be converted into fodder or ensilage, as the case may be; or it can be used to prepare cornstalks for the silo or for fodder after the corn has been husked by hand. It differs from the ensilage cutter in that it is provided with a shredder head, as shown in figure 21, which may be constructed in various ways, but consists usually of a set of saw blades so arranged that they will shred the fodder into fine particles, whereas the cutter head is fitted with knives which cut the fodder into lengths ranging from one-fourth inch to 2 inches. These cutting devices are usually interchangeable, so that the user can put into the same machine either a cutter head or a shredder head, as best suits his needs or preference.

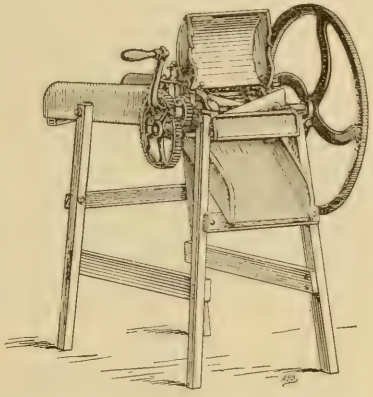


Fig. 19.—Cylindrical feed cutter.

These machines are provided with safety devices so arranged that the feed rolls can be stopt and started at will while the machine is running. This is quite an advantage, as it prevents the sacrifice of fingers, hands, and even of arms. They are also provided with friction safety balance wheels and devices for changing the length of the cut of fodder.

No accurate information is at hand as to the difference in power required for shredding and for cutting a certain number of tons of fodder corn. It is generally conceded that the shredder head requires considerable more power and must run at a higher speed than the cutter, but the recent improvements in shredder heads have materially reduced their necessary speed. Machines of great capacity are now on the market shredding as high as 25 tons of fodder per hour. In the better forms of shredders the feed rollers are speeded at about 160 revolutions per minute, while the cutter heads are usually run at from 600 to 700 revolutions per minute, and shredder heads at about 1,000 revolutions per minute. The power required to run the machines is from 12 to 15 horsepower.

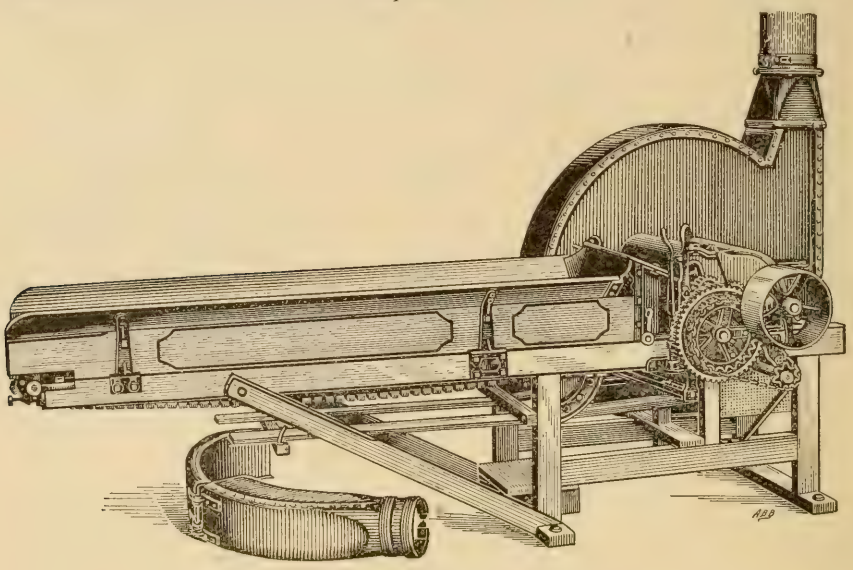


FIG. 20.—Self-feeding ensilage cutter with blower.

The ensilage cutters and shredders were at first provided with swivel carriers driven from bottom, which, by means of metal buckets fastened to a chain, elevated the fodder into the silo or mow. Now, however, most of the larger machines are provided with blowers, which consist of a steel fan inclosed in a case, and a galvanized iron pipe usually 10 inches in diameter, extending to the silo or the mow. The fan is sometimes mounted on the main shaft of the cutter or shredder head and is thus driven by the same belt that furnishes power to the machine. The current of air created by the fan forces the fodder into the place desired. For green silage it is necessary to carry the pipe nearly perpendicular to the height of the silo window and to put an elbow on the top to convey the fodder into the silo. The reason for this is that when the pipe is perpendicular, or nearly so, the force of the wind created by the fan works directly against the force of

gravity, which acts upon the silage, whereas when the pipe is slanting the silage tends to collect at the lower side of the pipe and the wind pressure tends to pass over the silage, thus causing clogging in the pipe.

One of the earliest attempts to turn the stalk into feed in any other than its natural condition, or simply to cut it into short lengths by means of a cutting machine, is embodied in a machine patented in 1872, which comprised two parallel gangs of saw-like cutters, between which the stalk is cut into short pieces.

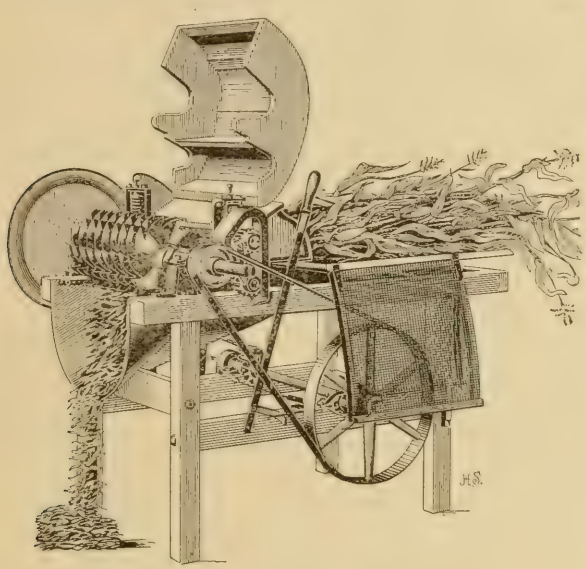


FIG. 21.—Corn shredder.

The modern shredder was first suggested in 1881, as appears from a patent granted to Messrs. Behringer, Stouffer, and Potts, of Pennsylvania. This consisted of two rollers between which the cornstalks were fed to a cylinder provided with knives that slit the stalk and beaters which pounded it, rendering it soft and pliable.

## HUSKERS AND SHREDDERS.

### SIMPLE HUSKING DEVICES.

One of the earliest devices used for husking corn was the husking peg. Several patterns of this are in common use. There are also other aids to corn husking made in the form of gloves, with projecting points or pegs. Equipped with such a glove the man passes along the rows, husks the ears by tearing off the husks and snapping the stems, and tosses them into the wagon which is drawn alongside. Such husking pegs and gloves are also used in husking corn from the shock.

The early colonists did not remove the husks from the ears immediately upon bringing the corn from the fields. They usually snapt the ears from the stalks without removing the husks. They held that it was better to allow the husks to remain on the ears for protection against frost and moisture. Later in the season the crops were often husked by husking parties assembled at the various farms in their respective communities during the autumn days and early evenings; and their work was always followed by some form of merrymaking, as a dance or a "play party," which often extended into the early morning hours. The corn was stored in high cribs erected at convenient points near the other farm buildings.

### EARLIER MECHANICAL HUSKERS.

The first patent on a corn husker was issued in 1837. The machine comprises essentially a pair of roughened parallel rollers designed to tear off the husks. This machine represents one of the earliest attempts to utilize machinery for preparing the corn crop for the market. It assumes that the ear shall be plucked from the stalks by hand.

In 1866 a New York concern began the manufacture of a husker having a single snapping roll made of hardwood. Another roller set with stiff knives located just behind the hardwood roller, cut the stalk into short lengths. The ears of corn as they were broken off by the snapping roll fell down upon the husking rolls. These were about 2 inches in diameter and rotated toward each other. A small revolving shaft set with spikes and located directly above the line of contact of the husking rolls, caused the ears to revolve so as to present all of the husks to the action of the husking machine.

Another form of husker consisted of a snapping roll much the same as that described above, and several husking rolls whose effectiveness depended upon the action of rubber aprons. These past over each roller like belts over a pulley, and tended to draw the husks in with them. Later, about 1880, the Phillips and Jones machines added to this idea by putting on a pair of snapping rolls. These were the first really successful huskers.

### COMBINED HUSKERS AND SHREDDERS.

Thus far no machine had been produced designed to perform more than one operation on the stalks, except some of the unsuccessful and later experimental harvester types designed to pick and husk the ears, as previously described. Between 1880 and 1890 a great deal of attention was given to thrashing corn. This practise so battered the stalk as to make every part of it available as a cattle food. Fodder cutters had been in use for many years, yet this method of preparing corn fodder left the fibrous part of the stalk in a tough,

woody condition which the cattle did not much relish. The bruising and shredding action of the thrasher put the stalk in a more palatable form. The repeated shortages and failures of the hay crop during the decade 1880–90, together with the results of attempts at thrashing corn led to the invention of the combined husker and shredder, which takes the stalks with the ears on them, removes the ears, husks them, and prepares the stalks for feeding. A combined husker and shredder patented by J. F. Hurd, of Minnesota, in 1890, application having been filed in 1887, is one of the earliest of the shredder type.

There are at this time many different makes of this machine in the market. They are of various designs and are frequently made so as to be fitted with exchangeable cutter and shredder heads. The general construction of all machines of this class is very much the same, however. Some are rather complicated in their construction

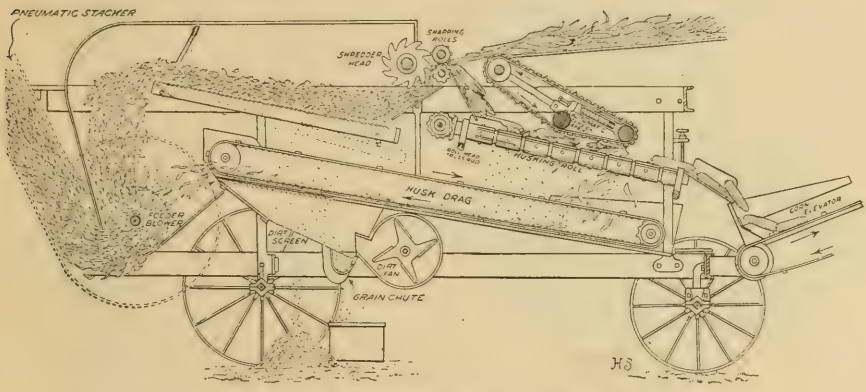



FIG. 22.—Skeleton of husker and shredder.

while others are very elementary. A discussion of one of the more complicated will serve to explain the general operation of all. By referring to figure 22 the construction will be easily understood.

The stalks are first fed to the snapping rolls, where the ears are broken from them. The stalks are driven forward by the snapping rolls until they meet the shredder head, where they are cut to shreds by knives of special forms shown in figure 23. The shredded parts of the stalk fall upon a vibrating carrier whose motion is complemented by the action of arms. The shreds fall from this carrier into the blast from the fodder blower, which carries them up thru the stacker.

The ears which are broken from the stalks by the snapping rolls drop upon the husking rolls where the husks are torn from them. The husked ears gradually descend along the inclined husking rolls until they finally fall upon an elevator which carries them to the bin or other place provided for them.

The husks fall upon a conveyor chain which drags them back to the fodder blower, where they join the shreds from the stalk. The loose grain falls from the vibrating carrier and husk conveyor upon a screen. As it falls it is met by a mild blast which removes the dust from it. This grain is then collected in a trough or chute and is driven by means of a screw conveyor to one side of the machine.

This machine combines in its construction many elements used in earlier machines, both huskers and fodder cutters. The snapping rolls and husking pegs are both ideas found in machines described in preceding paragraphs, while the shredder heads are not greatly different from those of the fodder cutters of earlier design. The blower

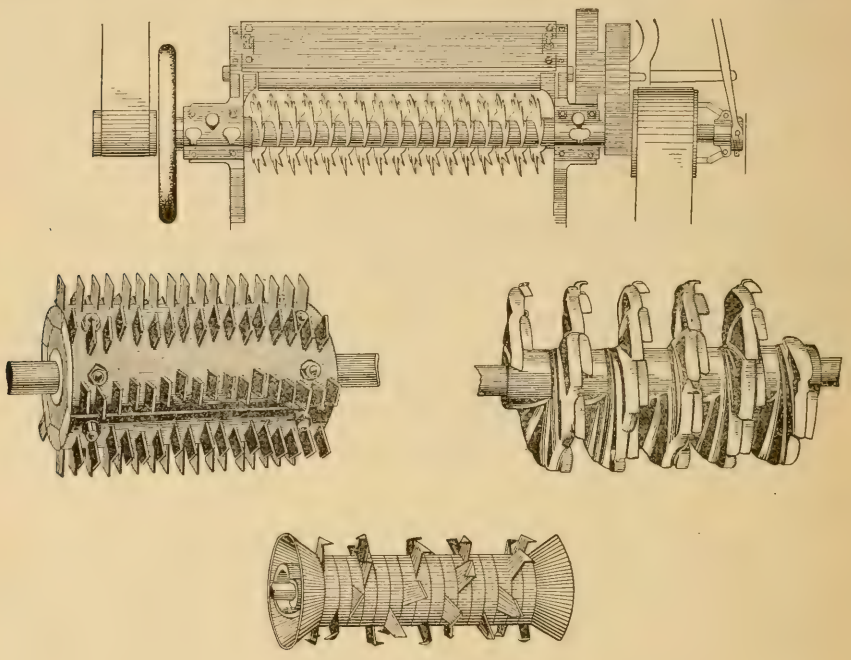
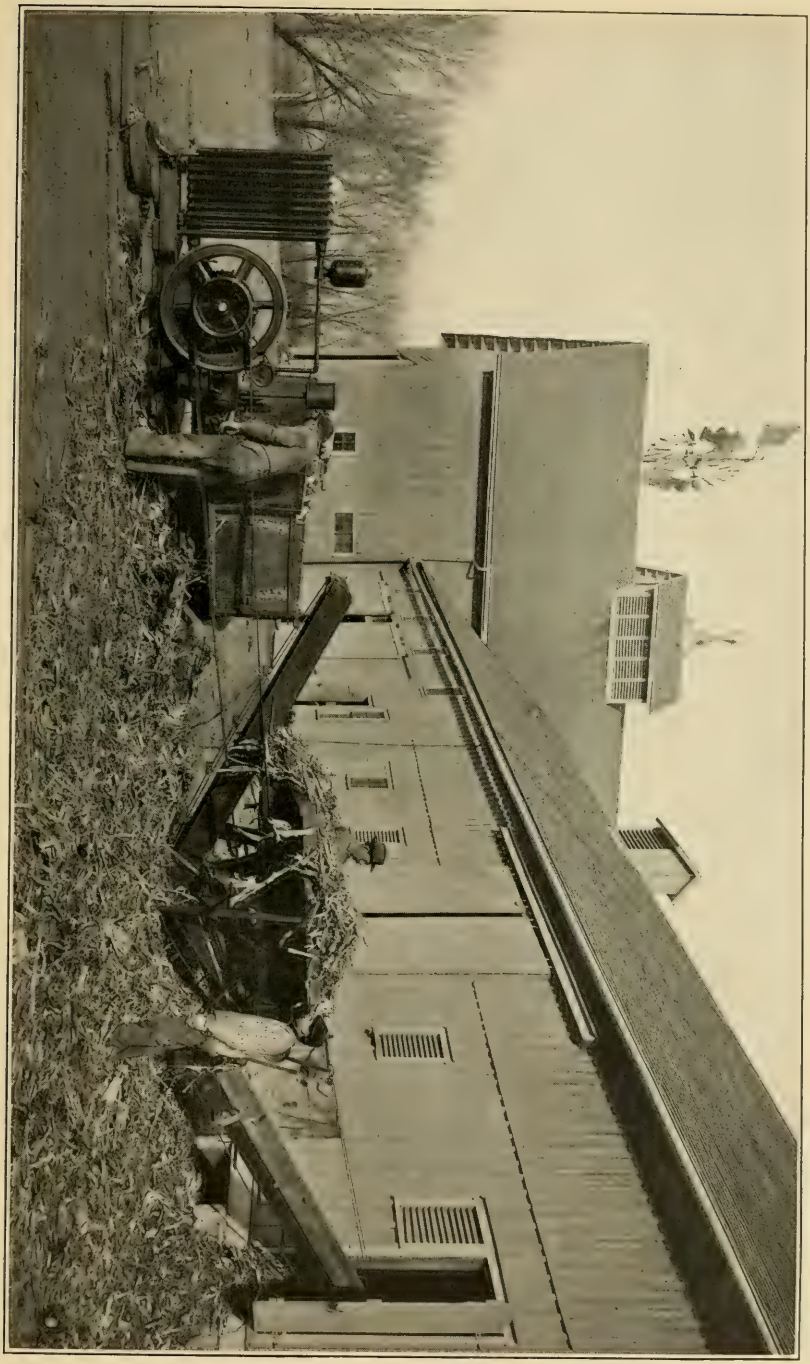


FIG. 23.—Forms of shredder heads.

and cleaning and carrying devices are very much like those of the thrasher. Self-feeding and safety devices are now largely used as a protection against the danger of having one's hand or arm caught in the mechanism (fig. 24). Where the self-feeder is used, a revolving band cutter is commonly placed a little ahead of the snapping rolls.

The superior convenience of having the stalks bound into bundles is most evident where these machines are used. In bundles the stalks keep straight and thus avoid the delay caused by having them come to the machine in a disordered condition. There is also less danger of choking the machine. Plate IV shows a husker and shredder run by a gasoline engine.



HUSKER AND SHREDDER RUN BY GASOLINE ENGINE.

## COST OF PREPARING CORN FODDER.

The cost of preparing corn fodder by the various methods and with the different machines depends upon a great many variable factors. It depends upon the yield of corn per acre, upon the method of harvesting, upon the distance the fodder is to be hauled, the size and efficiency of the working force; the size, capacity, and speed of the machine, and the motive power used.

### COST OF FILLING THE SILO.

In cutting corn for ensilage we have the records kept by several experiment stations, as to cost, a few of which are here given.

An accurate record was kept of the cost of harvesting and storing 45 tons put into the silo in three days.[a] The force employed was as follows: Portable engine, power cutter, one two-mule cart with mules, one single cart with mule, one mule hauling fuel and water for engine, one foreman, one engineer and fireman, two drivers, three corn cutters, two men at cutting machine, one man packing in silo, one boy helper on water cart.

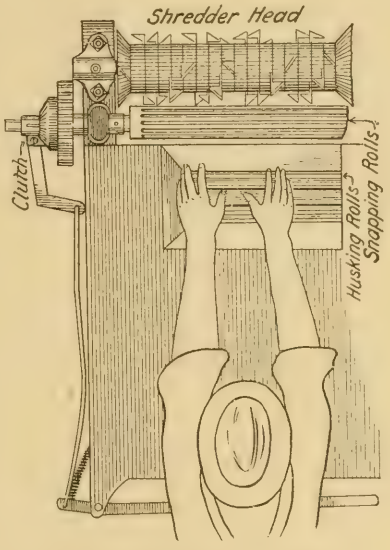



FIG. 24.—Safety device for shredder.

The items of cost were these: Hire of engine and engineer, three days, at $4 per day, $12; fuel, $3; teams and manual labor in all, $46.40; putting cover and weights on silo, $3; total, $64.40, or $1.43 per ton. It was estimated that the tangled condition of the corn in the field fully doubled the labor of cutting and loading it, and had the ensilage cutter been larger, the same engine and fuel could have doubled the quantity cut per day. It is easy to see how these improvements might have reduced the cost to $1 per ton for storing.

*Cost of harvesting and filling silo.*[b]

| | | |
|---|---|---|
| Capacity of machine, per 10-hour day | tons | 50 |
| Six men in field cutting and loading, at $1.33 | | $7.98 |
| Two teams hauling, at $2 | | 4.00 |
| One driver, at $1.33 | | 1.33 |
| Two men feeding machine, at $1.33 | | 2.66 |
| Two men packing in silo, at $1.33 | | 2.66 |
| One man at engine, at $1.33 | | 1.33 |
| Coal used, one-fifth ton, at $8 | | 1.60 |
| Cost of harvesting 50 tons | | 21.56 |
| Cost per ton | | .43 |

[a] Maryland Sta. Rpt. 1889, p. 103.

[b] Minnesota Sta. Bul. 2, p. 7.

Professor King found that the average cost of cutting and putting corn into the silo, on a number of Wisconsin farms, was 58.8 cents per ton.[a]

Professor Georgeson found that it cost 62.3 cents, 70.9 cents, and 50.8 cents for three different silos, or an average of 61.3 cents, per ton of silage put up.[b]

Mr. T. L. Allen, Kinsman, Ohio, says:

> With modern machinery and good management, corn can be put into the silo at 35 to 40 cents per ton. Indeed, with our large machinery and strong force of men we have put it in the silo for less than 30 cents.

With the larger and improved ensilage cutters having self-feeders and blowers, and the superior methods in handling the corn, it is safe to say that corn may be harvested and put into the silo in the form of silage, at an average cost of 50 cents per ton.

### COST OF SHREDDED FODDER.

The cost of making the cornstalk into shredded fodder after it has been allowed to cure in the field varies in the same way as that of preparing silage. We may, however, gather some ideas of the value of the machines used for this purpose.

We have already learned the cost of cutting the corn and putting it into shocks, and also that the average cost per bushel of husking corn from the shock in the fields is 5.3 cents per bushel, or at an average of 44 bushels per acre, the cost will be $2.33 per acre. To this should be added about 35 cents per acre for hauling the ears to the crib, or a total of $2.68 per acre for husking the corn by hand, and this leaves the stover in the field. If the stalks are hauled to the feed lot it will involve an additional cost. When huskers and shredders are used for husking the corn and shredding the fodder, the farmer will have to decide the question as to what method of doing the work he desires to employ. There are machines on the market which will husk but 100 bushels per day, and there are those which will husk 1,000 bushels per day. The smaller ones are for the farmer who desires to do his own work.

With the general introduction of the gasoline engine on the farm, a small individual outfit (Pl. IV) is very desirable. With such an outfit the farmer may do his work at his convenience as he needs the corn and the fodder, and may also do some work for neighbors, which will aid in paying for the machine. It requires one man to feed; one to look after the engine, shredder, and the corn in the wagon; one man in the mow to remove the fodder, one to unload the wagons, two teams, and one loader in the field. Six gallons of gasoline will supply the fuel for a ten-hour run. The computed cost would be:

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[a] F. W. Woll, Book on Silage, p. 118.

[b] Kansas Sta. Bul. 48, p. 37.

*Cost of shredding corn.*

| | |
|---|---|
| Use of engine and shredder and repairs, per day | $1.00 |
| Five men, at $1.50 each | 7.50 |
| Two teams, at $3 each | 6.00 |
| Power, 6 gallons of gasoline, at 15 cents per gallon | .90 |
| Total cost per day | 15.40 |

From experiments conducted by the author with the above outfit, it was found that the number of bushels husked per hour varied considerably with conditions, but that the average was 18 bushels, or 180 bushels per day. This, at the average yield of corn per acre previously derived, would be equal to 4 acres per day. To husk 180 bushels by hand and put it in the crib would cost $10.96. This would leave a cost of $4.44 for 4 acres of corn fodder shredded and delivered in the mow. The average yield of shredded fodder is 2 tons per acre. This would give a cost of 55 cents per ton for hauling the fodder from the field, shredding it, and placing it in the barn ready to feed. When corn has been husked in the field and the farmer wishes the fodder shredded, it costs him about $1.50 per acre for shredding the fodder by machine.

With large machines the work of husking and shredding corn is usually custom work. The owner of the machine furnishes the shredder and engine, with two men, charging the farmer from 4 to 5 cents per bushel for this work. The farmer will have to furnish the fuel and the teams, as well as the balance of the help to run the machine. These large machines require from 6 to 8 teams and 20 to 25 men for full operation. The large machine, while it does the work quickly, has the disadvantage of requiring a large crew of men and teams, and if anything goes wrong with either engine or shredder, this force is idle at the expense of the farmer until the machine is repaired.

From some investigations conducted by sending out letters of inquiry from the Iowa Experiment Station to all parts of the State, the following results were obtained:

From the entire number of reports received, the average cost of machines for shredding was $1.55 per acre; the cost of fuel was 31.4 cents; and the total cost of shredding, per acre, varied from $2.45 to $6.65. This is a wide range, but the conditions under which the shredding was done varied correspondingly according to the distance hauled, yield of stover per acre, kind and size of machine used, and work required in moving the outfit; also as to physical conditions of the fodder and accidents with machine.

The average cost of shredding 1,600 acres was found to be $4.41 per acre, and this is believed to be a fair average under ordinary conditions.

The estimate of yield of corn per acre in the above case was 57.25 bushels, which is rather high even for Iowa; the yield of fodder, 2 tons per acre, and the cost of husking in the field, 5 cents per bushel. At these figures the cost of shredding the fodder would be 77 cents per ton.

## SUMMARY.

The following table summarizes the data obtained as to the cost and value of corn-harvesting machines:

*Summary of data regarding corn-harvesting machinery and its use.*

AVERAGE DATA FOR HARVESTING BY HAND.

| | |
|---|---|
| Cost of implement | $1. |
| Number of hills per shock | 160. |
| Acres 1 man harvests per day | 1.47 acres. |
| Cost of cutting and shocking | $0.065 per shock; $1.50 per acre. |

AVERAGE DATA FOR HARVESTING WITH SLED HARVESTER.

| | |
|---|---|
| Cost of implement | $5 to $50. |
| Number of hills per shock | 144. |
| Acres 2 men and 1 horse harvest per day | 4.67 acres. |
| Cost of cutting and shocking | $1.18 per acre. |

AVERAGE DATA FOR HARVESTING WITH CORN BINDER.

| | |
|---|---|
| Cost of implement | $125. |
| Life in years or acres cut | 8.17 years; 669 acres. |
| Acres cut per day by 1 man and 3 horses | 7.73 acres. |
| Acres shocked per day, 1 man | 3.31 acres. |
| Cost of cutting and shocking | $1.50 per acre. |

AVERAGE DATA FOR HARVESTING WITH CORN SHOCKER.

| | |
|---|---|
| Cost of implement | $125. |
| Number of hills per shock | 100. |
| Shocks or acres 1 man and 3 horses harvest per day | 151 shocks; 4.67 acres. |
| Cost of cutting and shocking | $1.06 per acre. |

*Cost per bushel of picking and husking corn.*

| | Cents. | | Cents. |
|---|---|---|---|
| By hand from field | 3.5 | Additional cost of team for cribbing | 0.79 |
| Additional cost of team for cribbing | 1.0 | By corn picker from field | 4.1 |
| By hand from shock | 5.3 | By husker and shredder from shock | 4.5 |

*Cost per acre of husking corn and preparing fodder.*

| | By hand. | Sled cutter. | Binder. | Shocker. |
|---|---|---|---|---|
| Cutting and shocking corn | $1.50 | $1.18 | $1.50 | $1.06 |
| Husking out of shock by hand | 2.68 | 2.68 | ..... | ..... |
| Husking and shredding by machine | ..... | ..... | 4.41 | 4.41 |
| Hauling and shredding fodder | 2.50 | 2.50 | ..... | ..... |
| Comparative cost | 6.68 | 6.36 | 5.91 | 5.47 |

*Comparative returns per acre of husking corn from the field, of cutting and feeding from shock, and of cutting and shredding by the various methods.*

| Method employed. | Bushels per acre. | Price per bushel. | Value of corn per acre. | Cost of husking per acre. | | Net value of corn. | |
|---|---|---|---|---|---|---|---|
| | | | | By hand. | By machine. | Hand. | Machine. |
| Stalks left standing | 44 | $0.44 | $19.36 | $1.98 | $1.80 | $17.38 | $17.56 |
| Cut, and stalks fed whole | 44 | .44 | 19.36 | 2.68 | ..... | 16.68 | ..... |
| Cut, and stalks shredded | 44 | .44 | 19.36 | ..... | 1.98 | ..... | 17.38 |

| Method employed. | Yield of stover per acre. | Value of stover per ton. | Total value of stalks per acre. | Net value of stalks per acre. | | | Net value of entire crop. | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Hand. | Large-crew machines. | Individual machines. | Hand. | Large machines. | Small machines. |
| | *Tons.* | | | | | | | | |
| Stalks left standing | ..... | ..... | $0.55 | ..... | ..... | ..... | $17.93 | $17.81 | ..... |
| Cut, and stalks fed whole | 2 | $4.00 | 8.00 | $3.82 | $3.82 | $4.26 | 23.18 | 23.50 | $23.62 |
| Cut, and stalks shredded | 2 | 6.00 | 12.00 | 5.32 | 6.09 | 7.09 | 24.68 | 25.45 | 26.45 |

The net value of the crop is found to be $17.93 for husking by hand and leaving the stalks standing in the field. This is obtained by adding to the net value of the corn 55 cents per acre for the stalks and subtracting the cost of husking by hand.

By allowing 25 cents per acre as the value of the fodder in field where corn picker is used, and adding this to the net value of the corn and subtracting $1.80 per acre for picking with the machine, we derive the net value of the crop of $17.81 for this method of harvesting, which indicates a small loss per acre as a result of using the corn picker.

The net value of the crop by feeding the stalks whole is obtained by taking the total value of the corn and fodder and subtracting the costs of cutting and husking by hand, cutting with sled harvester and husking by hand, and cutting with corn shocker and husking by hand.

The net value of the crop by utilizing the fodder in the shredded form is obtained by assuming a greater value of shredded fodder over whole cornstalks of 33 per cent, adding this value of the fodder to the value of the corn and subtracting the various costs of cutting, husking, and shredding the corn by the various hand and machine methods.

## CONCLUSIONS.

The best way to preserve the greatest quantity of food materials of the original corn fodder for feeding of farm animals is by means of the corn harvester, ensilage cutter, and the silo. The cost of placing 1 acre of corn in the silo is about the same as that of an acre of cured fodder.

The farmer who would secure the full value of his corn crop should secure the fodder with as much care as he gives his clover hay, har-

vesting it at the proper period, and not allowing it to become ruined by rain or frost. By the use of the proper machinery for harvesting the corn crop, the farmer may increase the net income from his crop $8.72 per acre over hand methods of harvesting the ears and wasting the stalks and still allow full price for the use of the different machines.

There is a limit beyond which it is not profitable for a farmer to invest in corn-harvesting machinery, and the amount of work to be done by the machine each year should be carefully considered before a purchase is made.

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