Calculating Forage Yields on Vermont Farms[1]

Yield measurements are extremely important in nutrient management planning. Knowing average yields will allow producers to better match nutrient applications of manure and fertilizer to minimize costs, maximize fertilizer efficiency and reduce potential environmental problems. Yields are also critical as a measuring tool to evaluate new products, improve management techniques and allow producers to make more informed decisions concerning feeding practices for their livestock. Knowing you forage supplies for the year in the fall would allow producers to buy or sell forage at the time of the year that would be most financially rewarding to their operation.

Various methods of measuring yields are available to producers. The most accurate would be to weigh truck or wagon loads going into a silo or barn and taking dry matter samples. This is often not feasible to producers due to time and limitations of necessary equipment (scales). Other methods of yield checks include field sampling and documenting estimated weights of loads.

Field Sampling for Yield

As with soil sampling, testing forage yields must be done in a manner that will give you a representative sample of the whole field or fields. It is also important to consider the dry matter of the sample as moisture contents can vary greatly depending on when and how forages are harvested. It is always best to compare yields on a dry matter basis.

Calculating Dry Matter - To calculate dry matter, you can use various methods, including a microwave oven, or a Koster Moisture tester. In each instance, you need to measure the weights of the sample before and after drying to determine the amount of water driven off by drying. Almost all dried hay products are in the 10-15% moisture range or 85-90% dry matter. For more detailed information call your local Extension office and request NRAES publication 59 “Forage Moisture Determination”.

Some example calculations:

Before drying-- 85 ounces After drying -- 25 ounces 25/85 = 29.4% dry matter

(As is yield) x % dry matter = dry matter yield

If you harvested 23 tons of corn silage at 29.4% dry matter
23 x 29.4% = 6.76 tons of dry matter per acre

Measuring cornfields and other row crops - To take representative samples from cornfields, it is often easiest to determine what 1/1000 of an acre would be in the field. Yields from that size plot could then be cut, harvested and weighed to estimate the yield per acre. For most corn grown in Vermont, the following row widths and lengths would

[1] Adapted from "Calculating Forage Yields on Maine Farms" by Rick Kersbergen/ Extension Educator, University of Maine with some additions by Sid Bosworth, Extension Agronomist, UVM

correspond to 1/1000th of an acre. Counting the number of plants in this length of row and multiply by 1000 will also give you an estimate of the population of plants in the field per acre.

Row width	**Measure, cut count and weigh….**
30” (2.50ft)	**17’5”** (17.42 ft)
32” (2.67 ft)	**16’4.5”** (16.32 ft)
34” (2.83 ft)	**15’4.75”** (15.39 ft)
36” (3.00ft)	**14’6”** (14.50 ft)

The raw weight from 1/1000 of an acre divided by 2 will give you the estimated yield in tons per acre. Once you determine the dry matter of the sample, you can then multiply the yield by the % dry matter to get an estimate of dry matter yield per acre.

Example:

17’5” of a 30” corn row weighs 53 pounds
Divided by 2 = 26.5 tons per acre yield
26.5 tons/acre X 33% (dry matter of sample)=8.75 ton dry matter per acre

Note:
If your sample was wetter (23% dry matter) and your weight of yield was the same (26.5 tons) your dry matter yield would be quite a bit less
26.5 tons/acre X 23% (dry matter of sample) =6.1 ton dry matter yield per acre

Measuring hay and drilled fields - For checking yields of haycrop fields, a similar procedure except since there are no defined rows, you would simply harvest a known plot size and calculate that to a percentage of an acre. **There are 43,560 ft^2 in one acre.**

Example:
2’ by 2’ area = 4 ft^2
43,560 ft^2 / 4 ft^2 = 10,890 units in an acre
If your sample weighed 1.8 pounds
1.8 lbs. x 10,890 = 19,602 pounds or 9.8 tons of grass per acre
If the grass was 25% dry matter (75% water)
9.8 tons (as is) x 25% = 2.5 tons of dry matter yield per acre.

Another method involves weighing a section of the mowed windrow and calculating the percentage of an acre that you weighed.

Example:
Mower cuts a windrow 14 ft. wide. If you pick up and weigh 10 ft of the windrow, you have .003214 of an acre (14 X 10 divided by 43,560)
If you harvested 55 lbs
55/.003214 = 17,113 lbs or about 8.6 tons of yield
If the grass was 25% dry matter (75% water):
8.6 tons (as is) x 25%dm = 2.2 tons dry matter yield per acre

Both of these methods are subject to extreme variation within the field so it would be important to take at least <u>six to eight plots</u> randomly chosen out of each field.

Measuring Wagon Loads - Measuring yields by wagonloads is probably the most common method used by producers. Ideally producers should weigh average loads to get a representative "load weight" Again, it is important to know the dry matter of the forage to get an accurate measure of actual nutrient harvest.

Some recent work in Wisconsin at the Marshfield Ag. Research Station found that wagon loads in the 30-50% dry matter range averaged around 5 lbs. of dry matter per cubic foot of wagon. Suprisingly, the forage density did not vary greatly with forage type (corn silage or haylage).

Working with this information, we can now estimate the load on a wagon by multiplying volume times density.

Example:

A wagon measures 16 ft long by 7.25 feet wide and filled to a depth of 6 feet.
(16 ft x 7.25 ft x 6 ft = 696 ft^3)

696 ft^3 x 5 lbs. dry matter per ft^3 = 3,480 lbs. dry matter or 1.74 tons of dry matter yield per acre

If we wanted to calculate actual weight, we need to divide this figure by the dry matter of the forage

Forage is 28 % dry matter
1.74 tons divided by 28% = 6.96 tons of feed on the wagon.

Clearly, weighing all loads would provide a more accurate figure but this is often not feasible.

Measuring stored forage - Another method of estimating yields is to determine the total amount of stored forage and divide that by the number of acres to produce it. This will give an average yield across all fields that support that particular crop. This is a good method for "checking" field sampling or wagon load counting methods and works best with corn silage since it is only harvested once per year and the yield check can be made soon after harvest. Multi-cut forages are much more difficult to determine with this approach since silo fill and removal often occurs throughout the season.

For bunk silos, you will need to know silo volume (cubic feet) and silage density (lbs. of dry matter per cubic feet). Silage density depends on the type of forage, length of chop and degree of packing. A well packed bunk silo will have densities ranging from 12 to 17 lbs. d.m. per cubic foot.

Example,

A bunk silo measures 200' long by 30' wide and 10' high. It is filled to capacity with corn silage and is packed real well. Assuming a density of 16 pounds dry matter per ft^3,

200' x 30' x 10' = 60,000 ft^3 x 16 lbs./ft^3 = 960,000 lbs. dry matter

960,000 lbs. ÷ 2000 = 480 tons dry matter

480 tons ÷ 0.35 = 1371 tons of 65% moisture silage

If corn was grown on 80 acres, then

1371 tons ÷ 80 acres = 17.1 tons per acre

For upright silos, you can obtain estimates of dry matter capacity from the following chart.

Depth of settled silage	Inside diameter of silo (ft)										
	10	12	14	16	18	20	22	24	26	28	30
(ft)	tons										
2	0	1	1	1	2	2	2	2	3	3	4
4	1	2	2	3	4	5	5	6	8	9	10
6	2	2	3	4	5	7	8	10	11	13	15
8	3	4	5	7	9	11	13	16	18	21	24
10	4	5	7	9	11	14	17	20	24	28	32
12	5	7	9	11	14	18	22	26	30	35	40
14	5	8	11	14	17	22	26	31	36	42	48
16	6	9	12	17	21	26	32	37	44	51	58
18	7	11	14	19	24	29	35	42	49	57	65
20	8	12	16	21	27	33	40	47	56	65	74
22	9	14	19	24	30	38	46	54	64	74	85
24	11	15	21	27	34	43	52	61	72	83	96
26	12	17	23	30	38	48	58	68	81	94	107
28	13	19	26	35	44	53	64	76	90	104	119
30	15	21	29	38	47	59	71	84	99	115	132
32	16	23	32	41	52	65	78	93	109	127	145
34	18	25	34	45	57	70	85	101	119	137	158
36	19	28	37	48	62	76	92	109	129	150	172
38	21	30	41	53	67	82	100	118	139	161	185
40	22	32	44	57	72	89	107	127	150	173	199
42	24	34	47	61	77	95	115	137	161	186	214
44	26	37	50	65	82	102	123	146	172	200	229
46	27	39	53	69	88	109	131	155	183	212	244
48	29	42	56	74	93	115	140	166	195	226	260
50	31	44	60	78	99	122	148	175	206	239	274
52	32	47	64	83	105	129	157	186	219	254	291
54	34	49	67	88	111	137	165	197	231	267	306
56	36	51	71	93	117	144	174	207	243	282	324
58	38	54	74	98	123	151	183	218	261	297	339
60	40	56	78	102	129	159	192	228	273	309	357
62	To find the tons remaining				135	167	201	239	287	324	374
64	in a silo after part of the				142	174	210	250	301	339	391
66	silage is removed: (1) find				149	182	219	260	314	354	407
68	the tons of silage when the				155	190	228	271	328	369	424
70	silo was filled, (2) find the tons in a silo filled to the height				162	198	237	282	342	384	441
72	equal to the depth of silage removed, (3) subtract the							293	356	400	458
74	number of tons in Step 2 from the number of tons in Step 1.							305	371	415	476
76	Example: A 20-foot silo is filled to a settled depth of 60 feet and 22 feet							316	385	431	493
78	were removed (1) 20 x 60 equals 159 tons (2) 20 x 22 equals 38 tons							328	400	446	511
80	(3) 159 minus 38 equals 121 tons remaining.							339	462	462	528

Source: Adapted from Silo Dry Matter Capacity Tables by the National Silo Association.