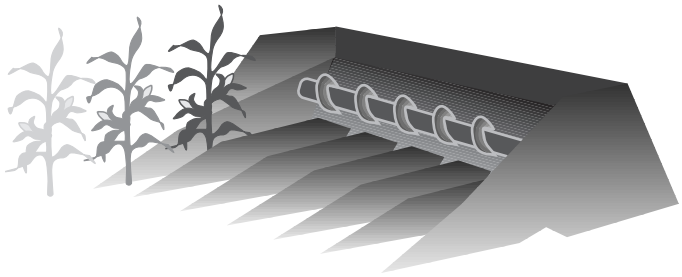
Machinery Management

Estimating Field Capacity of Farm Machines



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, and 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 the following table. Average field conditions are assumed. 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 on the final page of this publication.

Average Field Speeds, Field Efficiencies, and Effective Field Capacities for Iowa Farm Machines

Machine	Size	Speed (mph)	Field Efficiency (%)	Effective Field Capacity (A/h)
Fertilizer Spreader	40'	6	70	20.4
	50'	6	70	25.5
Manure Spreader	10'	5	63	3.8
	15'	5	63	5.7
	15'	6	63	6.9
	20'	6	63	9.2
	30'	6	60	13.1
Anhydrous Ammonia Applicator	9 knife	5	65	8.9
	13 knife	5	65	12.8
	17 knife	5	63	16.2
Plow	7–16"	5	85	4.8
	8–16"	5	85	5.5
	8–18"	5	85	6.2
	10–18"	5	83	7.5
	12–18"	5	83	9.1
Subsoiler	5–24"	5	85	5.2
	5–30"	5	85	6.4
	7–24"	5	85	7.2
	7–30"	5	83	8.8
Chisel Plow	11'3"	5.5	85	6.4
	13'9"	5.5	85	7.8
	16'3"	5.5	83	9.0

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Average Field Speeds, Field Efficiencies, and Effective Field Capacities for Iowa Farm Machines, continued

Machine	Size	Speed (mph)	Field Efficiency (%)	Effective Field Capacity (A/h)
Offset Disk	12'	5.5	85	6.8
	15'	5.5	85	8.5
	18'	5.5	83	10.0
	20'	5.5	83	11.1
	22'	5.5	83	12.2
	24'	5.5	83	13.3
Tandem Disk	14'	6	83	8.5
	17'	6	83	10.3
	21'	6	83	12.7
	24'	6	80	14.0
	30'	6	80	17.5
	33'	6	80	19.2
Field Cultivator/Seedbed Conditioner	15'	7	85	10.8
	21'	7	85	15.1
	27'	7	83	19.0
	34'	7	83	23.9
	42'	7	80	28.5
	50'	7	80	33.9
Planter, seed only	6–30"	5	65	5.9
	8–30"	5	65	7.9
	12–30"	5	63	11.5
	16–30"	5	60	14.5
	24–30"	5	60	21.8
	8–38"	5	65	10.0
	12–38"	5	63	14.5
Grain or Soybean Drill	10'	6	70	5.1
	12'6"	6	70	6.4
	15'	6	70	7.6
	20'	6	70	10.2
	30'	6	68	14.8
Air Drill	24'	6	70	12.2
	32'	6	70	16.3
	40'	6	68	19.8
	48'	6	68	23.7
	56'	6	68	27.7
Broadcast Seeder	20'	5	70	8.5
Sprayer	20'	6	65	9.5
	30'	6	65	14.2
	45'	6	65	21.3
	60'	8	63	36.7
	80'	8	63	48.9
	90'	8	63	55.0
Rotary Hoe	15'	10	80	14.5
	20'	10	80	19.4
	30'	10	80	29.1
	40'	10	78	37.8
Row-crop Cultivator*	6–30"	4	80	5.8
	6–30"	7	80	10.2
	8–30"	4	80	7.8
	8–30"	7	80	13.6
	12–30"	4	78	11.3
	12–30"	7	78	19.9

*Slower speed (4 mph) is for early cultivation rates, faster speed (7 mph) for later or lay-by cultivation rates.

Continued

Average Field Speeds, Field Efficiencies, and Effective Field Capacities for Iowa Farm Machines, continued

Machine	Size	Speed (mph)	Field Efficiency (%)	Effective Field Capacity (A/h)
Mower Conditioner	9'	7	83	6.3
rotary	12'	7	83	8.5
	15'	7	80	10.2
cutterbar	12'	5	80	5.8
	14'	5	80	6.8
	16'	5	78	7.6
Self-propelled Windrower	15'	6.5	83	9.8
	18'	6.5	80	11.3
	21'	6.5	80	13.2
	25'	6.5	78	15.4
	30'	6.5	78	18.4
Rake	9'	6	83	5.4
	14'	6	80	8.1
	18'	6	80	10.5
	24'	6	78	13.6
Combine, soybeans*	15'	3.8	73	5.0
	17'6"	3.8	73	5.2
	20'	3.8	70	6.4
	22'6"	3.8	70	7.3
	25'	3.8	70	8.1
	30'	3.8	68	9.4
	36'	3.8	68	11.3
Combine, corn*	4–30"	3.8	73	3.4
	6–30"	3.8	73	5.0
	8–30"	3.8	70	6.4
	12–30"	3.8	68	9.4
	4–38"	3.8	73	4.3
	6–38"	3.8	73	6.4
	8–38"	3.8	70	8.2

	Tons/h**
Small Square Baler	7
w/accumulator	7
w/bale thrower	6
load/haul/stack	5***
Large Rectangular Baler	12
Large Round Baler	9
and move in field	6
and haul/store	5***
Forage Harvester	
pull-type, 150 hp	15
175 hp	18
200 hp	22
250+ hp	32
self-propelled, 2 rows	25
3 rows	35
4 rows	50

*Capacity in acres/hr may be increased about 8 to 10 percent for unloading "on-the-go."
**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/h) = width (ft) × speed (mph)/8.25[1]

A machine cannot maintain its TFC for very long periods of time. 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 might include turning, idle travel across headlands or to wagons, filling seed and pesticide hoppers, emptying grain tanks, cleaning a plugged machine, checking a machine's performance and making adjustments, and waiting for wagons 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 a 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 × 100

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

(4) EFC(A/h) = TFC × FE%/100 =
(width (ft) × speed (mph) × FE%) / (8.25 × 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/h) = EFC(A/h) × crop yield (bu or tons/A)

For example, a baler with an EFC of 2.5 A/h working in a field yielding 2 tons of hay per acre would have an MC of 2.5 A/h × 2 tons/A, or 5 tons/h.

[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 you make good machinery management decisions are:

PM 709 *Fuel Required for Field Operations*
PM 710 *Estimating Farm Machinery Costs*
PM 786 *Combine Ownership or Custom Hire*
PM 787 *Acquiring Farm Machinery Services: Ownership, Custom Hire, Rental, Leasing*
PM 952 *Farm Machinery Selection*
PM 1373 *Joint Machinery Ownership*
PM 1450 *Transferring Ownership of Farm Machinery*
PM 1860 *Replacement Strategies for Farm Machinery*
PM 1874 *Fieldwork Days in Iowa*

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