August 2017

Harvesting cornstalks for industrial uses

J. Brownlee Davidson  
Iowa State College

Edgar V. Collins  
Iowa State College

Follow this and additional works at: http://lib.dr.iastate.edu/bulletin

Part of the Agriculture Commons, and the Bioresource and Agricultural Engineering Commons

Recommended Citation

This Article is brought to you for free and open access by the Extension and Experiment Station Publications at Iowa State University Digital Repository. It has been accepted for inclusion in Bulletin by an authorized editor of Iowa State University Digital Repository. For more information, please contact digirep@iastate.edu.
Harvesting Cornstalks for Industrial Uses

BY J. BROWNLEE DAVIDSON AND EDGAR V. COLLINS

A car of baled cornstalks on the way to the factory and a car of wall-board from the factory being unloaded.

AGRICULTURAL EXPERIMENT STATION
IOWA STATE COLLEGE OF AGRICULTURE
AND MECHANIC ARTS

C. F. Curtiss, Director

AGRICULTURAL ENGINEERING SECTION

AMES, IOWA
SUMMARY

The development of industrial uses for cornstalks is dependent, in a large measure, upon an adequate supply of raw material at a reasonable cost.

Cornstalks, being light and bulky, are difficult to handle, and economical harvesting is essentially a problem of reducing labor.

The yield of cornstalks (15 percent water content basis) varies from 1 to 2 tons per acre.

Dry, wind-blown stalks in Iowa may be expected to yield from \( \frac{1}{2} \) to \( \frac{3}{2} \) tons per acre.

Cornstalks cannot be harvested economically by hand.

Harvesting with corn binder, husker-shredder and baler costs about $7 per ton under average conditions.

Harvesting by breaking, raking and baling in the field is a very practicable method, and the cost for average conditions is about $3.55 per ton. Under favorable conditions the cost may be $2.70 or less per ton.

Combination machines, consisting of mower, rake and baler, reduce labor. The harvesting of 236.8 tons at Ames, Iowa, in 1930 cost $2.49 per ton, exclusive of machinery costs. A reasonable estimate of the cost of machinery, exclusive of power, is 50 cents per ton.

New machines are being developed. A combination corn picker and field baler is such a machine.

The cost of collecting baled stalks in the field, transporting 8 miles and unloading, is about $1.80 per ton. Collection of 236.8 tons of stalks at Ames, Iowa, hauling to station 1 to 4 miles and loading into cars, cost $1.23 per ton.

Special freight rates are in force for shipping baled cornstalks.

The harvesting and sale of cornstalks should return \( \frac{1}{2} \) to \( \frac{3}{2} \) the value of the grain crop.

In the purchase of cornstalks, deduction must be made for excess dirt and water.

Cornstalks when baled without shredding do not absorb water so readily and tend to store better when piled. The capacity of the baler, however, is increased if the stalks are shredded and the weight of bales is increased.

The cost of piling cornstalks was 35 cents per ton with an inclined elevator.
Harvesting Cornstalks for Industrial Uses

By J. Brownlee Davidson and Edgar V. Collins

The use of cornstalks in an extensive way as now proposed for the manufacture of fiber products, such as paper, wall-board, lumber substitutes and insulating materials; alpha cellulose (the basic material for such products as rayon and pyroxylin varnishes); and other promising products, has created a demand for definite and specific information concerning the best and most economical methods of harvesting. An extensive program of investigation and experimentation has been carried out at Iowa State College by the Chemical Engineering section of the Engineering Experiment Station, in cooperation with the Bureau of Standards of the United States Department of Commerce, to determine the practicable use of cornstalks for industrial purposes. One factory has been established in the state for the manufacture of wall-board from cornstalks, and factories for manufacturing other products have been established in adjoining states. It is recognized that the successful use of cornstalks for the manufacture of industrial products depends upon the availability of an adequate supply of raw material at a reasonable cost. In fact, the use of cornstalks at present in the successful production of valuable industrial products makes the problem of economical harvesting one of immediate importance.

The purpose of this bulletin is to describe some of the tried methods of harvesting cornstalks and furnish estimates of the cost of harvesting. During the past three years the Agricultural Engineering Section has, in the experiments conducted, harvested over 500 acres. The harvesting methods practiced in Iowa and other states have also been studied.

THE YIELD OF CORNSTALKS

The yield of air-dry cornstalks, that is, stalks containing less than 15 percent moisture, varies with the grain yield, the variety of corn and the method of harvesting practiced.

At Iowa State College many records have been kept on the yield of silage. In 55 records, corn harvested for silage yielded
an average of 9.8 tons per acre. The ratio of cornstalks to grain in good corn varies from 60 to 125 percent, or an average of about 1 to 1 for air-dry material. If it is estimated that the silage contains 70 percent moisture, these records would indicate a yield of 1.5 tons of cornstalks per acre free from moisture. The average yield of corn in Iowa in 1926 was 39.7 bushels. With a ratio of 1 to 1, this would indicate a moisture-free yield of cornstalks and corn cobs of 2,240 pounds.

A review of the experiment station literature for a number of states indicates that the yield of corn stover, given as air-dry in some instances and moisture-free in others, varied from 1.3 tons to 3 tons per acre.

During the fall of 1926 a field of corn yielding approximately 60 bushels was harvested with the corn binder, placed in shock and shredded later. The yield was 1.4 tons per acre.

Sixty acres of cornstalks, which had been pastured to a limited extent, were harvested in the spring of 1927 giving a yield of ¾ ton per acre. In this case the leaves and lighter portions of the stalks were not secured, and the stalks were very dry averaging less than 10 percent moisture.

During the winter and spring of 1928 several fields of stalks were harvested, some of which had been pastured with livestock. The yield was from .5 to .8 of a ton per acre.

The yield of stalks harvested in Grundy County during the spring of 1930 varied from 0.83 to 1.5 tons per acre of baled cornstalks as shipped to the factory. In some instances these stalks had been pastured with livestock and were wind-blown.

Approximately 250 acres harvested at Ames during the winter and spring of 1930 yielded 236 tons of baled stalks as loaded on cars for shipment to factory. All of these stalks were wind-blown and some were pastured with livestock, but the fields selected were better than the average. Some of the stalks were harvested during the winter season, and in some cases the down stalks were frozen to the surface of the ground which prevented their collection.

These data indicate in a general way that, with the varieties of corn now grown in the state, from 1 to 1 ¾ tons of moisture-free cornstalks may be expected when the stalks are harvested early enough to secure all the leaves and husks, and that a yield of from ½ to 1 ton may be expected in the spring after the stalks are wind-blown and pastured with livestock to a limited extent.

THE SUPPLY OF CORNSTALKS

The supply of cornstalks which could be available for industrial purposes in Iowa is very large. In 1927 there were 10,901-380 acres of corn in the state, of which 83 percent or 9,026,024
acres were harvested for the grain. It is unreasonable to think tho, that any large part of this supply of raw material could be used for industrial purposes within the next few years.

In a considerable area of Iowa, as much as one-third of the total acreage of farm land, is planted to corn.

REQUIREMENTS OF A FACTORY

In order to picture the problem of collecting cornstalks, it is desirable to know how large a supply of cornstalks would be needed to supply a factory producing some product such as wallboard. Dr. O. R. Sweeney, of the Department of Chemical Engineering, estimates that a factory, to be operated on an economical basis, should have at least 30 tons of cornstalks per day, or for a year of 300 days, about 10,000 tons. In those sections of Iowa where one-third of the total area is grown to corn, it would be possible to have within a radius of 10 miles of a selected factory site 133,000 acres of corn, of which 100,000 will be harvested for grain. If the yield of stalks is 1 ton per acre, the total tonnage available within the radius of 10 miles would be 100,000 tons, or 10 times the requirements of a factory. This would provide an average haul of about 8 miles for all the material. It has been observed, however, that it is necessary to select the better fields and increase the haul over the average suggested.
THE PROBLEM OF HARVESTING

To the casual observer passing thru Iowa, where fields during the fall and winter are to be seen on every side with cornstalks ready to be harvested, the problem of harvesting seems simple and easy. The harvesting of cornstalks at the present time, however, with the equipment available, requires good management and skill in order that the cost of the harvested cornstalks will not be excessive. Dry cornstalks are light, bulky and coarse, and do not handle well with the equipment designed to handle hay and less bulky materials. Cornstalks are, therefore, difficult to handle unless bound in bundles or compressed into bales. They are not easily handled with a fork while loose, and to handle directly with the hands is a laborious task.

During the early part of the corn husking period when the corn is sufficiently dry to be placed in storage, the stalks still contain a high percentage of moisture, often as much as 30 to 40 percent. The handling of the extra weight due to moisture is expensive and undesirable.

HARVESTING OF CORNSTALKS BY HAND

It is possible to harvest cornstalks by hand, but the practice would be impractical in Iowa with labor at the prevailing wage. The cutting of corn is often paid for on the basis of so much per shock. For a shock 12 hills square, the rate is from 12 to 15 cents. At 12 cents, the rate per acre would be $2.96 and at 15 cents, $3.70. This is greater than the cost of cutting with the machine where the area is of consequence. The total cost of harvesting cornstalks by this method may be estimated from data furnished later by substituting the cost of hand harvesting for machine harvesting.

HARVESTING OF CORNSTALKS WITH MACHINERY

In making a study of the problem of harvesting cornstalks, several objectives were sought. It was recognized that the cost of labor was the item most easily reduced. Cornstalks are too light and too bulky to be handled by hand economically. In conducting experiments to reduce the labor required, due consideration has been given to keeping the cost of equipment and power down to a reasonable amount. It was also desired to put the cornstalks in a form which would permit easy transportation and handling. In other words, it was observed that the earlier in the harvesting process the stalks were put into the compressed bale form, the easier they could be handled.

The Agricultural Engineering Section during the past year has actually harvested several hundred tons of cornstalks for the purpose of securing accurate data on the cost of harvesting.
Method A. Harvesting Cornstalks with Corn Binder, Husker-Shredder and Baler

This plan of harvesting cornstalks contemplates the use of machinery now in general operation without modifications. A field of 15 acres was actually harvested by this method in 1926 and a record made of the labor requirement, but the estimate presented here is based largely upon custom rates of performing the various operations.

The advantages of this method may be enumerated as follows:

1. The method utilizes machinery now in general use without modification, i.e., the corn binder, the husker-shredder and the baler. The process is now practiced by farmers in part or in whole.
2. The cornstalks are allowed to dry in the shock, and the expense of handling heavy material is avoided.
3. The labor of husking, shredding and baling may be carried out in slack seasons.
4. All of the crop may be saved, thus increasing the tonnage per acre.
5. The raw material harvested will be clean and free from dust and soil.

The disadvantages of the method are:
1. An excessive amount of labor is required for shocking, hauling, feeding the husker-shredder and the baler. Cornstalks are not easily handled either as whole stalks or as shredded stover.
2. There is an item of expense for twine.

Fig. 2. Husker-shredder at work. The stacker can be arranged to discharge shredded cornstalks into hopper of press or baler.
Method A. Estimate of Cost Per Acre (Revised)

Cutting corn with corn binder per acre, includes 6 lbs. twine $0.78, horse labor $0.50, man labor $0.45 and machine charge $0.40. $2.13

Shocking 2 2/7 hours at 35c $0.80

Hauling and unloading at husker-shredder varies much (estimated) $1.50

Husking-shredding (custom rate) $4.00

Baling, including wire $3.75

Total cost per acre 1 1/4 tons $12.18

Credit for husking 50 bu. at 7c $3.50

Net cost per ton (15 percent moisture) $8.68

$6.94

Method B. Harvesting with Stalk Breaker or Shaver, Rake and Field Baler

This method is the one which was most extensively used in Iowa during the past three years. The corn is picked in the usual manner, either by hand or machine, but the use of the mechanical corn picker breaks up and leaves so many of the stalks on the ground that it is necessary to harvest the stalks immediately following corn picking if a worthwhile yield is to be secured. The stalks are loosened from the ground either by breaking with a railroad iron or a stalk shaver, raked with a dump rake into wind-
Fig. 4. Dump rake gathering stalks after breaking with railroad iron.

rows, crossraked into piles and baled with a motor-driven baler brought to the piles either with teams or a tractor. The bales are then gathered for transportation to the factory or railroad. This method requires but one hand operation before baling, that of pitching the stalks to the baler.

The advantages of this method are as follows:

1. It is an economical method of harvesting cornstalks, as a large part of the labor of handling is eliminated.
2. The equipment required is not extensive, and the use of the baler may be extended over a long period.
3. The expensive operation of shredding is eliminated. The shredding of cornstalks is of little value in preparing the stalks for factory use. Whole stalks when baled, due to the fact that moisture is not so readily absorbed, will resist decay while in storage better than shredded cornstalks.
4. The method permits the owner of the stalks to pasture with livestock and to secure the waste grain and the most valuable part of the stalks for feed.
5. Harvesting of stalks by this method may be carried out during periods of slack labor demand on the farm.
6. The stalks are harvested after being thoroughly dried out and the cost of handling the water contained in green fodder is avoided. When dry, cornstalks may contain as little as 10 percent water.

The disadvantages of this method are:

1. The yield of stalks is low due to inability to collect loose, broken stalks, the effect of the wind and pasturage, if practiced.
2. The stalks will contain more dirt and dust, a serious objection in the making of certain products and an important consideration in harvesting cornstalks for any purpose.
3. Harvesting of cornstalks by this method cannot be practiced when cornfields are soft and muddy—a condition which prevails in the spring when the frost is leaving the ground—or during the winter when the stalks are covered with snow.

Loosening the Stalks

The usual method of loosening stalks for field baling is to break the stalks down with a railroad iron. This can be done very effectively when the ground is frozen and the stalks are brittle with frost. If a railroad iron is used when the ground is soft, many corn roots will be pulled and dirt will be collected with the stalks, which necessitates the factory making a deduction in weight. There will also be a loss in handling and transporting the dirt. The railroad iron should be pulled with a hitch that will cause the sharp flange always to come in contact with the stalks, cutting them off close to the ground. Weighted harrows with the teeth set back have been used successfully, but in general they are not as satisfactory as a railroad iron. When the ground is soft and the frost is out, the stalks can be loosened best with a stalk-cutting or shaving machine. This machine has knives set at an angle with the direction of travel and high enough to cut the stalks even with the surface of the ground. The stalk shaver may be made in the form of a sled or a truck with small wheels. Two, three or four rows may be cut at a time. A mowing machine may be used for cutting stalks if it is equipped with pea or brush guards. The standard type guard may be
used if stalks are dry, but it will clog if used early in the season or when the stalks are damp.

Raking

After they are loosened by breaking or cutting, the cornstalks may be raked with a dump rake. A wide dump rake (11 or 12 feet) is desirable. Close spaced and heavy runner, pointed teeth are most desirable. The practice recommended is to break the stalks lengthwise of the corn ridges, then rake crosswise of ridges into windrows. It has been found of advantage to “stagger” windrows. This makes a wide windrow and increases the capacity of the rake in bunching. As it is desirable to make the bunches as large as possible, it is best to rake from both directions. This is done by driving down the windrow until the rake is loaded; after dumping the rake is held up until an equal distance has been passed over. Returning from the other direction, the parts of the windrow that were skipped are raked, making each pile double size.

The stalks may be bunched in the windrow with sweep rakes or may be hauled short distances to the baler. An experiment in fitting a sweep rake with knives for cutting the stalks as they were raked gave some promise of success. A rake so equipped
is shown in the accompanying illustrations. This outfit will gather and carry about 325 pounds of stalks on the average, and in field trials it gathered stalks at the rate of approximately 4 acres per hour, leaving them in very large windrows.

Baling

The large hay baler that makes a bale 17x22 inches is the most convenient size for baling cornstalks. A feed table, with an attendant to assist in feeding the machine, has been considered advantageous, altho in some instances the stalks have been pitched directly into the hopper. Forks with blunt pointed tines have been found best, and two pitchers can often hold a large bunch of stalks between their forks if they will work together. Extension feeders for the balers would no doubt prove advantageous in feeding.

The baler should be equipped with an engine for furnishing the power and may be moved from pile to pile with teams or tractor. As the ground is often soft, four horses will be needed in most instances.

With a baler of this kind a bale about 40 inches long, when made of dry stalks, will weigh from 90 to 125 pounds. Two heavy (No. 14) bale ties will be needed if the bales are to be tight and will save time over the use of three ties.

The baled stalks may be collected with a team and wagon or truck. The distance traveled in collecting the bales may be reduced by arranging the piles of stalks to be baled in rows.

Fig. 7. Windrow of stalks made with rake shown in fig. 5. Note the size.
Estimate of cost of harvesting by method B. Breaking, raking and baling in field.

Cost per acre with a yield of 1 ton of cornstalks per acre:
- Breaking stalks with railroad iron: $0.25
- Raking—1 man and team at 60c: $0.30
- Baling: $3.00

Total: $3.55

If the yield is greater than 1 ton per acre, the cost should be reduced, and if it is less, the cost will tend to be greater. In actual practice in Grundy County, the cost of harvesting, exclusive of hauling, was from $3 to $4.60 per ton.

The following expense of baling the stalks from 20 acres, yielding 21.93 tons, is typical:
- 2 men to pitch—21 hours each day at 40c: $16.80
- 1 man to tend team and help pitch—21 hours at 60c: $12.60
- 1 man to feed baler (furnished team)—21 hours at 60c: $12.60
- 1 man to tie bales—21 hours at 40c: $8.40
- Gasoline and oil for motor: $4.23
- 4 bundles of wire at $1.50: $6.00
- Use of baler at $1.50 per day: $3.00

Total for 21.93 tons: $63.63
Per ton: $2.90

Method C. Combination Machine Consisting of Mower, Hay Loader and Baler

This method provides for continuous operation in the field and represents an attempt to reduce the labor of handling the stalks to the minimum. The stalks are mowed with a power-driven mower attachment mounted on the side of a baler. A modified hay loader is drawn directly behind the mower attachment. It
Fig. 9. Field baler in use.

rakes the cut cornstalks and elevates them to a table or hopper from which they are delivered to the baler. The baler is operated either by power delivered from the tractor motor by a power take-off, or by a separate motor mounted on the baler.

Three such combination machines have been built by the Agricultural Engineering Section during the past three years and operated in harvesting of several hundred acres of cornstalks.

The first machine represented the simplest possible assembly of the three machines, a mower, a hay loader and a baler with a power unit for continuous field work. This machine required four men for its operation: a tractor driver, a feeder, a bale threader and a bale tier. A platform and seat were provided on the side of the baler for the attendants to ride in safety. The width of the tires of the wheels was increased to facilitate travel over soft ground.

The second machine represented an attempt to reduce the number of men required for operation and to arrange for operation over soft or frozen ground. A baler having threading needles was used, dispensing with blocks between the bales. A self-feeding device was added and the baler mounted on wheels of large diameter with wide tires and cushioned with rubber blocks between the axle and baler frame. In the first construction, power was used from the towing tractor motor thru a power take-off, but later a motor was mounted upon the baler. The independent drive gave much better results. This outfit enabled the labor to be greatly reduced and under favorable conditions could be used very successfully.

The third machine built by the Agricultural Engineering Sec-
tion was a self-propelled outfit with the major portion of the weight carried on tractor tracks. It was demonstrated that this machine could be used under the most adverse field conditions. In fact, during the winter of 1930 the machine was operated in snow and in mud. When a self-feeder was used, two men were required for operation. The bale threader steered the machine with his feet by means of a suitable star wheel. When a self-feeder was not used, three men were required for operation.

The mowing of standing dry cornstalks is easily accomplished with a mower equipped with brush or pea guards. The knife sections with this type of guard reach to the end and are non-clogging. Two rows were mowed and raked at a time. When traveling at 2½ miles per hour, the machine covered slightly more than 2 acres per hour.

The fork type of hay loader was used for raking the stalks and delivering to the feeder. It proved satisfactory, but the service was more severe than the machine is designed for. A rake which would leave the ground cleaner is more desirable.

In the self-propelled machine the traction drive was independent of the baler drive, permitting the baler to continue in motion while standing.

Accompanying illustrations will show the general construction of the machines.

In addition to baling cornstalks, the machines were used for baling hay and straw in the field from the windrow.

**The Advantage of Method C. The Combination Mower, Rake and Baler**

All the advantages and disadvantages of Method B. apply to
Method C. In the latter method some labor is saved, but the heavier machinery must be moved a greater distance.

Cost of Harvesting Cornstalks

The cost of harvesting cornstalks with a two-man machine (fig. 13) under favorable conditions was as follows:

- Rate of harvesting—2 acres per hour.
- Yield 2/3 tons per acre.
- Cornstalks harvested, 1 1/3 tons per hour.

Cost of operation per hour

| Labor, 1 man at 60c, 1 man at 40c | $1.00 |
| Power | 1.25 |
| Wire | .45 |
| Machinery | .50 |

Cost per hour (1 1/3 tons) $3.20
Cost per ton $2.40

The harvesting of cornstalks, if followed thru the winter and spring months in Iowa, is greatly hampered by the weather. In 1928 the actual cost of harvesting cornstalks per ton with a four-man outfit (fig. 12) was as follows:

| Labor—per ton | $3.38 |
| Fuel | .67 |
| Wire | .40 |
| Allowance for tractor | .50 |
| Allowance for machine* | .50 |

$5.45

*The estimate of machine cost is based upon 400 hours of service at an annual cost of $200.

Fig. 11. The first attempt to assemble a mower, hay loader and baler for continuous operation.
During the late winter and early spring of 1930, a machine (fig. 14) was operated in the harvesting of 236.8 tons of gross at a total cost, exclusive of machinery, of $590.90, or $2.49 per ton. To this should be added a machinery charge of 50 to 75 cents per ton. As machines are developed, the loss of time should be reduced and the output greatly increased.

**New Combination Machines**

As the harvesting of cornstalks is practiced, new machines may be expected to be developed. Such a machine is a combination corn picker and stalk baler (fig. 16). A successful machine of this kind should materially reduce the labor required to harvest the complete corn crop. Two limitations to the use of it, however, are: First, the water content of cornstalks in the early part of the corn picking season and second, the short season available for picking corn in the northern states. These difficulties tho, are by no means insurmountable.

**TRANSPORTATION**

**COST OF HAULING CORNSTALKS**

To the cost of harvesting must be added the cost of collecting and transportation to factory or railroad station.

The cost of collecting and hauling has been found in practice to vary considerably. At Ames, Iowa, in 1929 collecting, hauling 2½ miles and placing in cars, was contracted for at $1.25 per ton. During the year 1930 the cost of delivering 236.8 tons from
the field to car from distances varying from 1 to 4 miles was $301.55 or $1.23 per ton.

If cornstalks are to be collected and delivered to the factory from a circle with a radius of 10 miles, the average haul will be about 8 miles.

Special equipment in the nature of special truck and wagon bodies is required to haul cornstalks economically. The character of roads, however, is the most important factor in determining hauling costs where the distances are great. The following estimate is intended to indicate average costs for collecting, hauling and unloading baled cornstalks. With well-organized and well-managed outfits, the cost may be materially reduced.

Average cost of collecting, hauling 8 miles and unloading baled stalks: (Fair road, and 2-ton truck with special body.)

\[
\begin{align*}
\text{Per ton} & \\
\text{Cost of collecting and loading in field} & = .50 \\
\text{Cost of hauling—8 miles at $0.15} & = 1.20 \\
\text{Cost of unloading. (Does not include piling)} & = .10 \\
& = 1.80
\end{align*}
\]

It is to be noted that the cost of hauling must necessarily vary much. In Illinois, with long hauls and paved roads, hauling has actually been done at a cost of less than 8 cents per ton-mile.

**FREIGHT**

Baled cornstalks can be shipped by rail advantageously and are given a low rate.

A special freight rate was effective on baled cornstalks during the year 1930 (supplement No. 11 to Freight Tariff No. 160-F,
effective Jan. 15, 1929). Where shipment is over one railroad only, rates were, in brief, as follows:

<table>
<thead>
<tr>
<th>Distance (miles)</th>
<th>Rate (per ton)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 or less</td>
<td>$1.20</td>
</tr>
<tr>
<td>25 to 50</td>
<td>$1.30</td>
</tr>
<tr>
<td>50 to 75</td>
<td>$1.50</td>
</tr>
<tr>
<td>75 to 100</td>
<td>$1.60</td>
</tr>
<tr>
<td>100 to 125</td>
<td>$1.80</td>
</tr>
<tr>
<td>125 to 150</td>
<td>$1.90</td>
</tr>
<tr>
<td>150 to 175</td>
<td>$2.10</td>
</tr>
<tr>
<td>175 to 200</td>
<td>$2.20</td>
</tr>
<tr>
<td>200 to 220</td>
<td>$2.40</td>
</tr>
<tr>
<td>220 to 250</td>
<td>$2.60</td>
</tr>
</tbody>
</table>

These rates are applied to a minimum load of 20,000 pounds. There are special joint rates for cornstalks shipped over two or more carriers. These run somewhat higher for total mileage than the local commodity rates quoted above.

VALUE OF CORNSTALKS TO THE FARM

It was not the purpose of the investigation reported herewith to consider the fertilizing value of cornstalks or the establishment of a farm price for cornstalks. It is to be noted that opinions among soil specialists differ much in regard to the fertility value of cornstalks. It is desirable that the farmer should receive as much for the cornstalks as the developing industry is able to pay. In other words, there should be a division of the financial reward.
accruing from the utilization of the cornstalks between the manufacturer and the farmer. It has been suggested by a number of investigators that a cost of air-dry (15 percent moisture) baled cornstalks at the factory of $10 per ton should be no obstacle in the development of the industry.

Actual experience in buying cornstalks in the vicinity of Ames, Iowa, indicated that a net price of $1.75 per ton after pasturing by livestock was attractive to most farmers. Cornstalks sold for pasture usually bring from $0.75 to $1.25 per acre.

It is to be noted that where cornstalks are pastured by livestock to glean the grain, much of the fertility is left on the soil.

VALUE OF HARVESTING CORNSTALKS IN PREPARATION OF FIELD FOR FOLLOWING CROP

In many localities throughout Iowa, if corn ground is to be planted again to corn, the cornstalks are broken, raked and burned, leaving the fields clean for the cultivation of the new crop. Opinions differ greatly in regard to the desirability of such a practice, but as long as it is followed, it should be considered in connection with the harvesting of cornstalks for industrial purposes, as harvesting leaves the ground clean and saves the expense of breaking, raking and burning. The cost of breaking and raking will vary from 50 to 75 cents per acre, and when saved should be credited to cornstalk harvesting.

RELATION OF CORNSTALK HARVESTING TO CORN BORER CONTROL

One of the principal methods of fighting the corn borer at present is to clean up and destroy all of the remnants of the corn crop. It will be possible to develop the equipment used and described in this report, so as to meet fully the requirements of a
clean-up plan of combatting the corn borer. With the development of cornstalk harvesting equipment, there is no reason why the ground cannot be thoroughly cleaned, not only by removal of all of the cornstalks but also grass and weeds. It is reported that the average cost of cleaning ground of cornstalks for corn borer control averages between $1.50 and $2 per acre. This phase of the problem is particularly worthy of further investigation.

**NET RETURN FROM THE SALE OF CORNSTALKS**

Cornstalks during the past year have been purchased at the factory at $10 per ton for clean stalks with a water content not exceeding 15 percent. The foregoing data indicate the gross and net returns that may be expected from the sale of cornstalks. At the present it is safe to suggest that stalks should add from one-fourth to one-half to the gross and net returns from the corn crop when harvested for grain. The additional labor return is of considerable advantage to many farmers. During the past year some tenant farmers by contributing their labor and equipment have been able to pay their rent from the sale of cornstalks.

**DIRT AND WATER CONTENT**

In order to afford protection against excessive amounts of dirt and water in the stalks, the factories have found it necessary to provide for deduction in weight for dirt and water exceeding 15 percent. Air-dry cornstalks will contain about 10 percent of water. The water content of cornstalks has no value to the purchaser, and an adjustment of price is reasonable and necessary.

*Photograph courtesy R. D. McDonald.*

Fig 16. A combined two-row corn picker and baler.
STORAGE OF BALED CORNSTALKS

An important phase of the storage problem is that of piling cornstalk bales in high piles to resist weather.

The Agricultural Engineering Section has devised an inclined elevator which is adaptable to almost any type of load which materially reduces the labor of piling. The cost of piling by this method was found to be as follows:

Cost of Piling Baled Cornstalks With Inclined Elevator

Basis of estimate:
60 lb. bales, 10 percent moisture__________________33 bales to 1 ton
Rate of elevation:
4 bales per minute, 8 minutes per ton.
To provide for loss of time and moving machine, etc., add 7 minutes, making 15 minutes per ton.
Cost per ton:
2 men at 40c per hour for 15 min._________________$.20
Use of machine. Cost $400 with engine, fuel, depreciation, etc.
1,000 hrs. (Does not include truck)_________________.15

Cost per ton____________________________________$.35

Fig. 17. Inclined bale elevator.