A Mechanical
HARVESTING AND HANDLING SYSTEM
For Tobacco

Knowing how fast a mechanical harvester can strip the tobacco in the field is only part of the knowledge needed to develop a practical harvesting and handling system. This rate then must be adapted to the rate required for taking the harvested tobacco to the curing facility and unloading it there . . .

Before a successful system for mechanically harvesting and handling Virginia-type tobacco can be developed, many questions must be accurately answered—such as practical ground speeds for the different "primings" or harvests; how to achieve minimum leaf loss; correlation of the priming, racking, and unloading routines to avoid costly delays. Many tobacco farmers prefer to fill a bulk curing barn within the day of harvest. Can system capacity permit mechanical harvesting in increments of barn capacities?

Studies already have resulted in devices to successfully remove a swath of tobacco leaves and assemble them mechanically. The tests described here, carried on over a two-year span, were conducted specifically to determine operating rates in the field, leaves left in the field, time losses due to turning and unloading, expected ground speeds for harvest and transport, and variations in filled rack weight. This data then would establish useful criteria to aid in determining over-all machine capacity for the different primings or harvests (Fig. 1).

Test Setup

Between 9 and 10 acres were harvested each test year. Terrain and soil were typical of major Virginia-type tobacco-growing areas. Two commercial tobacco lines and one experimental one were harvested yearly. The traditional six primings were made during each of the two test years with the commercial lines.

The prototype harvester (Fig. 2) was operated with a driver plus two men to rack the tobacco. Their rates were compared with those of a hand crew harvesting and handling tobacco in the conventional manner.

Two primary factors limit the mechanical harvesting rate: the maximum rate at which the driver can control the machine to harvest an acceptable swath of ripe leaves without excessive loss; and the rate at which the leaves can be racked and stored in the pallet. These rates should match for greatest efficiency in use of equipment and crew.

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This is a condensation. The complete paper also contains formulas used in establishing specific operational parameters for this mechanical harvesting-harvesting system, additional statistics indicating the specific effects of system variables, and a reference list. This paper may be obtained by requesting Report No. G--137 from ASAE, 420 Main Street, St. Joseph, Mich. 49085. Cost is 50¢ each (or ASAE Member Order Form).

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In conventional bulk curing, two workers must lift the filled racks from an open frame pallet and position the tobacco on rails in the bulk curing barns. This system was compared with an experimental one in which enclosed and insulated pallets are backed end to end on rails to form a curing structure holding five pallets on either side of a down draft blower-furnace room (Fig. 4).

In this experimental system, when the 10 pallets are in place, conditioned air is forced through the slatted floors of these pallets and up through the tobacco leaves, which are held vertically on the metal racks. Louvers on the other ends of the pallets may be opened for exhaust air passage or the heated air can be returned through the open connected pallet gables to the furnace room.

The cured tobacco from both the conventional and experimental systems then was taken to a packhouse for grading and tying in the traditional manner.

The average unloading time was 5.65 min. This includes the time from the exit from one row to the entry of the next row - including turning time and time to drop off the filled pallet and pick up an empty one. Time for turning the harvester to reenter the row is cut as operator proficiency increases — this averaged 0.71 min the first year and 0.52 min the second. It required an average of 1.04 min, however, per turn for that first pruning the first year, but only 0.45 min per turn for the fifth pruning the second year. The same driver was used both years.

The advantage of using a tobacco variety which would require only three annual prunings was clearly shown. The average time to harvest a pallet of the conventional variety for the first pruning was 38 min, but was only 14 min with the experimental variety.

The operating capacity of the harvester, including turn- ing and unloading time but excluding stoppages, averaged 0.71 acres per hr. Non-mechanical machine stoppages averaged 9 percent of total time. Row width and ground speed were the most important factors in determining acres per hour covered.

It is essential that the trailer taking the filled pallet to the curing facility return in time for the next pallet. Our tractor driver could, without extra help, unload the pallet on the pallet curve and return to the field (about 1/2 mile) in about 15 min. The pallets could be unloaded by hand into a commercial bulk curing barn in 15 to 20 min by the driver plus one more worker.

Because the air being forced through the leaves in the experimental curing facility will follow the line of least resistance, the most heavily loaded rack fails to receive adequate air flow — with consequent spoilage of the leaves. An accurate machine designed for rack curing is essential to help the rack curing crew obtain uniform rack weights — this variation should be held to under 5 percent.

The man-hours per acre to harvest the tobacco and place it in the curing barn are shown in Table II. The pallet curing crew included a driver, two drivers, one gleaner and one pallet loader. One extra man was used at the conventional bulk curing barns to help unload. (These figures do not include time lost for stoppages for either crew.) The hand crew was made up of farm personnel familiar with normal harvesting operations. Total hand labor includes pruning, sledding, stringing and hanging in the barn.

### Table I  MAN-HOURS PER ACRE FOR MECHANICAL AND HAND HARVESTING

<table>
<thead>
<tr>
<th>Year</th>
<th>Machine harvesting</th>
<th>Hand harvesting</th>
<th>Total</th>
<th>Differences</th>
</tr>
</thead>
<tbody>
<tr>
<td>1963</td>
<td>40.0</td>
<td>8.8</td>
<td>48.8</td>
<td>153.2</td>
</tr>
<tr>
<td>1964</td>
<td>40.9</td>
<td>41.0</td>
<td>81.9</td>
<td>209.0</td>
</tr>
</tbody>
</table>

It was noted, however, that about 17 percent more time was required to tie the machine-harvested tobacco.

During the first year, 654 lb of hand-harvested tobac- co was sold on a commercial auction floor for an average price of $5.32 per lb, which compared with $610 lb of machine harvested tobacco for an average of $48.18 per lb. Table 2 gives results when matched lots of hand and machine harvested tobacco were sold.

### Table II  SALE OF MATCHED lots OF TOBACCO — 1963

<table>
<thead>
<tr>
<th>Harvesting method</th>
<th>Grade</th>
<th>Pounds</th>
<th>Price Per lb</th>
</tr>
</thead>
<tbody>
<tr>
<td>Machine harvesting</td>
<td>XLS</td>
<td>482</td>
<td>$6.55</td>
</tr>
<tr>
<td>Hand harvesting</td>
<td>XLS</td>
<td>538</td>
<td>$6.62</td>
</tr>
<tr>
<td>Machine harvesting</td>
<td>P5L</td>
<td>110</td>
<td>0.17</td>
</tr>
<tr>
<td>Hand harvesting</td>
<td>P5L</td>
<td>150</td>
<td>0.30</td>
</tr>
</tbody>
</table>

The decrease in market value of mechanically harvested leaf thus amounts to about $100 per acre for these tests. Steps necessary to minimize quality degradation would include special attention to leaf handling, especially in the racking operation and in decreasing rack weight variation for more uniform cure.

The economic importance of field losses can be esti- mated by assigning a value of 10 to 12¢ per lb of cured leaves as the cost of production up to time of harvest. Thus the 10 percent field loss encountered in these tests for to- bacco yielding 2000 lb of cured leaf per acre would cost the producer about $21 per acre.

While the added time needed for grading and tying the mechanically cured leaf (about 17 percent in these tests) penalizes the grower, the present trend toward mark- eting the leaf un tied may be significant here.

On the basis of these tests, this mechanical harvesting- bulk curing system should allow the harvest of six to seven acres of tobacco, filling two conventional bulk curing barns in one day's operation.