Alberta Dairy Management
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Estimating Silage Inventories

When planning your winter feeding programs, you'll need to estimate your inventories of silage to determine the optimum amounts to include in your rations. Here are some guidelines to help you make those estimates:

Counting loads at harvest

One common method of estimating the amount of silage harvested is to multiply the number of loads brought in from the field by the average load size. If you are hauling in more than one truck or wagon, you'll have to maintain a count of each, assuming they each carry different amounts of silage. Load sizes can be calculated by multiplying the volume of silage in the forage box by its bulk density. For example, if your forage wagon measures 8 feet wide by 16 feet long and you fill it to an average depth of 6 feet, then the volume is:

8 feet x 16 feet x 6 feet = 768 cubic feet (ft^3).

Trials at the University of Wisconsin showed that forage box bulk densities varied from 4.6 to 5.7 pounds of dry matter (DM) per cubic foot (lb DM/ft^3) for a variety of grass, legume and cereal silage crops. The average bulk density was very close to 5 lb DM/ft^3. Using this figure, the amount of DM in the wagon above would be:

768 ft^3 x 5 lb/ft^3 = 3840 lb = 1.92 tons.

This method is subject to a good deal of error. The Wisconsin trials indicated that there was a 68% probability that DM bulk density of a crop would actually be between 4.2 and 5.8 lb/ft^3. Combine this uncertainty with normal variation in load sizes and it's not hard to imagine that your estimate of the total amount of silage DM harvested could be out by plus or minus (±) 20%.

An alternative and more accurate method is to estimate the amount of silage that actually ends up in the silo. Here's how:

Estimating horizontal silo inventory

Measuring volume is the most difficult problem in estimating inventories in horizontal silos. The easiest way to do this is to make a drawing and approximate the shape of the stack or bunker with a number of triangles and rectangles. In the example shown in figure 1, the total volume of silage is the sum of the volume in the body plus the volume in the wedge. Body volume is:

BODY HEIGHT x BODY LENGTH x WIDTH

Wedge volume is:

$$\frac{\text{WEDGE HEIGHT}}{2} \times \text{WEDGE LENGTH} \times \text{WIDTH}$$

Dennis Darby, a farm structures engineer with Alberta Agriculture, measured silage densities in 21 bunker silos in southern and central Alberta. Here's what he found:

- DM density of bunker silage is independent of moisture content. If 2 samples of the same silage have different moisture contents, the wetter sample will have the higher wet bulk density. But, when these 2 samples are dried, their DM bulk densities will be the same.
- In horizontal silos, there is no significant variation in DM bulk density from top to bottom.
- On average, the DM density of barley silage (14.5 lb/ft^3) was lower than that of grass-legume silage (16.3 lb/ft^3).

Therefore, calculation of silage inventories in horizontal silos simply involves multiplying total volume by the DM bulk density for the particular type of crop. When using these inventories to determine ration inclusion rates, you should plan to use a minimum of 4 inches off the face of the silage each day (more in warm weather) to prevent spoilage. Calculate the amount of DM this represents by using body height and width.

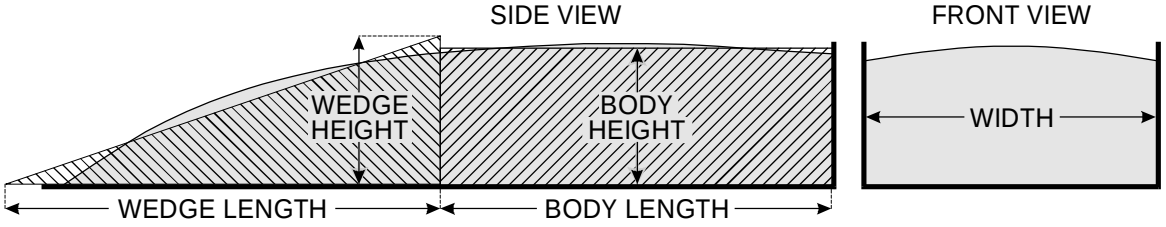

Figure 1 : Dimensions required to estimate silage volume in a bunker silo.

Estimating vertical silo inventories

In contrast to horizontal silos, it is a relatively simple matter to calculate silage volume in an upright tower:

$$3.14 \times \left[\frac{\text{silo diameter}}{2}\right]^2 \times \text{silage depth}$$

However, in vertical silos, bulk density is influenced by silage depth, moisture content and silo diameter. Since these relationships are complex, it is not possible to estimate inventory by simplying multiplying volume by a uniform density estimate. Table 1 provides DM capacities for vertical silos, based on work done at the University of Guelph. To use the table, choose the diameter of your silo, then interpolate between values in that section of the table. For example, if you have 55 feet of 65% moisture barley silage in an 18 foot tower:

- if the settled depth of silage were 50 feet, DM inventory at 65% moisture would be roughly midway between the inventory at 60% moisture and that at 70% moisture – about 59 tonnes;
- similarly, if silage depth were 60 feet, DM inventory at 65% moisture would be about 72.5 tonnes – midway between 80 and 65;
- since the 65% moisture level is midway between 60 and 70%, you can estimate a DM inventory midway between 59 and 72.5 tonnes – about 66 tonnes.

If you silage is a grass-alfalfa mix, you can also interpolate between values for straight alfalfa and straight grass silages.

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SILO DIAM		SILAGE DEPTH	BARLEY SILAGE MOISTURE CONTENT (%)				ALFALFA SILAGE MOISTURE CONTENT (%)				GRASS SILAGE MOISTURE CONTENT (%)			
			40	50	60	70	40	50	60	70	40	50	60	70
ft	x	ft	DM INVENTORY (tonnes)				DM INVENTORY (tonnes)				DM INVENTORY (tonnes)			
12	x	30	18	17	15	13	21	20	18	15	22	21	20	18
12	x	40	26	23	21	18	30	27	25	21	31	30	28	25
12	x	50	33	30	27	23	39	35	32	27	41	39	36	32
14	x	40	36	33	29	25	43	38	34	29	45	42	39	35
14	x	50	48	43	38	32	56	50	44	37	59	55	51	44
14	x	55	54	48	42	35	63	56	49	41	66	62	57	49
16	x	50	66	58	50	42	77	68	59	49	81	75	68	59
16	x	60	82	72	62	51	96	84	73	60	101	93	84	72
16	x	65	91	79	68	56	106	93	80	65	112	102	91	78
18	x	50	87	76	65	53	102	88	76	62	107	97	87	75
18	x	60	110	94	80	65	128	111	94	76	135	122	108	91
18	x	70	133	114	96	77	155	133	112	90	163	146	129	108
20	x	60	141	120	101	81	165	140	118	95	173	154	135	114
20	x	70	172	145	120	96	201	170	141	112	211	186	162	135
20	x	80	203	170	140	111	237	199	164	130	249	219	189	156
24	x	60	216	181	149	118	253	211	174	138	266	232	200	165
24	x	70	263	221	178	135	308	259	209	158	323	284	240	190
24	x	80	310	261	210	159	363	305	246	185	381	336	283	223
24	x	90	358	299	244	190	419	350	286	223	440	385	329	267
30	x	80	505	426	354	283	590	498	415	331	620	548	477	397
30	x	90	580	493	413	332	678	577	484	388	712	635	556	466
30	x	100	655	562	473	381	767	657	554	446	805	723	637	536
30	x	110	731	630	534	432	856	737	624	505	898	811	718	606

Table 1 : Dry Matter (DM) capacities for vertical silos of different diameters and settled silage depths.