Estimating the Field Capacity of Farm Machines

Ag Decision Maker

File A3-24

The field capacity of a farm machine is the rate at which it performs its primary function, i.e., the number of acres that can be disked per hour or the number of tons of hay that can be baled per hour. Measurements or estimates of machine capacities are used to schedule field operations, power units, labor, and to estimate machine operating costs.

The most common measure of field capacity for agricultural machines is expressed in acres covered per hour of operation. The effective field capacity (EFC) of a machine in the field can be easily calculated by dividing the acres completed by the hours of actual field time. Recording acres and hours for several fields over the whole season can be used to find an average field capacity in differing terrain and weather conditions.

Effective field capacities for many implements are estimated in Table 1. Average field conditions are assumed. Not all implements are shown, particularly the wide range of combination tillage tools (strip till, vertical till, disc-subsoiler/ripper, rotary harrows, etc.). If your implement differs markedly in size, speed, or field efficiency from those listed, effective field capacity should be calculated by using the information and equations shown at the end of this publication. Deeper or more aggressive tillage, high-yielding crop, or adverse field conditions slow travel speed.

Table 1. Average field speeds, field efficiencies, and effective field capacities for Iowa farm machines

Machine	Size	Speed (mph)	Field Efficiency (%)	Effective Field Capacity (A/hr)
Fertilizer spreader	40'	6	70	20.4
	60′	6	68	29.7
	60′	12	68	59.3
	80′	6	68	39.6
	80′	12	68	79.1
Manure spreader – box or liquid	15'	5	63	5.7
	20'	6	63	9.2
	30'	6	60	13.1
– liquid inject	36'	5	60	13.1
	45'	5	60	16.4
Anhydrous ammonia applicator	15 knife	6	65	17.7
	17 knife	6	63	19.5
	23 knife	5	63	22.0
Moldboard plow	6–16"	5	85	4.1
	8–18"	5	85	6.2
	10–18"	5	83	7.5

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Table 1. Average field speeds, field efficiencies, and effective field capacities for Iowa farm machines (continued)

Machine	Size	Speed (mph)	Field Efficiency (%)	Effective Field Capacity (A/hr)
Subsoiler	5–30"	5	85	6.4
	7–24"	5	83	7.0
	7–30"	5	83	8.8
	9-24″	5	83	9.1
Chisel plow	11′	6	85	6.8
	17′	6	83	10.3
	21′	6	83	12.7
	42′	5	83	21.1
Disk, primary	21′	5	83	10.6
	24'	5	83	12.1
	30′	5	83	15.1
	36′	5	80	17.5
	40′	5	80	19.4
	44'	4.5	80	19.2
Disk, secondary	21′	6	83	12.7
	24'	6	83	14.5
	30′	6	83	18.1
	36'	6	80	20.9
	40′	6	80	23.3
	44′	5.5	80	23.5
	49'	5	80	23.8
Field cultivator/seedbed, conditioner	20'	7	85	14.4
	24'	7	85	17.3
	36'	7	83	25.4
	45'	7	80	30.5
	50'	7	80	33.9
	65'	7	78	43.0
Planter, row-crop	6–30"	5.5	65	6.5
	8–30"	5.5	65	8.7
	12–30"	5.5	65	13.0
	16–30"	5.5	63	16.8
	24–30"	5.5	60	24.0
	36–30"	5.5	58	34.8
	48–30"	5.5	55	44.0
Grain or soybean drill	10'	6	70	5.1
	15′	6	70	7.6
	20'	6	70	10.2
	25'	6	68	12.4
	30'	6	68	14.8
Air drill	25'	6	70	12.7
	30'	6	70	15.3
	40'	6	68	19.8
	50'	6	68	24.7
	60'	6	68	29.7

Continued

Table 1. Average field speeds, field efficiencies, and effective field capacities for Iowa farm machines (continued)

Machine	Size	Speed (mph)	Field Efficiency (%)	Effective Field Capacity (A/hr)
Sprayer – pull type	30'	7	65	16.5
	60'	7	63	32.1
	80'	7	63	42.8
– self-propelled	90'	12	60	78.5
	100'	12	60	87.3
	120'	12	58	101.2
Mower conditioner, rotary	8′	7	83	5.6
	10'	7	83	7.0
	13'	7	80	8.8
	14'	7	80	9.5
	16'	7	78	10.6
	19'	7	78	12.6
Rake	16'	7	80	10.9
	20'	7	80	13.6
	25'	7	78	16.5
Combine, soybeans*	25'	4.5	78	10.6
	30′	4.5	78	12.8
	35'	4.5	75	14.3
	40′	4.5	75	16.4
	45'	4.5	75	18.4
Combine, corn*	4–30"	4.5	82	4.5
	6–30"	4.5	82	6.7
	8–30"	4.5	80	8.7
	12–30"	4.5	78	12.8
	16-30″	4.5	75	16.4

	Tons/hr**
Small square baler	7
w/accumulator	7
w/bale thrower	6
load/haul/stack	5***
Large rectangular baler	16
Large round baler	16
and move in field	12
and haul/store	10***
Forage harvester	
pull-type, 150 hp	18
175 hp	22
200 hp	27
250+ hp	40
self-propelled, 2 rows	30
3 rows	40
4 rows	55

**Capacity in acres/hr may be reduced about 8 to 10 percent for stationary unloading, travel speed dependent on conditions.*

***Material capacity for forage harvester varies with crop size and travel speed.*

****Hauling assumes bales are moved one mile from field.*

Calculating Effective Field Capacity

Theoretical field capacity (TFC) depends only on the full operating width of the machine and the average travel speed in the field. It represents the maximum possible field capacity that can be obtained at the given field speed when the full operating width of the machine is being used. It can be calculated from equation (1).

(1) TFC (A/hr) = width (ft) x speed (mi/hr) x (5,280 ft/mi)/(43,560 sq ft/A) = width (ft) x speed (mi/hr)/8.25[1]

Actual effective field capacity is less than this due to turns and other delays. The ratio of actual or **effective field capacity** (EFC) to TFC is called the machine's **field efficiency** (FE).

Field efficiency is expressed as the percentage of a machine's TFC actually achieved under real conditions. It accounts for failure to utilize the full operating width of the machine (overlapping) and many other time delays. These may include turning, filling with seed, fertilizer, or pesticide, emptying grain, traveling to a supply tender or grain cart, cleaning a plugged machine, checking a machine's performance and making adjustments, waiting for trucks, and operator rest stops. Delay activities that occur outside the field, such as daily service, travel to and from the field, and major repairs are not included in field efficiency measurement.

Average field speed can be easily measured by marking off a distance of 88 feet in the field, placing a stake at each end, and counting the seconds it takes to drive between the stakes. Average field speed can then be calculated from equation (2).

(2) Speed (mph) = 60/seconds to travel 88 feet

For example, if you traveled between the stakes in 12 seconds, your average field speed was 5 mph.

After you have calculated the machine's average field speed, TFC can be calculated from equation (1) using the full width of the machine. The FE can be taken from the table in this publication or estimated using equation (3) if you have a representative value of EFC.

(3) FE (%) = EFC/TFC x 100

Conversely, if you need to estimate a machine's EFC and have an estimate of FE, use equation (4).

(4) EFC(A/hr) = TFC x FE%/100 = (width (ft) x speed (mph) x FE%) / (8.25 x 100)

The working capacity of harvesting machines is often measured by the quantity of material harvested per hour. This capacity is called the machine's **material capacity** (MC), expressed as bushels per hour or tons per hour. It is the product of the machine's EFC and the average yield of crop per acre, and can be calculated from equation (5).

(5) MC(bu or tons/hr) = EFC(A/hr) x crop yield (bu or tons/A)

For example, a baler with an EFC of 5 A/hr working in a field yielding 3 tons of hay per acre would have an MC of 5 A/hr x 3 tons/A, or 15 tons/hr. Harvest travel speed is often adjusted to keep a consistent mass flow of crop suitable for the harvester.

Points of Interest

- Although wider equipment operated at the same speed covers more acres per hour, measurements in the field document slightly lower field efficiency of wider equipment. With wider equipment, turns at headlands are longer with raised implements not in use and headland areas are often larger.

- Wider equipment occasionally results in a smaller number of acres covered per hour if travel speed is slowed due to limited tractor horsepower available or too much wheel slippage.

[1]The factor 8.25 is derived by dividing the number of square feet in an acre, 43,560, by the number of feet in a mile, 5,280.

Other publications that will help make good machinery management decisions are:
PM 709/AgDM A3-27 Fuel Required for Field Operations
PM 710/AgDM A3-29 Estimating Farm Machinery Costs
PM 786/AgDM A3-33 Self-Propelled Harvesting and Spraying: Machinery Ownership Versus Custom Hire
PM 787/AgDM A3-21 Acquiring Farm Machinery Services
PM 952/AgDM A3-28 Farm Machinery Selection
PM 1373/AgDM A3-34 Joint Machinery Ownership
PM 1450/AgDM A3-32 Transferring Ownership of Farm Machinery
PM 1860/AgDM A3-30 Replacement Strategies for Farm Machinery
PM 1874/AgDM A3-25 Fieldwork Days in Iowa

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