

ENERGY REQUIREMENTS FOR AIR SEEDERS

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Introduction

The Alberta Farm Machinery Research Centre and the Prairie Agricultural Machinery Institute have measured the power of requirements for various seeding components during evaluation tests over the past years. This paper summarizes the power requirements for the seeding components that are suitable for use with air delivery systems. These seeding components can be divided into four areas: the soil opener, the soil finisher, the centrifugal fan drive and rolling resistance due to the tank. This paper also discusses a method to calculate tractor size and works through three practical examples on calculating power requirements.

Power Requirements

1. Soil Opener

There is a variety of soil openers that an air delivery system can be used with:

Cultivator

Chisel Sweep

Spike

Banding Knife

Air Drill

Disc

Heavy Duty Disc

Hoe

Bander/Seeder

Backswept Knife

Point Attached to Chisel Sweep

Other

Morris

Clarke

The following tables give the actual horsepower requirements (hp/ft (kW/m)) for cultivators in primary and secondary tillage at various seed depths and speeds. This data was compiled by averaging the draft results obtained from the evaluation tests of cultivators over the years.

Table 1. Power requirements (hp/ft (kW/M)) for cultivators in primary tillage

Depth		Speed		
in	(mm)	4.0 (6.4)	5.0 (8.0)	6.0 (9.7)
2	(50)	1.7 (4.2)	2.2 (5.4)	2.6 (6.4)
3	(75)	2.5 (6.1)	3.1 (7.6)	3.7 (9.0)
4	100)	3.2 (7.8)	3.9 (9.5)	4.8 (11.7)
5	(125)	3.9 (9.5)	4.8 (11.7)	5.8 (14.2)

Table 2. Power requirements (hp/ft (kW/m)) for cultivators in secondary tillage.

Depth		Speed		
in	(mm)	4.0 (6.4)	5.0 (8.0)	6.0 (9.7)
2	(50)	1.3 (3.2)	1.7 (4.2)	2.0 (4.9)
3	(75)	1.9 (4.6)	2.4 (5.9)	2.9 (7.1)
4	(100)	2.5 (6.1)	3.1 (7.6)	3.8 (9.3)
5	(125)	3.1 (7.6)	3.9 (9.5)	4.7 (11.5)

The following table gives the power requirements for single spikes and banding knives in primary tillage at 5 mph (8 km/h).

Table 3. Power requirements per unit in primary tillage at 5 mph (8 km/h).

in	Depth (mm)	Spike		Banding Knife	
		hp	(kW)	hp	(kW)
3	(75)	2.0	(1.5)		
4	(100)	2.5	(1.9)	3.3	(2.5)
5	(125)	3.5	(2.6)	4.6	(3.4)
6	(150)	4.8	(3.6)	6.2	(4.6)

Table 4. Average power requirements for drills

	Average Power Requirements	
	hp/ft	(kW/m)
Disk Drill	1.50	(3.7)
Heavy Duty Disc Drill	2.50	(6.1)
Hoe Drill	2.75	(6.7)

The Alberta Farm Machinery Research Centre measured the power requirements of four different methods of banding and seeding simultaneously. These power requirements vary because of the various depths that the fertilizer is placed below the seed. The depths ranged from 1 to 2 in (25 to 50 mm) below the seed. The depths ranged from 1 to 2 in (25 to 50 mm) below the seed. One system also included a packer. The average power requirements in hp/ft (kW/m) for the combination banding/seeding systems at a 2 in (50 mm) seed depth and 5 mph (8 km/h) are as follows:

Table 5. Average Power Requirements at 5 mph (8 km/h and a 12 in (305 mm) Spacing.

	Average Power Requirements	
	hp/ft	(kW/m)
Clarke Dual Delivery System	4.0	(9.8)
Morris Air Hoe Packer Attachment	5.0	(12.2)
Point Attached to Chisel Sweep	3.5	(8.6)
Backswept Banding Knife	2.7	(6.6)

2. Soil Finisher

Tine harrows, packers and rodweeder can be used for soil finishing behind an air seeder. The power requirements in hp/ft (kW/m) for these soil finishing methods are as follows:

Table 6. Power requirements for soil finishing methods.

	Average Power Requirements	
	hp/ft	(kW/m)
Tine Harrows	0.75	(1.8)
Rodweeder	1.30	(3.2)
Packers	0.50	(1.2)

3. Centrifugal Fan Drive

Hydraulic, power take-off, ground and auxiliary engine drives are used on the air delivery systems to power the centrifugal fans. The average power requirements for the various centrifugal fan drives are list in Table 7.

Table 7. Average power requirements for various centrifugal fans

Type of Drive	Power Requirements
Ground	16 hp (11.9 kW)
Engine (size)	17 to 30 hp (12.6 to 22.8 kW)
PTO	6 to 13 hp (4.5 to 9.7 kW)
Hydraulic	6 to 12 gal/min (27.3 to 54.6 L/min) or 4 to 14 hp (3.0 to 10.4 kW)

4. Rolling Resistance Due to Tank

Rolling resistance of the tanks vary from 1.5 to 10 hp (1.1 to 7.5 kW) depending on type of tank, whether it is empty or full and the soil conditions. Maximum rolling resistance occurs when the tank is full and towed behind and when the soil is soft.

Tractor Size

All of the above power requirements are actual measured values or averages of these values. They do not include any safety margins for operation on hills and in hard soil. The tillage power requirements listed above can be related to the drawbar output listed in the Nebraska Tractor tests. The above power requirements can also be related to the manufacturers' PTO and engine horsepower with the use of some factors. The factors are listed in Table 8.

Table 8. Factors to Calculate Tractor Size

Tractive Efficiency Factor for Hard Soils	1.24
Tractive Efficiency Factor for Loose Soils	1.44
Tractor Load Factor	1.25

Using these factors would give a tractor size in power take-off horsepower. The Tractor Load Factor assumes a tractor operates at 80% of maximum output.

Practical Examples

Example No. 1

Bourgault Air Seeding System – secondary tillage, 40 ft (12.2 m) wide, 2 in (50 mm) depth and 4.5 mph (7.2 km/h) speed. System consisted of cultivator, mounted harrows, tow behind tank (one quarter full) and packer drawbar.

Bourgault Seeding System

<u>Component</u>	<u>Power Requirement</u>
Cultivator	$1.50 \times 40 = 60$
Harrows	$0.75 \times 40 = 30$
Packers	$0.50 \times 40 = 20$
Tank	$= 5$
TOTAL	$= 115 \text{ hp (85.7 kW)}$

Actual draft measurements by the Alberta Farm Machinery Research Centre in the spring of 1990 were 8397 lbs (37.3 kN) at 4.5 mph (7.2 km/h). This calculates to a power requirement of 100.8 hp (75.1 kW). The lower actual power requirement was attributed to the low harrow angle setting.

The recommended power take-off tractor requirements for this system and application would be $115 \times 1.44 \times 1.25 = 207 \text{ hp (154 kW)}$ + Fan Requirements

Example No. 2

Victory Seed-o-vator – primary tillage, 28 ft (8.5 m) wide, 3 in (75 mm) depth and 5 mph (8 km/h) speed. System consisted of cultivator sweeps, rod weeder and an empty tow between tank.

Victory Seed-o-vator

<u>Component</u>	<u>Power Requirement</u>
Cultivator	$3.1 \times 28 = 86.8$
Rodweeder	$1.3 \times 28 = 36.4$
Tank	= 1.5
TOTAL	= 124.7 hp (92.9 kW)

Actual draft measurements in the spring of 1988 were 7686 lbs (34.2 kN) at 5 mph (8 km/h). This calculates to a power requirement of 102.5 hp (76.4 kW). The actual power requirement was lower because the rodweeder was attached to the last row of shanks and not a separate tow behind unit.

The recommended power take-off tractor requirements for this system and application would be $124.7 \times 1.24 \times 1.25 = 193$ hp (144 kW) + Fan Requirements

Example No. 3

Flexi-coil Air Drill – primary and secondary tillage, 39 ft (11.9 m) wide, 2.5 in (64 mm) depth and 4 mph (6.4 km/h) speed. System consisted of the hoe drill and an empty tow behind tank.

Flexi-coil Air Drill

<u>Component</u>	<u>Power Requirement</u>
Drill	$2.75 \times 39 = 107.3$
Tank	= 5.0
TOTAL	= 112.3 h p (83.7 kW)

Actual draft measurements by the Alberta Farm Machinery Research Centre in the fall of 1989 were 8000 lbs (35.6 kN) in secondary tillage and 11000 lbs (48.9 kN) in primary tillage at 4 mph (6.4 km/h). This calculates to a power requirement range of 85 to 117 hp (63.3 to 87.2 kW). The above theoretical power requirement falls within this range. The recommended power take-off tractor requirement range for this system and application would be:

$112.3 \times 1.44 \times 1.25 = 202$ hp (151 kW) + fan requirements for primary tillage and

$112.3 \times 1.24 \times 1.25 = 174$ hp (130 kW) + fan requirements for secondary tillage.



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