

- Question 1: A soil specimen has a water content of 35%, a wet bulk density of 1.8 g/cc and the specific gravity of solids is 2.70. Find the void ratio and degree of saturation.
- Question 2: A soil sample weighs 1903 g and has a volume of 930 cc. The water content is 10%. The specific gravity of the solids is 2.70. Determine the wet bulk density, dry bulk density, void ratio and degree of saturation.
- Question 3: A soil sample is taken from a field prior to tillage. The dry bulk density of the soil is 1.71875 g/cc, and the degree of saturation is 80%. The particle density is 2.7 g/cc. Determine:
- The porosity and void ratio of the sample.
 - The mass of soil and water in 1 cc of bulk sample.
 - The wet bulk density and water content of the soil.
- After tillage the total void volume increases by 40%. After a period of time the moisture content of the tilled soil is 16%. A second soil sample is taken from a field. (The particle density does not change.) Determine:
- The total volume of bulk tilled soil occupied by 1.71875 g of dry soil.
 - The porosity and void ratio of the tilled soil sample.
 - The degree of saturation of the tilled soil sample.
 - The dry and wet bulk density of the tilled soil sample.
- Question 4. Consider a 20-foot (6.1 m) wide tandem disk harrow operating 4 inches (10.2 cm) deep at 5.25 mph (8.46 km/hr) in medium soil. Determine the following:
- Specific draft.
 - Drawbar power required.
 - Required axle power of tractor. Assume tractive efficiency is 0.75.
- Question 5. TRACTOR/IMPLEMENT MATCHING. You are to advise a farmer about the size of a moldboard plow and a tandem disk harrow for a John Deere 4555 tractor. Nebraska Tractor Test 1629 shows the 2-wheel drive tractor developed 156.83 Engine hp (116.95 kW) maximum at rated engine speed of 2200 rpm. Assume that 75% of the engine is available at the drawbar. Available gear ratios provide ground speeds of 4.71 mi/hr (7.58 km/h) in fourth, 7.02 mi/hr (11.30 km/h) in eighth gear. The soil texture for both moldboard plowing and disking is medium. The disk is to be used for secondary tillage.
- What size moldboard plow should I purchase for the tractor, if I wish to plow in fourth gear? Assume plow bottoms are available only in widths of 18 inches (45.72 cm).
 - What size tandem disk (width) should I purchase if I wish to disk in eighth gear?
- Question 6. You are to advise a farmer about the size of a narrow point subsoiler for primary tillage and field cultivator for secondary tillage for a John Deere 7920 tractor, with 175 PTO hp (130 kW). The subsoiler tools are spaced 20" (50 cm) and the field cultivator tines are on a 15" (38 cm). The required depth of operation is 16" (40 cm) for the subsoiler and 4" (10 cm) for the field cultivator. The tractive efficiency for this tractor under primary tillage conditions is estimated to be 85% and under secondary tillage is 75%. Conditions in the field limit the primary tillage speeds to 5 mph (8 km/h) and secondary tillage to 7 mph (12 km/h). The soil is a fine textured for both operations. The disk is to be used for secondary tillage. The farmer's questions in regard to the plow are:
- What size subsoiler should I purchase for the tractor?
 - Determine the drawbar power for the subsoiler purchased during operation.
 - What size field cultivator (width) should I purchase?
 - Determine the drawbar power for the cultivator purchased during operation.

Table 1 – Draft parameters and an expected range in drafts estimated by the model parameters for tillage and seeding implements

Implement	SI Units				English Units				Soil Parameters			Range ±%
	Width units	Machine Parameters			Width units	Machine Parameters			F ₁	F ₂	F ₃	
		A	B	C		A	B	C				
MAJOR TILLAGE TOOLS												
Subsoiler/Manure Injector												
narrow point	tools	226	0.0	1.8	tools	129	0.0	2.7	1.0	0.70	0.45	50
30 cm winged point	tools	294	0.0	2.4	tools	167	0.0	3.5	1.0	0.70	0.45	50
Moldboard Plow	m	652	0.0	5.1	ft	113	0.0	2.3	1.0	0.70	0.45	40
Chisel Plow												
5 cm straight point	tools	91	5.4	0.0	tools	52	4.9	0.0	1.0	0.85	0.65	50
7.5 cm shovel/35 cm sweep	tools	107	6.3	0.0	tools	61	5.8	0.0	1.0	0.85	0.65	50
10 cm twisted shovel	tools	123	7.3	0.0	tools	70	6.7	0.0	1.0	0.85	0.65	50
Sweep Plow												
primary tillage	m	390	19.0	0.0	ft	68	5.2	0.0	1.0	0.85	0.65	45
secondary tillage	m	273	13.3	0.0	ft	48	3.7	0.0	1.0	0.85	0.65	35
Disk Harrow, Tandem												
primary tillage	m	309	16.0	0.0	ft	53	4.6	0.0	1.0	0.88	0.78	50
secondary tillage	m	216	11.2	0.0	ft	37	3.2	0.0	1.0	0.88	0.78	30
Disk Harrow, Offset												
primary tillage	m	364	18.8	0.0	ft	62	5.4	0.0	1.0	0.88	0.78	50
secondary tillage	m	254	13.2	0.0	ft	44	3.8	0.0	1.0	0.88	0.78	30
Disk Gang, Single												
primary tillage	m	124	6.4	0.0	ft	21	1.8	0.0	1.0	0.88	0.78	25
secondary tillage	m	86	4.5	0.0	ft	15	1.3	0.0	1.0	0.88	0.78	20
Coulters												
smooth or ripple	tools	55	2.7	0.0	tools	31	2.5	0.0	1.0	0.88	0.78	25
bubble or flute	tools	66	3.3	0.0	tools	37	3.0	0.0	1.0	0.88	0.78	25
Field Cultivator												
primary tillage	tools	46	2.8	0.0	tools	26	2.5	0.0	1.0	0.85	0.65	30
secondary tillage	tools	32	1.9	0.0	tools	19	1.8	0.0	1.0	0.85	0.65	25
Row Crop Cultivator												
S-tine	rows	140	7.0	0.0	rows	80	6.4	0.0	1.0	0.85	0.65	15
C-shank	rows	260	13.0	0.0	rows	148	11.9	0.0	1.0	0.85	0.65	15
No-till	rows	435	21.8	0.0	rows	248	19.9	0.0	1.0	0.85	0.65	20
Rod Weeder	m	210	10.7	0.0	ft	37	3.0	0.0	1.0	0.85	0.65	25
Disk-Bedder	rows	185	9.5	0.0	rows	106	8.7	0.0	1.0	0.88	0.78	40
MINOR TILLAGE TOOLS												
Rotary Hoe	m	600	0.0	0.0	ft	41	0.0	0.0	1.0	1.0	1.0	30
Coil Tine Harrow	m	250	0.0	0.0	ft	17	0.0	0.0	1.0	1.0	1.0	20
Spike Tooth Harrow	m	600	0.0	0.0	ft	40	0.0	0.0	1.0	1.0	1.0	30
Spring Tooth Harrow	m	2,000	0.0	0.0	ft	135	0.0	0.0	1.0	1.0	1.0	35
Roller Packer	m	600	0.0	0.0	ft	40	0.0	0.0	1.0	1.0	1.0	50
Roller Harrow	m	2,600	0.0	0.0	ft	180	0.0	0.0	1.0	1.0	1.0	50
Land Plane	m	8,000	0.0	0.0	ft	550	0.0	0.0	1.0	1.0	1.0	45
SEEDING IMPLEMENTS												
Row Crop Planter, prepared seedbed												
mounted												
seeding only	rows	500	0.0	0.0	rows	110	0.0	0.0	1.0	1.0	1.0	25
drawn												
seeding only	rows	900	0.0	0.0	rows	200	0.0	0.0	1.0	1.0	1.0	25
seed, fertilizer, herbicides	rows	1,550	0.0	0.0	rows	350	0.0	0.0	1.0	1.0	1.0	25
Row Crop Planter, no-till												
seed, fertilizer, herbicides												
1 fluted coulter/row	rows	1,820	0.0	0.0	rows	410	0.0	0.0	1.0	0.96	0.92	25
Row Crop Planter, zone-till												
seed, fertilizer, herbicides												
3 fluted coulters/row	rows	3,400	0.0	0.0	rows	765	0.0	0.0	1.0	0.94	0.82	35
Grain Drill w/press wheels												
< 2.4 m drill width	rows	400	0.0	0.0	rows	90	0.0	0.0	1.0	1.0	1.0	25
2.4 to 3.7 m drill width	rows	300	0.0	0.0	rows	67	0.0	0.0	1.0	1.0	1.0	25
> 3.7 m drill width	rows	200	0.0	0.0	rows	25	0.0	1.0	1.0	1.0	1.0	25
Grain Drill, no-till												
1 fluted coulter/row	rows	720	0.0	0.0	rows	160	0.0	0.0	1.0	0.92	0.79	35
Hoe Drill												
primary tillage	m	6,100	0.0	0.0	ft	420	0.0	0.0	1.0	1.0	1.0	50
secondary tillage	m	2,900	0.0	0.0	ft	200	0.0	0.0	1.0	1.0	1.0	50
Pneumatic Drill	m	3,700	0.0	0.0	ft	250	0.0	0.0	1.0	1.0	1.0	50