



Factsheet 1: Feed Storage Tables

Source: Dairy Freestall Housing and Equipment, NWPS 7, 6th Edition, 1997

Sizing Silos

Crop moisture is an important consideration in determining silage needs and acreage requirements. But silos should be sized based on a dry matter, DM, basis for each type of forage desired. Silage is usually between 50 to 70% moisture content. Having two or more silos in a feeding system will increase handling and management flexibility.

The dry matter factor, DMF, converts moist silage to dry matter content. Estimate the percent "as-harvested" moisture, and select the DMF from Table 1. Corn silage is usually stored at about 65% and haylage at about 50% in upright silos. In horizontal silos, corn silage is stored at about 70% and haylage at about 65% moisture content.

Table 1. Dry matter factor, DMF.	
To convert from wet ton to ton of dry matter, divide by the DMF. To convert from ton of dry matter to wet ton, multiply by the DMF. $DMF = 100 / (100 - \% \text{ moisture})$.	
Moisture, %	DMF
30	1.43
40	1.67
50	2.00
55	2.22
60	2.50
65	2.86
70	3.33
75	4.00
80	5.00

Annual silage needs and length of silage storage time dictate the number of silos an operation needs. Annual silage needs should be based on DM intake. When calculating the number of acres needed for a particular forage crop, assume 15% dry matter handling loss from harvest to storage and an additional 10% dry matter handling loss from storage to feed delivery. Dry matter loss will increase if proper storage and handling methods are not employed.

Upright Silos

Upright silo capacity depends on height and diameter. Select the maximum diameter for upright silos from Table 2 using the minimum height and ton of DM. Silos with greater height and smaller diameter that meet the needed storage can also be used. If silage is stored at 65% moisture, determine silo size from Table 3 without converting to ton of DM.

Table 2. Upright silo capacity, ton DM.

Capacities allow 1 ft of unused depth for settling in silos up to 30 ft high and 1ft more for each 10 ft beyond 30 ft height. To determine silo capacity in "wet ton", multiply silo capacity value, dry matter, by the DMF value from Table 1. Capacities rounded to nearest 5 ton. Adapted from 1994 ASAE D252.1 DEC93.

Silo height, ft	Silo diameter, ft									
	12	14	16	18	20	22	24	26	28	30
	----- Ton -----									
20	10	15	20	25	35	40	45	55	65	75
24	15	20	25	35	45	50	60	70	85	95
28	20	25	35	45	55	65	75	90	105	120
32	25	30	40	50	65	80	95	110	125	145
36	30	35	50	60	75	90	110	130	150	170
40	30	45	55	70	90	105	125	150	175	200
44	35	50	65	80	100	125	145	170	200	230
48	40	55	75	95	115	140	165	195	225	260
52		65	85	105	130	155	185	220	255	290
56		70	95	115	145	175	205	245	280	325
60		80	100	130	160	190	230	275	310	355
64				140	175	210	250	300	340	390
68				155	190	230	270	325	370	425
72							295	350	400	460
76							315	375	425	490
80							335	390	455	520

Table 3. Upright silo capacity, wet ton.

Silage at 65% moisture, wet basis. Capacities allow 1 ft of unused depth for settling in silos up to 30 ft high and 1 ft more for each 10 ft beyond 30 ft height. Capacities rounded to nearest 5 ton. Adapted from 1994 ASAE D252.1 DEC93.

Silo height, ft	Silo diameter, ft									
	12	14	16	18	20	22	24	26	28	30
	----- Ton -----									
20	35	45	60	75	95	115	135	160	185	210
24	45	60	75	95	125	150	175	205	235	275
28	55	75	100	125	150	185	215	255	295	340
32	65	90	115	150	185	225	265	310	365	415
36	80	105	135	175	215	265	310	370	430	490
40	90	125	165	205	255	305	365	430	495	570
44	105	145	185	235	290	350	420	490	570	655
48	120	160	210	265	330	400	475	555	645	745
52		185	235	300	370	450	530	625	725	830
56		205	265	335	410	495	590	695	805	925
60		225	290	370	455	550	650	780	885	1,020
64				405	495	600	715	850	970	1,115
68				445	545	650	775	925	1,055	1,215
72							835	1,000	1,145	1,310
76							895	1,075	1,220	1,395
80							955	1,120	1,300	1,485

Horizontal Silos

Horizontal silo capacity depends on width, height, length, and packing density. Provide enough width to accommodate equipment during packing and removing silage, but minimize the width to reduce spoilage on the face and top. Packed silage will usually have a density between 30 to 50 pounds per cubic foot.

The following factors can affect dry matter loss in a horizontal silo:

- Moisture content.
- Length of cut.
- Length of time required to fill silo, that is, how long the surface is exposed to air and rain.
- Packing method and thoroughness of packing.
- Condition of silo walls and floor.
- Effectiveness of cover in excluding oxygen, avoiding air spaces between cover and silage surface.
- Method used to remove silage (front-end loaders increase rate of DM decomposition).

To determine silage needs and to calculate horizontal silo size, base calculations on the following criteria:

Daily Silage Needs: Consult a dairy nutritionist or feed specialist to help calculate average daily DM needs for each forage crop you will use. Add another 10% to your calculations to compensate for handling loss from storage to feed consumption.

Face Removal Rate: For design purposes, use a face removal rate of at least 6 inches per day. This will provide some leeway if feeding needs change over the year due to a change in the number of animals fed, feed quality, or ration fed. Face removal rates should never go below 4 inches per day during the summer and 3 inches per day during the winter. Minimum removal rates are most critical with hay crop silages and become more important as moisture content decreases.

Silo Sidewall Depth: Sidewall depths of 8 to 12 feet are considered most practical. These depths match sizes of commonly available precast panels. Typically, sidewalls have an 8:1 slope, and the silage is packed with a rounded top. Because of variations in packing, horizontal silos are usually designed by assuming vertical sides and a flat top.

Silo Width: A width of at least 16 feet is needed to facilitate packing. To increase labor efficiency, design for a bottom width of 30 feet or more. This will help in positioning the transport vehicle near the silage pack and minimize loader travel time. This is especially important when the silo length exceeds 75 feet. To maintain labor efficiency in smaller operations, it may be important to reduce the sidewall depth or reduce the feeding rate to keep the silo width at least 16 feet. When making the decision about silo width, remember that feed quality is more important than labor efficiency. Keep the design face removal rate above 6 inches per day when adjusting for width.

Storage Period: Providing quality feed at all times should be a high priority in all operations. The length of storage should be used to maintain feed quality. Consider using a separate bunker that is shallower and narrower for warm weather.

Silo Length: The silo length is determined by multiplying the face removal rate by the storage period. If calculated lengths are much over 150 feet, then using multiple horizontal silos should be a consideration because of labor efficiency. Another reason to use multiple horizontal silos may be because of construction limitations of the site where the silos are located. Designing horizontal silos that share a common wall may cost less than one long silo. Horizontal silos size

can be estimated using Tables 4 through 6. For design and management guidelines, refer to Managing and Designing Horizontal Silos, AED-43.

Table 4. Horizontal silo capacity, ton DM.
Silo assumed level full. Capacities rounded to nearest 5 ton.

Depth, ft	Silo floor width, ft								
	20	30	40	50	60	70	80	90	100
	----- Ton dry matter/10 ft length -----								
10	15	20	30	35	40	50	55	65	70
12	15	25	35	40	50	60	65	75	85
14	20	30	40	50	60	70	80	90	100
16	20	35	45	55	65	80	90	100	110
18	25	40	50	65	75	90	100	115	125
20	30	40	55	70	85	100	110	125	140

Table 5. Horizontal silo capacity, wet ton.
65% moisture; 40 lb/ft³ or 50 ft³ = 1 ton; 1.25 ft³/bu. Silo assumed level full. Capacities rounded to nearest 5 ton. To calculate capacity of other silo sizes, multiply silage depth, ft, by silo width, ft, by silo length, ft, and divide by 50.

Depth, ft	Silo floor width, ft								
	20	30	40	50	60	70	80	90	100
	----- Wet ton/10 ft length -----								
10	40	60	80	100	120	140	160	180	200
12	50	70	95	120	145	170	190	215	240
14	55	85	110	140	170	195	225	250	280
16	65	95	130	160	190	225	255	290	320
18	70	110	145	180	215	250	290	325	360
20	80	120	160	200	240	280	320	360	400

Table 6. Horizontal silo capacity.
Assumes 65% moisture, 40 lb/ft³ silage density (14 lb DM/ft³). Capacities rounded to nearest 5 lb.

Depth, ft	Silo floor width, ft									
	16	20	30	40	50	60	70	80	90	100
	----- lb DM per inch of face removal -----									
8	150	185	280	375	465	560	655	745	840	935
10	185	235	350	465	585	700	815	935	1,050	1,165
12	225	280	420	560	700	840	980	1,120	1,260	1,400

Sizing Dry Hay and Straw Storages

Indoor hay and straw storage helps preserve quality and reduce dry matter losses. Store hay and straw near loading or feeding areas. Hay and straw storage sheds can be sized using Tables 7 and 8.

Material	ft ³ /ton	lb/ft ³
Loose		
Alfalfa	450-500	4-4.4
Non-legume	450-600	3.3-4.4
Straw	670-1,000	2-3
Baled		
Alfalfa	200-300	6-10
Non-legume	250-330	6-8
Straw	400-500	4-5
Chopped		
Alfalfa, 1½-inch cut	285-360	5.5-7
Non-legume, 3-inch cut	300-400	5-6.7
Straw	250-350	5.7-8

Shed width, ft	Baled	Chopped	Loose
	----- ton/ft of length -----		
24	2.0	1.9	0.8
30	2.6	2.3	1.0
36	3.1	2.8	1.2
40	3.4	3.1	1.4
48	4.0	3.7	1.7

Sizing Commodity Storages

In most cases the amount of storage needed for a particular ingredient will be a multiple of the unit truck capacity plus a cushion of 25 to 50% depending on purchasing and transportation arrangements.

A semi-trailer truck's capacity is about 24 ton. For dense products such as grain, cottonseed, soybean meal, and pelleted ingredients, one truck load will nearly equal the semi's weight capacity. For less dense products like brewers and distillers grain, experience shows that truck volume is the limiting factor; the load will contain about 20 to 22 ton of material.

Example 9-1:

Determine the commodity storage required for a semi-load of soybean meal.

Solution:

Assuming the semi-capacity is 24 ton, storage need per ton of soybean meal is 48 ft³/ton, Table 9. Allowing 25% extra storage, the storage required for soybean meal is:

$$24 \text{ ton} \times 48 \text{ ft}^3/\text{ton} \times 1.25 = 1,440 \text{ ft}^3$$

Table 9. Commodity storage densities and storage requirements.

Based on *Proceeding: Alternative Feeds for Dairy and Beef Cattle*, and American Feed Industry Association publications.

Description	Density, lb/ft³	Storage volume, ft³/ton
Alfalfa meal, dehydrated, 13%	16-18	111-125
Alfalfa meal, dehydrated, 17%	18-22	91-111
Barley, ground	24-26	77-83
Barley, malt	30-31	65-67
Blood meal	39	52
Bone meal	50-60	33-40
Brewers dried grain	14-15	133-143
Brewers grain, spent, dry	25-30	67-80
Brewers grain, wet	55-60	33-36
Calcium carbonate	75	27
Corn distillers dried grains	18	111
Corn distillers dried soluble	25-26	77-80
Corn, whole shelled	45	44
Cottonseed hulls	12	167
Cottonseed oil meal	37-40	50-54
Cottonseed with lint	18-25	80-111
Cottonseed, delinted	25-35	57-80
Dairy, concentrates	43	47
Dried beet pulp	11-16	125-182
Dried citrus pulp	21	98
Hay, loose	5	400
Hay, pressed	8	250
Limestone	68	29
Malt sprouts	13-16	125-154
Milo, ground	32-36	56-63
Oats, rolled	19-24	83-105
Oats, whole	25-35	57-80
Phosphate, tricalcium	21	95
Rice, hulls	20-21	95-100
Sorghum, grain	32-35	57-63
Soybean hulls, ground	20	100
Soybean hulls, unground	6-7	286-333
Soybean meal (solvent)	42	48
Soybean oil meal (Expeller)	36-40	50-56
Soybeans, grain	46-48	42-43
Wheat middlings (std)	18-25	80-111
Wheat, ground	38-39	51-53

Sizing Grain Storages

Grain can be stored at harvest or delivered when needed. The biggest bin is not always the least costly per bushel of storage. Bins should not exceed half of the total volume of the operation. Size the bin using Table 10. See *Grain Drying, Handling and Storage Handbook*, MWPS-13, for more information on drying, storing and aerating grain. Ground shelled corn, ground ear corn and whole shelled corn can also be stored in upright silos. Select silo size from Tables 11 and 12.

Table 10. Storage capacity for round grain bins.
Capacity does not include space above eave line. Based on 1.25 ft³ bushels.

Diameter, ft	Depth of grain, ft				
	1	11	13	16	19
	----- bushel -----				
14	125	1,375	1,625	2,000	2,375
18	203	2,200	2,635	3,250	3,850
21	277	3,050	3,600	4,400	5,300
24	362	4,000	4,700	5,800	6,900
27	458	5,050	5,950	7,300	8,700
30	565	6,215	7,345	9,040	10,735
36	814	8,950	10,600	13,000	15,450
40	1,005	11,050	13,050	16,100	19,100

Table 11. Upright silo capacity for ground shelled corn.
For 30% moisture grain and 68 lb/bu (1.25 ft³/bu) density. Capacities allow for 1 ft of unused depth and are rounded to the nearest 5 ton and 10 bu. Capacity increases 5% with moisture contents between 25-35%. Capacity also varies with fineness of grind and filling procedures. Values based on no settling or compaction of material. Because some settling and compaction will occur, these values should be considered minimums. DM = dry matter.

Silo height, ft	Unit of measure	Silo diameter, ft						
		10	12	14	16	17	18	20
20	Wet ton	40	60	80	105	---	---	---
	Ton DM	30	40	55	75	---	---	---
	Bushel	1,200	1,730	2,370	3,100	---	---	---
28	Wet ton	60	85	115	150	170	190	230
	Ton DM	40	60	80	105	120	135	160
	Bushel	1,700	2,470	3,330	4,370	4,930	5,530	6,830
36	Wet ton	---	110	145	190	215	245	300
	Ton DM	---	75	100	135	150	170	210
	Bushel	---	3,170	4,330	5,630	6,370	7,130	8,800
44	Wet ton	---	---	180	235	265	300	365
	Ton DM	---	---	125	165	185	210	255
	Bushel	---	---	5,300	6,900	7,800	8,770	10,800
52	Wet ton	---	---	---	280	315	355	435
	Ton DM	---	---	---	195	220	250	305
	Bushel	---	---	---	8,200	9,270	10,400	12,830
60	Wet ton	---	---	---	325	365	410	510
	Ton DM	---	---	---	230	255	285	355
	Bushel	---	---	---	9,570	10,800	12,100	14,930

Table 12. Upright silo capacity for ground ear and whole shelled corn.

For 30% moisture shelled corn and 27% kernel moisture (32% blend moisture) ear corn and 60 lb/bu (1.25 ft³/bu) density. Capacities allow for 1 ft of unused depth and are rounded to the nearest 5 ton and 10 bu. Capacities increase approximately 5% with moisture contents between 25-35%. Capacities also vary with fineness of grind and filling procedure. Values based on no settling or compaction of material. Because some settling and compaction will occur, these values should be considered minimums. DM = dry Matter.

Silo height, ft	Unit of measure	Silo diameter, ft						
		10	12	14	16	17	18	20
20	Wet ton	35	50	70	95	---	---	---
	Ton DM	25	35	50	65	---	---	---
	Bushel	1,200	1,730	2,370	3,100	---	---	---
28	Wet ton	50	75	100	130	150	165	205
	Ton DM	35	55	70	90	105	115	145
	Bushel	1,700	2,470	3,330	4,370	4,930	5,530	6,830
36	Wet ton	---	95	130	170	190	215	265
	Ton DM	---	65	90	120	135	150	185
	Bushel	---	3,170	4,330	5,630	6,370	7,130	8,800
44	Wet ton	---	---	160	205	235	265	325
	Ton DM	---	---	110	145	165	185	230
	Bushel	---	---	5,300	6,900	7,800	8,770	10,800
52	Wet ton	---	---	---	245	280	310	385
	Ton DM	---	---	---	170	195	215	270
	Bushel	---	---	---	8,200	9,270	10,400	12,830
60	Wet ton	---	---	---	285	325	365	450
	Ton DM	---	---	---	200	230	255	315
	Bushel	---	---	---	9,570	10,800	12,100	14,930