MAY, 1947

N. C. AGR. EXP. STA.
BULLETIN NO. 358

# THE SWEET POTATO VINE-ROW HARVESTER

# ACKNOWLEDGMENTS

Acknowledgement is made to J. W. Coggins, Professor of Agricultural Education, N. C. State College for many of the photographs in this bulletin.

Material for the value of sweet potato vines as a livestock feed was based on studies conducted jointly by the USDA and the Departments of Horticulture, Animal Industry, and Agricultural Engineering of the North Carolina Agricultural Experiment Station. Many helpful suggestions were contributed by members of the sweet potato committee in the development of the machine.

Appreciation is expressed to the many growers in the state who cooperated in the tests and especially to L. O. Page, Farm Superintendent, North Carolina State Hospital, Raleigh, N. C., for permitting the testing of the machine during the development period.

Data for sweet potato production was supplied by R. P. Handy of the Agricultural Statistics Division of the North Carolina Department of Agriculture.

July, 1946.


# The Vine-Row Sweet Potato Vine Harvester


By G. W. Giles,

*Professor of Agricultural Engineering*


## INTRODUCTION

This bulletin has been prepared to supply information on a new machine and a harvesting method developed by the N. C. Agricultural Experiment Station and now released for manufacture.

The "Vine-Row" harvester shown in Fig. 1 was developed to facilitate the harvesting of sweet potato vines. This machine was developed because the vines offered a good source of a large quantity of high quality livestock feed. The vines have been successfully used as silage and their use as hay or as a dehydrated feed seems probable. The harvester is extremely simple and should be inexpensive to manufacture. The machine and the method of use, may be easily adapted to both the large and small grower. There is no machine on the market at the present time for harvesting sweet potato vines. A tractor-operated machine, however, has been developed.[1]

[1] A Machine for Harvesting Sweet Potato Vines. Agricultural Engineering Vol. 27, No. 7, pp. 303, 304, July, 1946, O. A. Brown.

FIG. 1. THE VINE-ROW HARVESTER

## SWEET POTATO VINES AS LIVESTOCK FEED

"The meat and dairy industries in the South can expand no faster than feeds are made available. For this reason, every effort should be made to conserve and use all available feed crops. This is particularly true for sweet potato vines, since thousands of tons are wasted in southern growing areas each year."[2]

Sweet potato vines make an excellent feed. Although there is a rather general local use of the vines for a short period near the time of harvest of the potatoes, this is limited in extent. The vines could be harvested just before potato digging time and made into silage, dehydrated meal or hay. These products could be used as feed at any time of the year, and such practices would permit the saving of the entire vine crop.

"The green weight yield per acre of sweet potato vines, at the time the crop is harvested, will vary from 10 to 15 tons per acre. Recent feeding trials made at the North Carolina Agricultural Experiment Station have shown that good silage can be made from sweet potato vines, or a mixture of vines and roots. In fact, this silage has been shown to be as good as corn silage for feeding dairy cattle."[2]

"Winter roughages are often deficient in carotene (pro-vitamin A). Since sweet potato vine silage is rich in carotene, it is especially valuable as a winter feed in the South. Because sweet potato vine silage is highly palatable, stock will usually eat more roughage on the dry basis when fed both silage and hay, or other dry forage, than when receiving only dry feed. Its slight laxative effect on cattle is especially beneficial when legume hay is not available. Once animals are accustomed to the silage, it is eaten with practically no waste."[2]

From a nutritive standpoint sweet potato vine hay would compare favorably with many legume hays. However, unchopped or uncrushed vine stems dry very slowly, and for that reason it will probably be necessary to perform a separate machine operation of chopping or crushing to properly cure the vines.

Sweet potato leaves and vine terminals are being used in the preparation of mixed feeds. The entire vine may be utilized in a similar manner with proper harvesting equipment, and the dehydrated product would compare favorably with that of other dehydrated feeds.

## DESCRIPTION OF THE "VINE-ROW"

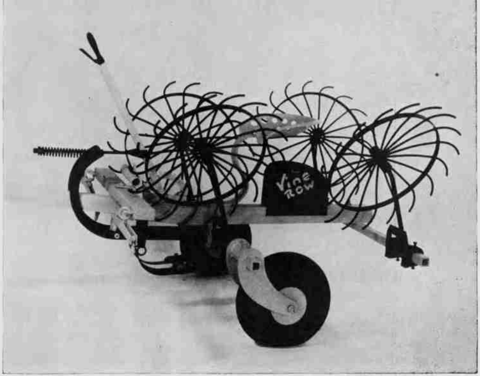
The "Vine-Row" shown in Figure 2 straddles one hilled row of potatoes. Two sets of knives spaced approximately seven inches apart cut the vines loose from the potatoes three and one-half inches on each side of the center of the row. Concave spoked wheels set at an angle to the direction of travel and having specially designed fingers lift the vines from the ground surface and move them into a windrow in the valley between two hilled rows.

The individual finger wheels are floating and will automatically fit themselves to variable bed heights. In operation it requires few adjustments.

The 1946 model as described in this bulletin is horse powered. However, the principle of operation may easily be adapted to a machine designed for tractor power.

[2] Quoted from "Sweet Potato Vine Silage," Circular No. 3, October, 1944, North Carolina Agricultural Experiment Station.





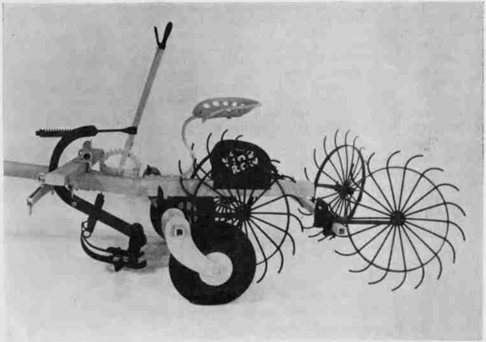



FIG. 2. ABOVE: 1946 MODEL "VINE-ROW" WITH TOOLS SET FOR TRANSPORTATION
BELOW: TOOLS SET FOR WORKING POSITION

FIG. 3. THE RESULTING ACTION OF THE FINGER WHEELS

## ANALYSIS OF THE LIFTING AND WINDROWING ACTION OF THE FINGER WHEEL

A view illustrating the action of the finger wheels is shown in Fig. 3. It will be noticed that the point of each finger is dragged through the soil a short distance parallel with the axle on which the wheel revolves. This action occurs because the wheel is set diagonally to the direction of travel and its velocity is slower than the velocity of the machine. The velocity of the toothpoint with respect to its axis will be a function of the cosine of the angle that the wheel makes with the direction of travel. By composition of the velocity vector quantities the resultant velocity will be parallel with the wheel axle. This drag stroke operation of each point lifts the vines where they are rooted in the soil and moves them at an angle to the direction of travel or to the row of potatoes. It will be further observed that the wheel is concave. This encourages the point of the tooth to slide under the vines. A convex tooth or even a straight tooth would tend to drag over the top of the vines. Each finger is curved backwards from its direction of rotation and in the plane of the wheel so that it sheds the vines soon after the end of the drag stroke.

Fig. 4 shows graphically the effective drag strokes made by a 30″ finger wheel with its axis inclined 55 degrees from the line of travel. The finger points in the end view of the wheel that are in contact with the soil are simply projected to a horizontal plane passing through the wheel and its axle. The resulting drag strokes would occur on flat, level ground. An explanation of the symbols is as follows:

- $\delta$ = angle between axis of wheel and line of travel = 55°.
- R = radius of finger wheel = 15″.
- $\beta$ = angle between respective fingers or spokes of wheel = 20° for 18 fingers.
- $\theta$ = angle between plane of wheel and direction of travel = $90° - \delta$.
- Y = perpendicular distance between respective drag strokes.
- X = length of the drag stroke.
- Z = effective width covered by a finger wheel.



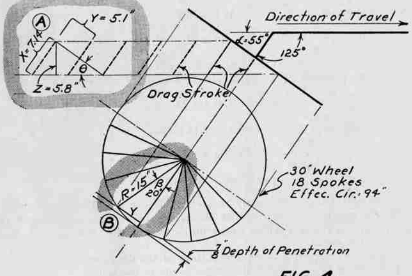



FIG. 4

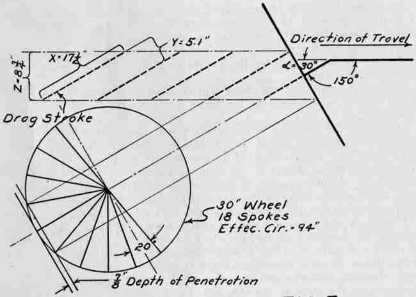
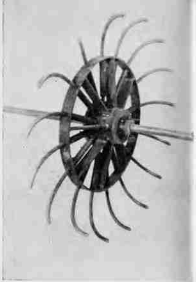



FIG. 5

FIG. 6. EXPERIMENTAL FINGER WHEEL



For determination of Y refer to Fig. 4B.

$$\text{Sin } \beta = \frac{Y}{R} \text{ or } Y = R \times \text{Sin } \beta.$$

substituting $Y = 15 \times .34 = 5.1$ inches.

For determination of X and Z refer to Fig. 4A.

$$\text{Tan } \theta = \frac{X}{2 \times Y} \text{ or } X = \text{Tan } \theta \times 2Y.$$

substituting $X = .7 \times 10.2 = 7.14$ inches.

$$\text{Sin } \theta = \frac{Z}{2Y} \text{ or } Z = 2Y \text{ Sin } \theta.$$

substituting $Z = 10.2 \times .57 = 5.8$ inches.

These calculations are purely theoretical. Under actual operating conditions the finger wheel will revolve slower due to the resistance caused by the vines. The resulting effect causes an increase in the value of X. Y and Z are not changed.

The following factors affect the pattern of the drag strokes:

1. Depth of penetration of the finger points in the soil.
2. Resistance of the vines as affected by their weight and by the strength of their secondary root system.
3. Diameter of the finger wheel.
4. Angle $\delta$.

Increasing the depth of penetration will increase X and Z. The factor Y is little influenced. In the above calculations a depth of ⅞ inches was assumed. This is approximately the working depth for the Vine-Row. It is influenced by the weight of the wheel, firmness of the soil and the resistance of the vines since the line of draft for each individual wheel is necessarily upward.

Greater resistance of the vines will decrease the speed of the finger wheel causing an increase in the value X. The value Z and Y are not influenced.

Increasing the diameter of the wheel will increase the value of Y for any given number of spokes. It will also increase both X and Z values. This offers the best method of increasing the harvesting efficiency of the machine. Along with a larger diameter the angle $\delta$ may be decreased without the possible trouble of vines wrapping around the wheel. However, one must not overlook the fact that the larger wheel will necessitate heavier construction and a larger machine, with the resulting greater cost.

Decreasing the value of $\delta$ will increase the value of X and Z. A graph showing the pattern for a 30 inch wheel set 30 degrees from the direction of travel is illustrated in Fig. 5. It will be observed that the pattern of the drag strokes covers a greater area and is more effective in covering that area. However, difficulty will be encountered with the wheel rotating and thus moving the vines to the side and also in shedding vines at the end of the drag stroke if it does rotate. Field experience indicated that the 55 degree angle is ideal for a 30 inch wheel operating under most conditions.



Figure 6 shows an experimental wheel in which the curved ends of the fingers are set parallel with the wheel axis, or the drag stroke, and by cam action are rotated 90 degrees soon after the end of the drag stroke in order to properly shed. The wheel was tried only at the 55 degree angle and did no better than the regular wheel (See Fig 7). The complicated construction would materially increase the cost of the machine. Experimental work will be continued.

FIG. 7. EXPERIMENTAL WHEEL IN USE

## FIELD OPERATION

Fig. 8 shows the harvester being used to windrow the vines in the valley. Where potatoes are grown on wide rows, or where the vines are rooted down in the valley, a second trip may be necessary to completely loosen all the vines. If a second trip is necessary, both sets of wheels are adjusted outwardly. For the farmer with a small acreage the vines may be picked up by fork from the windrows as they lay in the valley, or they may be raked first into piles and forked afterward into a wagon. The windrow is important for it permits wilting the vines for a short period.

FIG. 8. VINES ARE MOVED TO THE VALLEYS ON THE FIRST TRIP

The moisture content is relatively high on sweet potato vines, being too high to make ideal silage. Wilting the vines for a long period cannot be done successfully because of relatively slow loss of water from the stems as compared with the leaves.

One of the big advantages is the way the "Vine-Row" may be fitted into a method of harvesting for both the large and small grower. The farmer with a large acreage may use a pick-up type of commercial forage crop harvester or chopper as shown in Fig. 9. When the commercial chopper

FIG. 9. COMMERCIAL CHOPPER MAY BE USED TO PICK UP VINES FROM A WINDROW

is to be used the fingered wheels on the "Vine-Row" are interchanged and a second trip is made to move two windrows together on the top of one bed. (See Fig. 10.) This resulting windrow may again be allowed to wilt and is of a size suitable for the chopper and is in a better position to be picked up. The finger wheels might well be designed to mount on the front of a field chopper so that the separate operation of bringing two windrows together may be eliminated. The field chopper is a very popular machine and is one of the most important labor saving machines for the harvesting of grass silage and hay. It may be used to particular advantage in the case of sweet potato vines, for the chopped vines are much easier to unload at the silo. Unchopped vines are difficult to unload and feed into an ensilage cutter.



FIG. 10. TWO WINDROWS MAY BE BROUGHT TOGETHER ON TOP OF THE BED. NOTE THAT THE FINGER WHEELS ARE INTERCHANGED

## PERFORMANCE

Preventing mechanical injury to the potato was an important objective in the design of the machine. Tests indicate that no more than 4 per cent damage occurs to the potatoes by the "Vine-Row." The greater percentage of the damage was done by the parallel knives. A knife cut is not as serious as a bruise as it heals readily. This damage is considered to be only slightly more than that done by present vine cutters attached to the beam of the plow when the potatoes are dug. This method of harvesting the potatoes however, will cover up the vines and will not permit them to be saved for feed.

Observations indicate that approximately 80 per cent of the vines are saved by the use of the "Vine-Row."

## ADDITIONAL USES AND MARKET POSSIBILITIES

The "Vine-Row" may prove valuable for the grower who harvests his potatoes with a mechanical type digger. The vine removal problem has always been important when mechanical diggers are used. Removing the vines by hand, regardless of the purpose, is time consuming and has no place in efficient mechanized farming. It is estimated that 30 man hours per acre are required to cut the vines with a hoe and pull to the middles. The "Vine-Row" will do this job in approximately one and one-half hours per acre.

A certain percentage of farmers who usually dig their potatoes by plowing them out may want one of these machines for removing the vines previous to digging. Their present method is to remove the vines by hand or to drag them off by hay rakes or to use a vine cutter attached to the beam of a plow.[3] Most farmers who are not interested in saving the vines will find this type of vine cutter satisfactory. Where one is not saving the vines for feed, the cutter permits the vines to be covered up during the same trip for digging, and they are thus returned to the soil.

It is difficult to estimate the sales potential for the "Vine-Row." Table I gives some data on sweet potatoes in North Carolina that may be of help. Table II gives the total 1945 acreage in sweet potatoes for the important potato producing states.

**TABLE I**

**Sweet Potatoes—North Carolina, 1943**

| | .1-.4 Acres | .5-.9 Acres | 1-2.9 Acres | 3-9.9 Acres | 10 acres and over |
|---|---|---|---|---|---|
| No. Farms | 26,512 | 14,559 | 11,442 | 2,183 | 139 |
| Total Acres | 7,121 | 10,092 | 17,731 | 10,504 | 2,155 |

(Data on the individual counties for the state may be had upon request.)

**TABLE II**

**Sweet Potato Acreage—1945**

| | | |
|---|---|---|
| 1. Louisiana | 123,000 | acres |
| 2. Georgia | 89,000 | " |
| 3. Alabama | 75,000 | " |
| 4. Mississippi | 68,000 | " |
| 5. North Carolina | 66,000 | " |
| 6. South Carolina | 62,000 | " |
| 7. Texas | 52,000 | " |
| 8. Virginia | 31,000 | " |
| 9. Tennessee | 30,000 | " |
| 10. Arkansas | 20,000 | " |
| 11. New Jersey | 15,000 | " |
| 12. Kentucky | 14,000 | " |

The sweet potato is one of the South's most important crops, both from the standpoint of food and feed. Table I will show that the bulk of the acreage in North Carolina is now produced in plots less than 10 acres. It is expected that with the rapid expansion of commercial dehydration plants and with mechanization of the crop that the plot size will increase. The utilization of the vines makes almost complete utilization of the crop possible.

[3] Plan No. 548. Sweet Potato Vine Cutter for Middle Buster, Dept. of Agricultural Engineering, N. C. State College, Raleigh, N. C.



The "Vine-Row" was developed primarily for the harvesting of sweet potato vines, but it is thought that the principle of operation may have other farm field uses such as windrowing hay. Such a machine (See Fig. 11) utilizing this principle of fingered wheels would seem to have the following advantages:

1. Each spoked wheel is independent and floating and would fit uneven land such as caused by terraces. The lack of flexibility is the most serious objection to the present side delivery rakes.
2. No complicated and expensive power drives from ground wheels.
3. The amount of hay placed in a windrow may be varied by adding or decreasing the number of fingered wheels or by adjusting their spacing on a tool bar.

FIG. 11. EXPERIMENTING WITH THE "VINE-ROW" IN HAY

## PATENT

Steps have been taken to secure patent protection for this machine and its principle of operation.

## CONSTRUCTION DETAILS

The design on the following pages is for the 1946 "Vine-Row" and is included for the manufacturers' study and to aid in making up an estimated production cost. It is assumed that the company who is awarded the manufacturing rights will change and improve on the design in order to get the best production method based on the equipment and processes used in its plant. The rubber tires used on the 1946 model as shown in Fig. 2 are not considered desirable. They were substituted when it became impossible to secure standard farm implement tires.

The possible use of hard facing material to coat that portion of the finger tips subject to erosion was given consideration. The final criteria in the use of materials and construction procedure is, of course, in the final analysis, economy to the farmer. The test unit shown in Fig. 12 was devised to aid in making a sound decision. Two similar wheels were built of ½ round, cold drawn steel SAE 1020 with a Brinell hardness of 144 and tensile strength of 69,000 PSI. On one of the wheels the finger points were weld coated with a self hardening abrasion resisting metal having a Brinell hardness of approximately 400 after being deposited. The wheels were operated in a mixture of sand and gravel having a maximum diameter of ¾ inch and were set to travel at exactly the same angle to the instantaneous line of draft as they do during normal straight-line operation of the harvester. A test conducted over the equivalent of 160 acres of 3½ foot rows indicated that the non-coated wheel would last a minimum of 300 acres. The hand coated wheel was little affected. A machine being used to harvest a small acreage each year (less than 50 acres) would probably become obsolete or deteriorate from weather action before the wheels would need replacing. Hard facing is not recommended.

Considering further the wheel construction, it was decided to make the spokes out of 7/16 inch N.E. 8742 low alloy structural steel having the following properties: Tensile strength = 109,000 PSI, Hardness—Brinell = 363. The weight saved because of its greater strength offsets the greater cost. It is further thought that the greater hardness would make the life of the finger satisfactory even for a larger operator without hard facing the points.

A laboratory test such as described above is not satisfactory in itself. The sand, because of the continued stirring, looses its severe abrasive action. Any soil used for such a test would also be changed in its physical properties thus rendering the test inaccurate. Such a test would only be indicative of what might be expected and should therefore be supplemented by a further study of experimental machines operating under field conditions. The sweet potato vines would undoubtedly have some influence on wearability of the teeth.



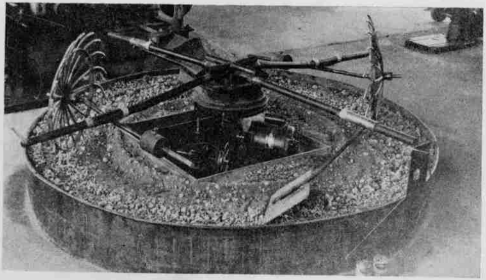
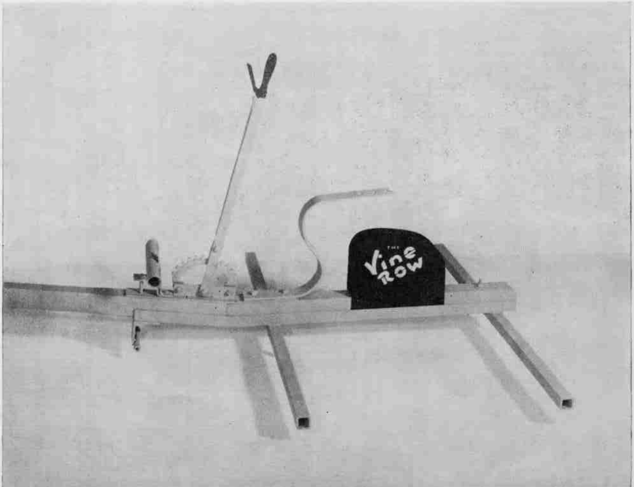
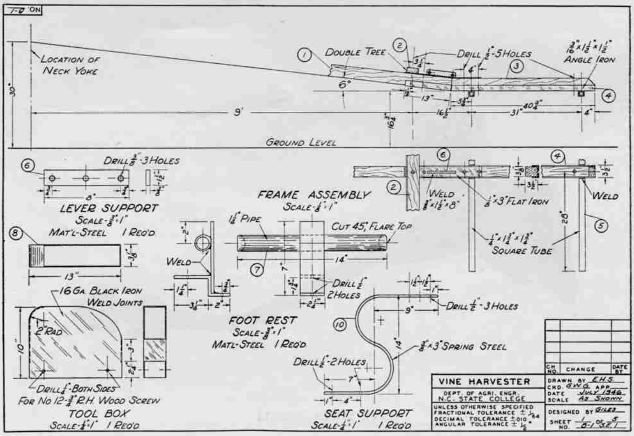


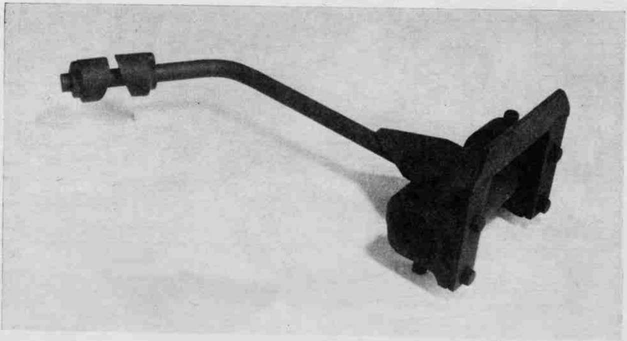
FIG. 12. TESTING THE WEAR ON THE FINGERS


THE
Vine
ROW

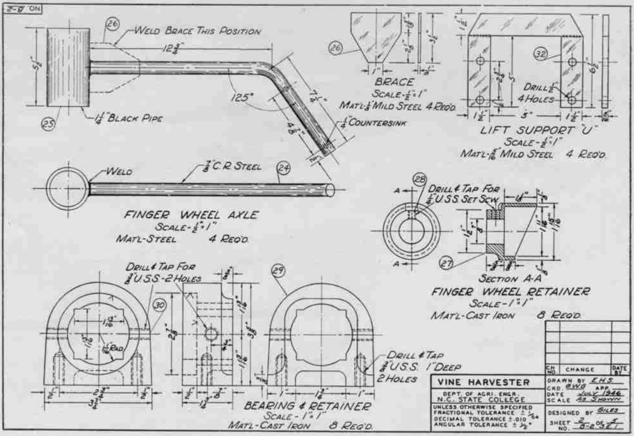



LOCATION OF
NECK YOKE
DOUBLE TREE
DRILL 1/2"-5 HOLES
3/16"x1 1/2"x1 1/2"
ANGLE IRON
GROUND LEVEL
DRILL 3/8"-3 HOLES
LEVER SUPPORT
SCALE-3/8"=1"
MAT'L-STEEL 1 REQ'D
FRAME ASSEMBLY
SCALE-1/8"=1"
WELD
3/8"x1 1/2"x8"
1/2"x3" FLAT IRON
WELD
1/4"x1 3/4"x1 3/4"
SQUARE TUBE
1 1/4" PIPE
CUT 45° FLARE TOP
WELD
DRILL 1/2"
2 HOLES
16 GA. BLACK IRON
WELD JOINTS
2" RAD
FOOT REST
SCALE-3/8"=1"
MAT'L-STEEL 1 REQ'D
DRILL 1/2"-3 HOLES
3/8"x3" SPRING STEEL
DRILL 1/2"-2 HOLES
DRILL 1/4"-BOTH SIDES
FOR NO 12-3/4" R.H. WOOD SCREW
TOOL BOX
SCALE-1/2"=1" 1 REQ'D
SEAT SUPPORT
SCALE-1/2"=1" 1 REQ'D
VINE HARVESTER
DEPT. OF AGRI. ENGR.
N.C. STATE COLLEGE
UNLESS OTHERWISE SPECIFIED
FRACTIONAL TOLERANCE ± 1/64
DECIMAL TOLERANCE ±.010
ANGULAR TOLERANCE ± 1/2°
CH. NO.
CHANGE
DATE BY
DRAWN BY E.H.S.
CKD. G.W.G. APP.
DATE JULY 1946
SCALE AS SHOWN
DESIGNED BY GILES

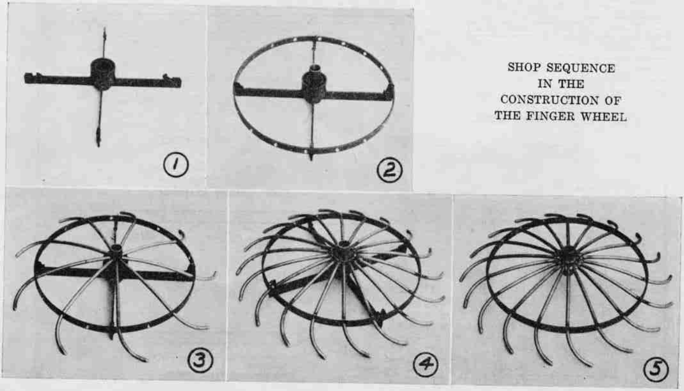
## FINGER WHEEL AXLE





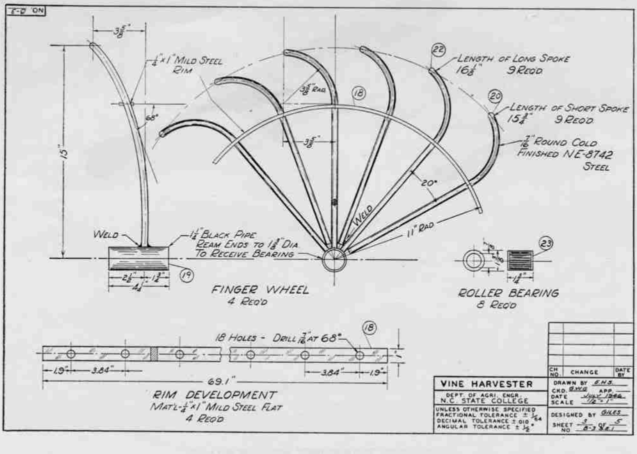


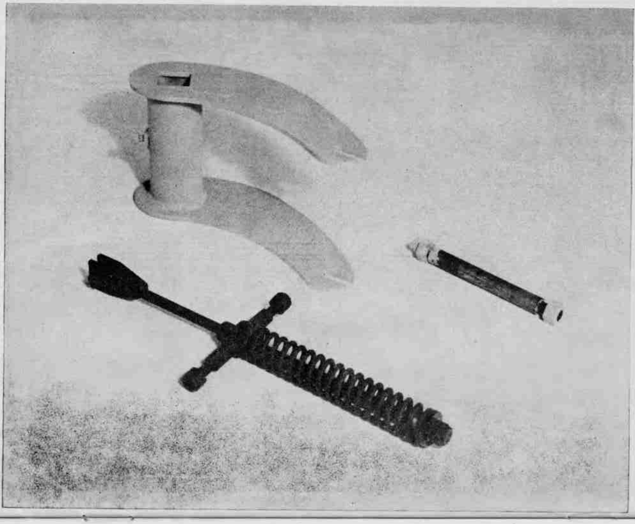
# FINGER WHEEL



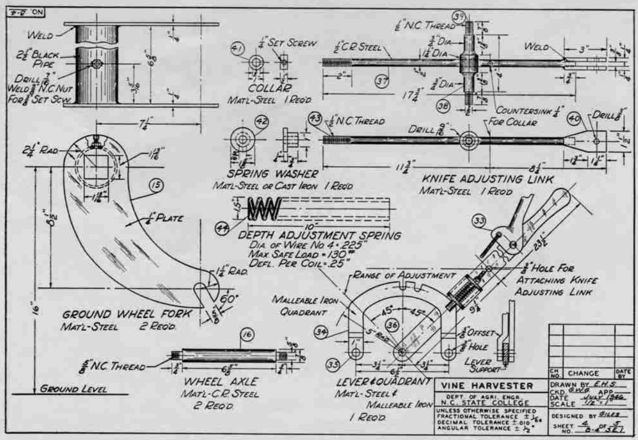

SHOP SEQUENCE
IN THE
CONSTRUCTION OF
THE FINGER WHEEL



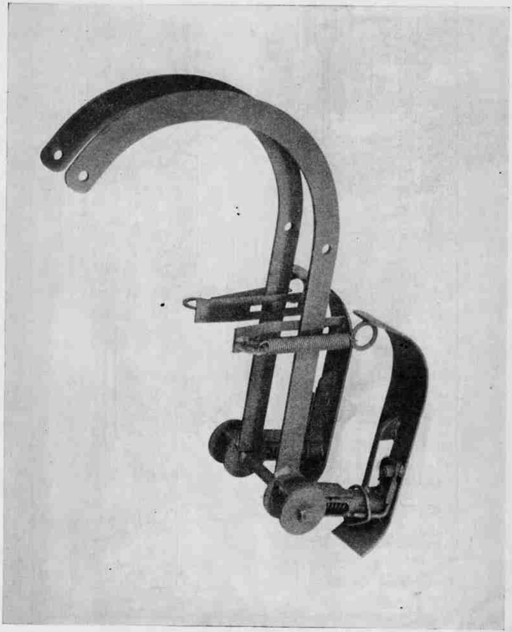




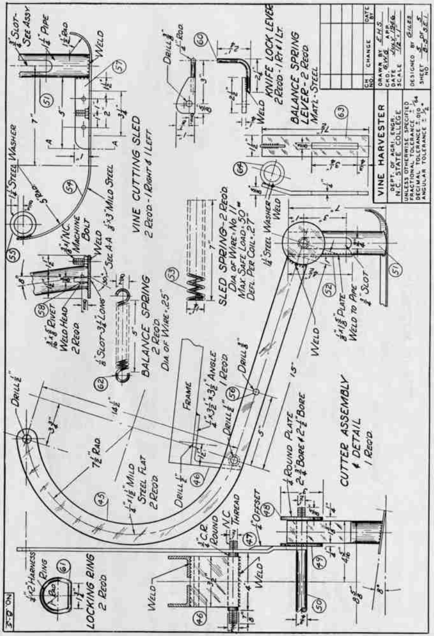




WELD
2½" BLACK PIPE
DRILL 7/16" WELD ⅜" N.C. NUT FOR ⅜" SET SCW
¼" SET SCREW
COLLAR
MAT'L-STEEL 1 REQ'D
½" C.R. STEEL
½" N.C. THREAD
COUNTERSINK ¼" FOR COLLAR
½" N.C. THREAD
SPRING WASHER
MAT'L-STEEL OR CAST IRON 1 REQ'D
KNIFE ADJUSTING LINK
MAT'L-STEEL 1 REQ'D
¼" PLATE
DEPTH ADJUSTMENT SPRING
DIA. OF WIRE No 4 = .225"
MAX SAFE LOAD = 130#
DEFL. PER COIL = .25"
RANGE OF ADJUSTMENT
⅜" HOLE FOR ATTACHING KNIFE ADJUSTING LINK
MALLEABLE IRON QUADRANT
GROUND WHEEL FORK
MAT'L-STEEL 2 REQ'D
⅛" OFFSET
⅜" HOLE
LEVER SUPPORT
⅝" N.C. THREAD
GROUND LEVEL
WHEEL AXLE
MAT'L-C.R. STEEL
2 REQ'D
LEVER & QUADRANT
MAT'L-STEEL & MALLEABLE IRON
1 REQ'D
VINE HARVESTER
DEPT. OF AGRI. ENGR.
N.C. STATE COLLEGE
UNLESS OTHERWISE SPECIFIED FRACTIONAL TOLERANCE ± 1/64 DECIMAL TOLERANCE ±.010 ANGULAR TOLERANCE ± ½°
CH NO.
CHANGE
DATE BY
DRAWN BY E.H.S.
DESIGNED BY GILES






VINE HARVESTER
DEPT. OF AGRI. ENGR.
N.C. STATE COLLEGE
CUTTER ASSEMBLY & DETAIL
1 REQ'D
VINE CUTTING SLED
2 REQ'D - 1 RIGHT & 1 LEFT
SLED SPRING - 2 REQ'D
BALANCE SPRING
2 REQ'D
KNIFE LOCK LEVER
2 REQ'D - 1 RT & 1 LT
BALANCE SPRING
LEVER - 2 REQ'D
MAT'L - STEEL
LOCKING RING
2 REQ'D
FRAME
WELD

## BILL OF MATERIAL

| Pc. Work | Sheet No. | Description | Quantity | Material Kind | Size | Weight Total Pounds | Remarks | Mfgr's. Notes |
|---|---|---|---|---|---|---|---|---|
| | | | | **Main Frame** | | | | |
| 1 | 1 | Tongue | 1 | Wood | 3"x 3"x 10½' | | | |
| 2 | 1 | Double Trees | 1 | Wood and Steel | Standard | 17 | | |
| 3 | 1 | Frame, Wood | 1 | Oak | 3⅛"x 3½"x 40" | | | |
| 4 | 1 | Frame, Metal | 2 | Steel Angle | 3/16"x 1½"x 1½"x 53" | 15.8 | | |
| 5 | 1 | Tool Bar | 2 | Steel Sq. Tube | ¼"x 1¾"x 1¾"x 56" | 25 | | |
| 6 | 1 | Lever Support | 1 | Flat Steel | ⅜"x 1½"x 8" | 1.25 | | |
| 7 | 1 | Foot Rest Assembly | 1 | | | 4.5 | | |
| | | | 1 | Black St. Pipe | 1¼"x 14" | | | |
| | | | 1 | Flat Steel | ¼"x 2¼"x 6¾" | | | |
| | | | 1 | Flat Steel | ¼"x 2¼"x 7" | | | |
| 8 | 1 | Tool Box | 1 | Black Sheet Iron | 16 Ga., 312 sq. in. | 6.2 | | |
| 9 | | Wood Screws | 4 | R. H. Steel | No. 12 ¾" | | For mounting tool box | |
| 10 | 1 | Seat Support | 1 | Spring Steel | ⅜"x 3"x 34" | 10.2 | | |
| 11 | | Seat | 1 | Steel | Standard | 4.2 | Commercial | |
| 12 | | Carriage Bolts and Nuts | 3 | N. C. | ½"x 4½" | | | |
| 13 | | Machine Bolts and Nuts | 1 | N. C. | ½"x 7" | | For double trees | |
| 14 | | Carriage Bolt, Nut & Washer | 1 | N. C. | ½"x 1" | | For seat | |
| | | | | | Total Weight Assembled | 141.5 | | |
| | | | | **Ground Wheel and Mounting** | | | | |
| 15 | 4 | Ground Wheel Fork Assembly | 2 | | | 11.1 | | |
| | 4 | | 2 | Black St. Pipe | 2½"x 6⅝" | | | |
| | 4 | | 4 | Flat Steel | ¼"x 6"x 14¾" | | | |
| | 4 | | 2 | Set Screws, Sq. hd. | ⅜"x 1¼" | | | |
| | 4 | | 2 | Nuts, N. C. | ⅜" | | | |
| 16 | 4 | Wheel Axle | 2 | 1020 Round C. R. | ⅞"x 8⅛" | | | |
| | | | 2 | Nuts, N. C. | ¾" | | For axle | |

## BILL OF MATERIAL (Continued)

| Pc. Work | Sheet No. | Description | Quantity | Material Kind | Size | Weight Total Pounds | Remarks | Mfgr's. Notes |
|---|---|---|---|---|---|---|---|---|
| | | | | **Ground Wheel and Mounting** | | | | |
| 17 | | Wheel and Tire including bearing and seal | 2 | Implement tire | 4:00 - 9 | 30 | Steel wheel may be used | |
| | | | | **Finger Wheel and Mounting** | | | | |
| | 3 | Finger Wheel Ass. | 4 | | | 70 | | |
| 18 | 3 | | 4 | Flat Steel | ¼"x 1"x 69.1" | | | |
| 19 | 3 | | 4 | Black St. Pipe | 1¼"x 4¼" | | | |
| 20 | 3 | | 36 | Round N. E. 8742 Steel | 7/16"x 15¾" | | | |
| 22 | 3 | | 36 | Round N. E. 8742 Steel | 7/16"x 16⅛" | | | |
| 23 | 3 | Roller Bearing | 8 | | ⅞"x 1¾" | | Commercial | |
| | 2 | Finger Wheel Axle Assembly | 4 | | | 26 | | |
| 24 | 2 | | 4 | 1020 Round C. R. Steel | ⅞"x 20" | | | |
| 25 | 2 | | 4 | Black St. Pipe | 2½"x 5½" | | | |
| 26 | 2 | | 4 | Flat Steel | ⅛"x 3½"x 3½" | | | |
| 27 | 2 | Finger Wheel Retainer | 8 | Cast Iron | | 5 | | |
| 28 | 2 | Set Screw Socket | 8 | Cup point, Self locking | ¼" | | Commercial | |
| 29 | 2 | Bearing and Retainer | 8 | Cast Iron | | 20.8 | | |
| 30 | 2 | Set Screw | 8 | Sq. Hd. | ⅜"x 1¼" | | Commercial | |
| 31 | | Felt Washer | 8 | Felt | ⅞" dia. x 1⅜" dia. | | Not shown on drawing | |
| 32 | 2 | Lift Support "U" | 4 | Flat Steel | 5/16"x 1½"x 18" | 9 | | |
| | | Cap Screw | 16 | N. C. | ⅜"x 1" | | Commercial | |
| | | | | **Lever System** | | | | |
| 33 | 4 | Lever | 1 | Steel | 32" | | | |
| 34 | 4 | Quadrant | 1 | Malleable | 92° | 6 | | |
| 35 | 4 | Machine Bolt and Nut | 2 | N. C. | ⅜"x 1½" | | | |
| 36 | 4 | Machine Bolt and Nut | 1 | N. C. | ⅜"x 1½" | | | |
| | 4 | Knife Adjusting Link Ass. | 1 | | | 4.1 | | |
| 37 | 4 | Rod | 1 | 1020 Round C. R. Steel | ½"x 17¾" | 1.0 | | |
| 38 | 4 | Cross Arm | 1 | 1020 Round C. R. Steel | 1¼"x 5¾" | 2.0 | | |

## BILL OF MATERIAL (Continued)

| Pc. Work | Sheet No. | Description | Quantity | Material Kind | Material Size | Weight Total Pounds | Remarks | Mfgr's. Notes |
|---|---|---|---|---|---|---|---|---|
| | | | | **Lever System** | | | | |
| 39 | 4 | Nuts | 2 | N. C. Self Locking | ½" | | | |
| 40 | 4 | Yoke | 2 | Flat Steel | ¼"x 1½"x 3" | 1.14 | | |
| 41 | 4 | Collar | 1 | Steel with Self Locking Screw | ½" | | Commercial | |
| 42 | 4 | Spring Washer | 1 | Steel or Cast | 9/16" Bore | | | |
| 43 | 4 | Nut | 1 | N. C. Self Locking | ½" | | | |
| 44 | 4 | Depth Spring | 1 | Closed End Comp. | No. 4 Wire, 25" Def. 1½"x 10" | | | |
| | | | | **Cutter System** | | | | |
| | 5 | Cutter Assembly | 1 | | | 26.5 | | |
| 45 | 5 | Lever Strap | 2 | Flat Steel | ¼"x 1½"x 36" | 7.6 | | |
| 46 | 5 | Pivot Bracket | 1 | Angle | ¼"x 3½"x 3½" | 1.5 | Weld to frame | |
| | | | 1 | 1020 Round C. R. | ¾"x 5¾" | .72 | | |
| 47 | 5 | Nuts | 2 | N. C. Self Locking | ½" | | | |
| 48 | 5 | Retaining Plate, Outside | 2 | Flat Steel | ¼"x 3" dia., ½" Bore | 1.2 | | |
| 49 | 5 | Retaining Plate, Inside | 2 | Flat Steel | ¼"x 3" dia., ¾" Bore | 1.2 | | |
| 50 | 5 | Sled Axle | 1 | 1020 Round C. R. | ¾"x 10⅜" | 1.4 | | |
| 51 | 5 | Sled Standard | 2 | Black St. Pipe | 1¼"x 7" | 2.6 | | |
| 52 | 5 | Slide Plate | 2 | Flat Steel | ⅛"x 1⅝"x 4½" | .52 | | |
| 53 | 5 | Sled Spring | 2 | Closed End Comp. | Noll Wire, 50 lb. Lead, 27" Def., 1¼"x 7" | | | |
| 54 | 5 | Sled | 2 | Flat Steel 1020 | ⅛"x 3"x 13" | 2.6 | | |
| 55 | 5 | Spring Holder | 2 | Washer | ⅛"x 1¼"x 2" | | Commercial | |
| 56 | 5 | Machine Bolt and Nuts | 2 | N. C. Self Locking | ⅜"x 1" | | | |
| 57 | 5 | Knife Holder | 2 | Flat Steel | ⅜"x 1"x 5" | 1.75 | | |
| 58 | 5 | Rivets | 4 | R. H. Soft | 3/16"x ⅝" | | | |
| 59 | | Knife Section | 2 | Mower, Smooth Edge | 3" St. | | Commercial | |
| 60 | 5 | Knife Lock | 2 | Flat Steel | ¼"x 1"x 2½" | .35 | | |

## BILL OF MATERIAL (Continued)

| Pc. Work | Sheet No. | Description | Quantity | Material Kind | Material Size | Weight Total Pounds | Remarks | Mfgr's. Notes |
|---|---|---|---|---|---|---|---|---|
| | | | | Cutter System | | | | |
| | | | 2 | Round | ¼"x 4½" | .12 | | |
| 61 | 5 | Locking Ring | 2 | Harness Ring | ¼"x 2" | | Commercial | |
| 62 | 5 | Balance Spring | 2 | Tension Hook End | ⅞"x 5", .25" Wire | | Commercial | |
| 63 | 5 | Spring Adjusting Lever | 2 | Flat Steel | ¼"x 1½"x 7½" | 1.6 | | |
| 64 | 5 | Spring Holder | 2 | Washer | ⅛"x 1¼"x 2" | | Commercial | |
| | | TOTAL WEIGHT OF ASSEMBLED MACHINE AS SHOWN IN FIG. 2 | | | | 350 | | |

THE AGRICULTURAL EXPERIMENT STATION
OF THE
NORTH CAROLINA STATE COLLEGE OF AGRICULTURE AND ENGINEERING
L. D. BAVER, DIRECTOR
STATE COLLEGE STATION
RALEIGH

---