1-1-1970

How many acres per hour?

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HOW MANY ACRES PER HOUR?

By J. G. DREVER, Agricultural Engineer, New South Wales Department of Agriculture
Reprinted from the Agricultural Gazette of N.S.W., 80:224-228, April, 1969

MANY farm tractor operators don’t know exactly how much land is covered in an hour by implements drawn by their tractors. This information, useful on any farm where tractors are used, is of particular value in contract work.

The capacity of the machine or implement, or in other words, its rate of working, depends on the width of the machine, how fast it travels, how efficiently it is operated and the time it works.

Machine width
When calculations are made of the capacity of a farm implement, the width of the implement, as quoted in its specifications, must be modified to the average width used when it is operating. There is always some overlapping in tillage and cultivation work; with implements such as mowers, headers and harrows it would be practically impossible to utilise the full width of the machine without occasional skips. The overlap necessary to cover a field thoroughly depends on such factors as speed, the condition of the ground and the skill of the operator. When harvesting, it might not be possible to use the full width of the header because of the density of the crop, even at the minimum forward speed of the machine.

Row crop planters and similar implements utilise all their rated width, unlike most other field implements, which cause losses from overlapping. The rated width of a row crop machine is found by multiplying the number of planting or seeding units by the spacing of these units. In other words, the rated width is assumed to include one half space beyond each outside unit.

Machine speed
Implement speed cannot be kept constant because all the time the machine is working changes in draft are caused by changing circumstances, for example the horse power available from the tractor; variations in the hilliness of the farm, the rolling resistances, which can vary from point to point in the field, and the traction of the tractor, which can vary according to the soil or vegetation the tractor is working on.

Methods for measuring approximate implement speed are handy to know. A common method is to walk behind an implement and count the number of steps taken in 20 seconds. This number divided by ten gives the approximate miles per hour. This approximation assumes you walk with a step of 3 feet. A more accurate method is to mark the position of the machine at the beginning and end of a twenty second interval and measure the distance in feet with a tape measure. From this an assessment can be made by dividing the distance by 2.94 and the result by 10. The answer will be a close approximation of the machine’s speed in miles per hour.

Time losses
The percentage of time lost per day or per hour will vary according to the time spent on lubricating and fuelling the machine; periodic checks and adjustments; breakdowns travelling to the job turning at headlands; clearing out blockages and clogging, adding seed and fertiliser; unloading harvested products, and stops for tea and meal breaks.

Time lost in turning, idle travel, and adjustment of machinery have been shown by overseas research workers to be generally proportional to the operating time of the machine.
Other time losses, such as in cleaning out blockages or filling seed and fertiliser boxes and filling spray tanks, tend to be in proportion to the area rather than the operating time.

Time lost during harvesting of crops tends to be proportional to the yield, the area, and length of haul of the harvested crops. Time losses of this nature become increasingly important as the width or speed of the machine is increased. This is because they then become a bigger proportion of the total time required for the operation per acre.

**Effect of field dimensions**

Turns at ends or corners of a field take up a lot of time, especially in short fields, irrespective of whether the machine is worked back and forth or around the area.

Time studies by agricultural engineers overseas indicate that having fields long in proportion to their width tends to reduce operating time and increase the work rate on an acreage per hour basis.

However, other factors may be of more importance in determining the proportions of a field, and should be taken into account. For instance, a square field requires less fence than a rectangular field of the same area; the length may be limited by irrigation requirements and there may be advantage in being able to work a field both ways.

Percentage of time lost when working various machines has not been studied in this country very closely, but figures published in the U.S.A. and the United Kingdom indicate the following figures would be common—

<table>
<thead>
<tr>
<th>Machine</th>
<th>Percentage of Time Lost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mouldboard ploughs</td>
<td>15 to 25</td>
</tr>
<tr>
<td>Disc ploughs</td>
<td>10 to 25</td>
</tr>
<tr>
<td>Grain drill and combines</td>
<td>20 to 30</td>
</tr>
<tr>
<td>Mowers</td>
<td>30</td>
</tr>
<tr>
<td>Balers</td>
<td>30</td>
</tr>
<tr>
<td>Headers</td>
<td>25 to 45</td>
</tr>
<tr>
<td>Corn pickers</td>
<td>35</td>
</tr>
</tbody>
</table>

Tests made on a wide variety of farms in Victoria showed that during haymaking 3½ hours out of a 7-hour day were lost through the following factors:

- Preparing machinery before and after work—60 min.
- Meal breaks—40 min.
- Voluntary delays—15 min.
- Shifting or establishing sites—7 min.
- Weather—3 min.
- Field maintenance and repairs to machinery—75 min.
- Waiting on other machines—10 min.

To improve efficiency it is suggested that a time study of your operations may be well worth while.

The accompanying chart, orginally devised by Mr. E. G. McKibben and published in the *American Agricultural Engineers' Year Book, 1956*, is now used widely throughout the world to determine field working rates. From the chart it is possible to read the rate of doing work in acres per hour for any normal width machine, given its speed and percentage of time lost, without making any calculations at all.

To use the chart to determine the acreage covered by an implement at a given speed, first find the horizontal scale corresponding to the “effective width of the implement.” From this point trace a line up the chart until it reaches the diagonal line representing the “speed” of the implement in the working gear. Then follow this line across horizontally until it meets the “uninterrupted capacity” line on the left vertical scale, and read off the acres per hour on it. This gives the theoretical acres per hour for the implement, assuming no time is lost.

**Example:**

Implement width, 5 ft.

speed, 6 m.p.h.

answer, 3.6 acres per hour.

If we assume that a percentage of time is lost, we proceed as before to find the point on the horizontal scale corresponding to the “effective width of the implement.” Follow, as before, up the chart until it reaches the diagonal line representing the “speed” of the implement in the working gear.

Then follow this across horizontally until it meets the diagonal “lost time” lines. At the point where it meets the particular
Effective capacity in acres per hour

Width of machine in feet

Charts for estimation of field working rates

Sample problems:
1. Width 5 ft., speed 6 m.p.h., time lost 20 per cent. Answer, 2.9 acres per hour effective capacity.
2. Width 5 ft., speed 6 m.p.h. Answer, 3.6 acres per hour uninterrupted capacity.

It may be desired to spread 1 cwt. of superphosphate to the acre. Five bags of superphosphate weigh 5 cwt., and should, therefore, cover 5 acres. By use of the chart it will be seen that a 6 ft. implement travelling 3\(\frac{1}{2}\) m.p.h. covers just a fraction over 2\(\frac{1}{2}\) acres per hour if uninterrupted, so a 12 ft. implement will cover approximately 5 acres per hour. At the end of one hour, therefore, the operator should have used five bags of superphosphate if the spreading rate is adjusted correctly, or one bag every 12 minutes.

When spraying weeds, and for similar operations, rates of application can be checked as follows:

Suppose the spray nozzles deliver 1 gallon per minute, that is, 60 gallons per hour, and it is desired to spread 25 gallons per acre. The machine must cover 60 divided by 25, equals 2.4 acres per hour, to obtain the desired rate of application. Consult

Percentage time lost diagonal in which you are interested, draw a line up the chart to the top line of the graph, and read off the "effective capacity" in acres per hour.

Example:
Implement width, 5 ft.
speed, 6 m.p.h.
time lost, 20%
answer; 2.9 acres per hour.

The charts may also be used to determine the size of an implement required to cover an area at a given speed. For example, it can be seen from the chart that to cover 3 acres per hour at 5 m.p.h. with 20 per cent. less time it would require an implement 6 ft. wide.

Other uses of the chart
A further use for the chart is as a check on the rate at which the fertiliser or seed is being distributed. With a fertiliser spreader 12 ft. wide, pulled at 3\(\frac{1}{2}\) m.p.h.
the chart for width covered by sprays, say 9 feet, and run across this horizontal line to where it meets the vertical line representing a coverage of 2.4 acres per hour. Then estimate the speed represented by a diagonal line drawn through this point. It will be seen that it is between 2 and 2\(\frac{1}{2}\) m.p.h. (2.2 m.p.h. or 2\(\frac{1}{4}\) m.p.h. approximately), and the tractor should be run at this speed by varying gear and throttle positions.

**Useful formula**

A useful formula for calculating the acreage per hour is to multiply the speed in miles per hour by the width of the cut in inches and divide the result by one hundred.

**Match implements**

As field operations become more mechanised, the operation time for each job must be studied more closely, and co-ordination of jobs must be more accurate or there will be a great deal of standing around time—and this adds to the cost.

For instance, in combined operations such as harvesting, bulk handling and silage making, it is important to match the capacity of various units reasonably well to avoid bottlenecks and standing time. The chart will help you in these calculations.

Reliability of each machine becomes of utmost importance, and preventive maintenance should be thorough, for delays with one machine can hold up all the others.