PART II
Forage Crops

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Pastures

Pastures are the backbone of Virginia's beef and sheep industries and are of increasing importance to the dairy industry. The over 2 million acres of pasture in Virginia provide feed for grazing livestock with minimal requirements for labor and equipment. Pasture plants growing in areas inaccessible to machinery and equipment or on soils unsuitable for cropping serve as a feed for livestock in the production of meat and fiber for human use. Forage crops can be grown successfully throughout Virginia if species and management are tailored to match the soils and climate in that region of the state.

Year-round grazing

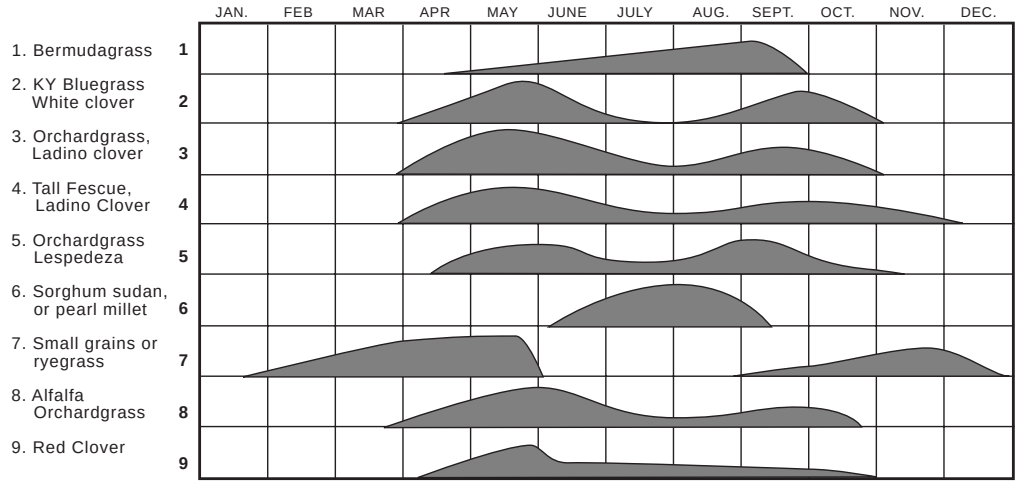
Year-round grazing should be an objective of most pasture-based livestock systems. Utilizing combinations of plant species which make their growth at different times of the year is key to successful year-round grazing programs.

Seeding

Pasture seeding recommendations are dependent upon the types of pasture already available in the system, the use for which it is intended, the type of soil, climatic conditions, and the intended management. Details given in the "Pasture Seedings" table will be helpful in selecting the mixture for individual needs. Seeding may be done in seedbeds prepared by plowing, disking, and firming with cultipacker or roller. New stands may also be established using no-till seeding equipment and management techniques. Before seeding, consult an Extension Agent who is familiar with local growing conditions and can provide specific recommendations for pasture establishment.

Seed after the first good rain in August or September or between February 15 and April 15, depending on the area of the state. Generally, moving from west to east, seeding can be done later in the fall and earlier in the spring. A reliable rule to follow is to seed 30-40 days before the first killing frost in the fall or 30 days before the last frost in the spring.

Figure 1. Seasonal Growth of Forage Species and Mixtures



December-March are the traditional winter feeding months. Most plants make little or no growth when temperature is much below 50°F.
Small grains and rye will grow anytime the average temperature is above 32°F. Plan to feed hay or silage for 60 to 120 days. Small grains and stockpiled tall fescue for pasture help reduce the need for harvested feeds.
April, May, and June are the surplus grass months. Save excess growth by making silage or hay.
July and August are the critical pasture months. Make definite plans for these months.

Managing pastures

Pastures can be limed and fertilized, according to soil test results, any time of the year, but late summer and fall applications are preferred. Tall-grass pastures should be fertilized every year. Native pastures are normally fertilized every three years.

High quality pastures will consist of 25-40% clover. Significant improvement in animal performance is realized when clover is present in a grass-based stand of forage. Because of clover's ability to fix nitrogen into the soil, no supplemental nitrogen is required for grass-clover pastures with significant clover content.

Overseeding clover is an excellent procedure for establishing clover in grass sods. Graze or mow the sod very closely by late February, then broadcast the seed on the soil surface. Freezing and thawing of the soil, plus traffic and early spring grazing by livestock, should result in good seed to soil contact for clover establishment.

The goal in grazing pastures is to *utilize* the forage that is produced without injuring the sod. Undergrazing produces high rates of gain per animal but low animal production per acre. Overgrazing results in low gains per animal and per acre. The challenge is to maintain optimal animal performance without compromising plant vigor.

Harvest excess pasture growth, especially in the spring, for hay. Graze only those pastures that livestock will keep grazed down. When growth slows during the summer, make more pasture acreage available.

Occasional clipping of pastures helps to remove tough, mature plant growth and prevents seed production by weeds. Mid June and late August are the most critical times for clipping. Proper grazing management helps to minimize the need for clipping.

When a pasture is grazed to a height of 2-3 inches, rotate livestock to another pasture. Plan pasture rotations so that young, growing livestock have access to the highest quality grazing. For example, permit steers to graze lush pastures first, then let the cows remove what is left. Plan to have calves "creep graze" high-quality pasture by placing small openings in the fence so they can leave their mothers to graze an adjacent pasture or hay field. Winter grazing can be obtained by grazing or clipping tall fescue stands in August, fertilizing with 70-80 lbs nitrogen per acre, then permitting plant growth to accumulate through late fall. One acre of "stockpiled" growth can provide 120 days of winter grazing for a beef cow.

An animal unit (AU) is usually defined as a 1000 lb cow and her calf, two 500 lb steers, or five ewes with lambs. Generally, one acre of *excellent* pasture is required to carry an AU through the grazing season, or 1.5 acres of *good* pasture per AU, or 3.0 acres of *average* pasture per AU, or 6.5 acres of *poor* pasture per AU. An animal unit month (AUM) is defined as the amount of pasture (400 lb TDN) required to provide adequate grazing for an AU for one month.

Refer to the **Recommendations for Pasture Seedings in Virginia Table** on the following page.

Hay

Red clover, alfalfa, orchardgrass, and tall fescue are the most widely grown hay crops in Virginia. However, any plant that can be cut, dried, and stored can be utilized for hay. The following table provides details on the most commonly used mixtures.

Crushing stems (conditioning) at the time of mowing will permit the stems to dry at nearly the same rate as the leaves. Curing time is decreased by about one day for large-stemmed plants. Raking while hay is moist (about 40% moisture) and baling before hay is crisp (16 -20% moisture) reduces field losses.

Refer to the **Recommendations for Hay and Haylage Seedings in Virginia Table** on the following page.

Recommendations for Pasture Seedings in Virginia

Use	Species	Seeding Rate (lb/acre)	Soil Adaptation	Management Tips
Frost seeding legume in grass pasture	Red clover White or Ladino clover or Annual lespedeza	3-6 1-2 10-15	Any medium to heavy textured soil with pH > 5.8 and medium or better fertility for clovers. Annual lespedeza for acid, lower fertility soils .	Graze grass sod closely by February then broadcast seed and allow cattle to tread the seed into the ground for 1 week. Frost seed every 2-3 years. Use to add legume to thinning alfalfa pasture.
Continuous Stocking	Tall fescue (E+ or E-)* White clover Red clover	10- 15 1-2 3-5	Broad drainage tolerance with pH > 5.8.	Should broadcast red clover every 2-3 years in late winter. E+ tall fescue will persist better than E- but will provide lower animal performance. Use more grazing pressure on E+ tall fescue to keep vegetative.
Continuous Stocking	Alfalfa (grazing tolerant variety) White clover Tall fescue (E+ or E-)*	10-15 1-2 6- 10	Well drained, deep, fertile soils with pH > 6.5.	E+ will persist better than E- but will provide lower animal performance. Use more grazing pressure on E+ tall fescue to keep vegetative.
Rotational Stocking	Alfalfa and Orchardgrass or Matua bromegrass or Tall fescue(E-)*	10-15 3-6 or 10-15 or 6-10	Well drained, deep, fertile soils with pH > 6.5	Graze when alfalfa is bud to early bloom down to 2-3" residual to reduce grass competitiveness. Grazing periods <7 days, rest periods 25-40 days. Maintain P and K in high range to maintain alfalfa. Be careful of bloat if alfalfa is predominate. Allow Matua mixture 45 days in late summer to reseed.
Rotational Stocking	Orchardgrass Red Clover Ladino Clover	8-12 3-5 2	Well drained to somewhat poorly drained soils with moderate or better fertility and pH > 6.0	Turn in at 6-10” and graze to 3” crop height.
Continuous or Rotational Stocking - Summer production	Bermudagrass or Caucasian bluestem	12-20 bu sprigs 2-3 PLS**	Any soil. Bermudagrass prefers lighter textured soils. Caucasian needs deep soils with pH > 5.5.	Use adequate stocking rate to maintain vegetative stage and palatability. With rotation, turn in at 8-12” and graze to 3-4”. Best to graze lightly or hay during establishment year.
Rotational Stocking - Summer production Rotational Stocking-Summer	Switchgrass or Dwarf, pearl millet or Sudangrass or Sorghum-Sudan Hybrids	7-10 PLS** 15-30D, 25-40B or 15-20D,25-35B or 20-30D,30-45B	Any deep soil. Good flooding tolerance. Medium to well drained soils. Pearl millet higher yielding on heavy-textured soils.	Turn in at 18-24”, graze down to 8-10”. Best to graze lightly or hay during establishment year. Turn in at 18-24”, “30” for sorghum-sudan and graze to 6”. Avoid prussic acid poisoning in sudan and sorghum-sudan by NOT grazing young seedlings, young regrowth, stunted growth, and frosted plants. All can accumulate nitrates during drought -- wait one week after rain before grazing.

*E+=High endophyte
E-=Low endophyte
**PLS= Pure live seed

D = Drilled
B = Broadcast

Recommendations for Hay and Haylage Seedings in Virginia

Species	Seeding Rate (lb/acre)	Soil Adaptation	Management Tips
Alfalfa Orchardgrass	15-20 3-7	Fertile, well drained soils with pH > 6.5	Cut when alfalfa is bud to early bloom stage. Allow at least one harvest to reach early bloom. Take first cutting when alfalfa is in bud stage.
Alfalfa	18-25	Fertile, well drained soils with pH > 6.5	Cut when alfalfa is bud to early bloom stage. Allow at least one harvest to reach early bloom. Take first cutting when alfalfa in bud stage.
Alfalfa and Matua bromegrass or Timothy or Smooth bromegrass	12-15 and 10-15 or 4-6 or 10-12	Fertile, well drained soils with pH > 6.5	Timothy and smooth bromegrass provide little forage after first cutting; best adapted west of Blue Ridge; avoid cutting during stem elongation to insure persistence. Smooth bromegrass is more drought tolerant than Timothy. Allow > 45 days between cuttings in late summer to allow Matua bromegrass to reseed.
Red clover and Orchardgrass or Tall fescue (E-)*	5-8 and 8 -12 or 8-12	Moderately to poorly drained soils not suitable to alfalfa with pH > 6.0	Cut when grass is in boot stage. Red clover may not persist beyond 2-3 years. Thus one should inter-seed every 2-3 years to maintain red clover component.
Tall fescue (E-)*	20-25	All types of soils with pH > 5.8.	Take first cutting before head emergence; subesequent cuttings every 30-40 days; does not produce seedheads after first harvest.
Matua bromegrass	20-30	Any fertile soil.	Cut in boot stage. Allow > 45 days between cuttings in late summer to allow reseeding.
Timothy or Smooth bromegrass	6-8 or 15-25	Light to medium-textured soils with at least moderate drainage.	Cut in boot stage to early heading. Avoid cutting during stem elongation. Timothy will not persist in southern Piedmont or Coastal Plain; limited production after first cutting in most of state. Smooth bromegrass is more drought tolerant.
Orchardgrass	10-15	Light to medium-textured soils with at least moderate drainage	First cutting at boot to early bloom stage. Subsequent regrowth will be vegetative and can be harvested every 30-40 days.
Reed canarygrass	6-8	Very tolerant of flooding and poorly drained soils. Also most drought tolerant of cool-season grasses. Tolerates pH of 5 to 8.	Cut during stem elongation to boot. Coarse at later maturity. Slow initial establishment; fills in with time from rhizome spread.
Switchgrass or Eastem Gamagrass	7-10 PLS** or 8-10 PLS**	Any deep soil. Good flooding tolerance	Cut in boot stage. Coarse at later maturity. Slow initial establishment fills in with time from rhizome spread in switchgrass, and crown widening in gamagrass.

*E+= High endorphyte *E-=Low endophyte **PLS = pure live seed

Hay storage

Losses in dry matter and quality of hay during storage can be high, particularly with round bales stored outside. On some farms, hay storage and feeding losses combine to account for over 10% of livestock production costs. Producers often do not realize how large their hay losses are or that with relatively little effort and expense they can be reduced considerably.

When hay is baled above 20% moisture, mold growth and heating occur. Dry matter losses are greater. Safe moisture levels for storage are 20% for rectangular bales, 18% for round bales, and 16% for large rectangular bales. Whereas storage losses are typically around 5% for hay stored inside at safe moisture levels, losses several times higher occur with extremely moist hay. Heating of hay is related to temperature. Peak temperature is usually reached within a week after baling, but with higher moisture hay and conditions which limit heat escape, it may take as much as three weeks.

The extent of weathering damage that occurs with hay stored outside varies with climatic factors, forage species, and bale diameter. Weathering primarily affects hay in the outside circumference of a large round bale. The percentage of hay lost decreases as bale size increases because a smaller proportion of the bale volume is contained in the surface layer. A weathered layer 6" deep on a 5' x 5' bale contains over one-third of the hay volume, a serious amount of loss. Half of the outside storage losses occur at the bale/soil interface due to the bale drawing moisture from the soil.

Total crude protein declines with weathering, but crude protein percentage may increase since protein is less subject than other plant constituents to weathering loss. The proportion of digestible crude protein will decrease, however, if hay undergoes excessive heating. Highly digestible soluble carbohydrates decline in weathered hay resulting in higher ADF concentration and lower digestibility. Losses in quality are usually greater for legumes than for grasses.

Measuring hay

To find the capacity of a stack, rick, or mow in tons, determine the volume of space occupied by the material in cubic feet and divide this volume by the number of cubic feet occupied by one ton of the respective kind of hay or straw.

Determining Storage Space (approximate) Occupied by One Ton of Hay or Straw

	Storage Space Required in Cu Ft
Hay, loose, barn cured	300 to 350
Square baled (loose)	200 to 250
Square baled (tight)	100 to 150
Hay, chopped, barn cured	250 to 325
Straw, loose	500 to 600
Straw, square baled (tight)	150 to 200
Straw, square baled (loose)	250 to 300

Factors that reduce outside storage losses with round bales

1. The denser or more tightly hay is baled, the lower the amount of spoilage as long as hay is baled at or below 18% moisture. Bale density is affected by the baling machine, the care/experience of the operator, and forage species with fine-stemmed hays naturally producing a tighter bale. The density of round bales should be a minimum of 10 pounds of hay per cubic foot.

2. Reducing twine spacing reduces storage losses, but increases costs. Net wrap usually reduces storage losses compared to twine. Although it costs more than twine, it is faster than twine wrap and bales are often better stabilized, making handling and storage easier.

3. Store bales in well drained upland sites. Hay/soil contact should be avoided if possible. Wooden pallets, telephone posts, scrap pipe, cross ties, and rock pads are all effective.

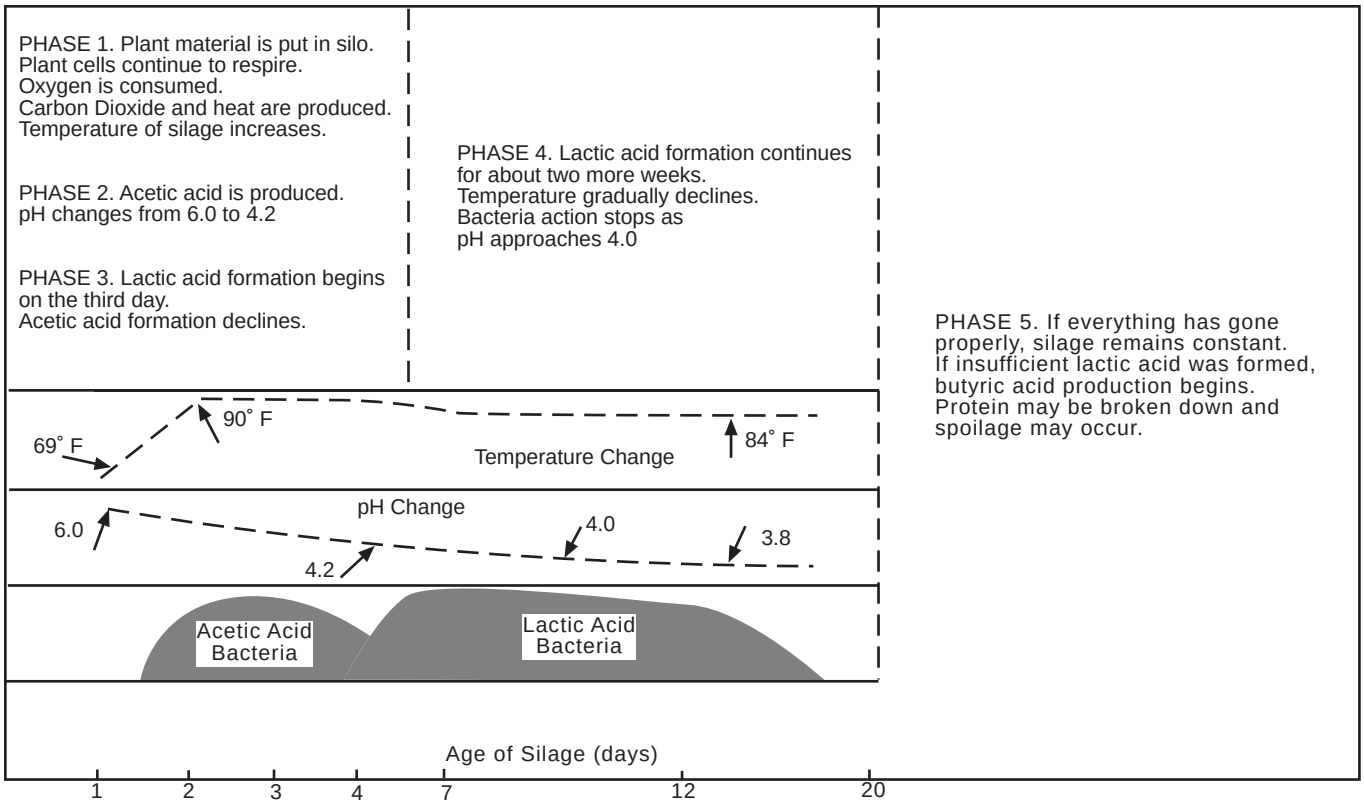
4. If a multiple-bale cover is NOT being used, bales should be stored in rows with rounded sides at least 3' apart. Flat ends should be firmly butted against one another. Align rows north and south to allow maximum exposure of the rounded sides to the sun. A gently sloping site will allow rapid drainage of rainwater. Bales should be oriented up and down the slope near the top of slope, preferably with southern exposure. Never store bales under trees.

5. Place three or five rows of bales in triangular stacks under a tarp or plastic sheet that is secured firmly. Inside storage is the best way to ensure low storage losses. The more valuable or porous the hay, the higher and/or more frequent the rainfall, and/or the longer the period of storage, the more easily barn construction can be justified. For example, with an estimated construction cost of $7.50 per square foot, it pays to build a barn to store hay valued at $60 per ton that otherwise would experience losses of 20% or more when stored outside. Hay valued at $100 per ton justifies barn construction if outside storage losses approach 15%.

Silage

Most crops grown for livestock feed can be allowed to ferment and be fed as silage. Handling of the crop for silage should always favor proper fermentation. Figure 2 below describes what actually occurs in the silo.

Figure 2. Changes in Bacteria Concentrations, pH, and Temperature During the Ensiling Process



The quantity and quality of siage varies with crop species. The following table gives generally expected yields, crude fiber and acid detergent fiber.

Annual Yield and Composition of Silage Crops

Crop	Stage	Yield, Tons/Acre 35% Dry Matter	Dry Matter Basis % Crude Protein	% Acid Detergent Fiber
Corn	Hard Dough	15-25	8	28
Grain Sorghum	Dough	10-15	9	42
Forage Sorghum	Early Head	10-15	11	29
Sorghum Sudan	Early Head	7-15	12	45
Barley	Dough	7-15	9	36
Wheat	Dough	7-15	9	36
Oats	Dough	5-10	10	38
Rye	Boot	4-6	13	40
Alfalfa (4x)	Late Bud-Early Bloom	10-12	18	33
Red Clover	Early Bloom	7-8	12	43

Silage Statistics

Dry matter content	32-42%
Moisture content	68-58%
Length of cut	1/4-3/4 inch
Time required for complete fermentation	14 days
Density in upright silo	40-45 lbs/cu ft
Density in wagon, freshly chopped	20-25 lbs/cu ft

Approximate Capacity for Corn Silage in Trench or Bunker Silos with Sides Sloped Outward 1 1/2" for Each Foot of Depth*

Bottom width (feet)	Approximate tons per foot of length, Depth -- feet 8	10	12	16	20
20	3.1	4.0			
30	4.6	5.9	7.1	9.6	
40	6.1	7.7	9.3	12.6	16.0
50	7.6	9.6	11.6	15.6	19.8
60		11.5	13.8	18.6	23.6
70			16.1	21.6	27.4
80			18.3	24.6	31.0
100				30.6	38.6

*Iowa State University Pm-417.

Direct cut vs. wilted silage

The grain-crop silages such as corn, barley, wheat, oats, and grain sorghum are normally chopped directly as they stand in the field when the grain reaches the dough stage. The relatively high dry matter content of the grain in such silage, plus the drying effects of advancing maturity, results in silage within the desirable dry matter range (35-42%).

When these same crops are harvested at a less mature stage, or when the traditional hay crops are handled as silage, it is necessary to partially dry or "wilt" the plants in the field before ensiling. Such wilting usually requires about one day under favorable drying conditions. Crushing the stems with a conditioner hastens the drying process.

Experience and good judgement are needed to determine when the crop is wilted to the proper dry-matter level. The "grab test" is useful as a guide to the dry matter content of forage. Squeeze very tightly for 90 seconds a fistful of finely chopped forage. Then observe the condition of the ball:

Description of the Forage Ball	Approximate Dry Matter Content
Holds its shape but has considerable free juice	Less than 25%
Holds its shape, hand is moist, but there is very little free juice	25-30%
Expands slowly, with no free juice	30-40%
Springs out and falls apart rapidly	More than 40%

High moisture corn and earlage

Harvesting the entire corn plant for silage makes full utilization of the corn plant. In some instances, harvesting a portion of the corn acreage by chopping only the ears for ensiling provides a source of grain for balancing the ration. Another variation is to shell the grain and allow it to ferment. These procedures provide grain storage without the costs of drying. Such high-moisture material can be easily mixed and fed with silage. Fewer harvest losses from shattering occur, and harvesting can be done 2-3 weeks earlier than dry corn, thus reducing lodging losses some years and providing additional time for establishing cover crops.

High-moisture shelled corn and earlage should be harvested when the ear reaches physiological maturity. At this stage, kernels are well dented and those near the center of the ear show the typical black layer at the base where they are attached to the cob.

Conventional concrete stave silos or oxygen-limiting units are an effective means for storing high-moisture shelled corn or earlage. If stored in concrete stave silos higher than 60 to 70 feet, placing extra hoops around the bottom 30 feet of the silo is suggested. Fermentation is complete in 15-20 days. The suggested moisture level for storing high-moisture shelled corn is 28%, with a range between 25-30%. It should be ground or rolled before being fed.

In earlage, the moisture range of the kernel is 28-30%, with 28% considered ideal. At this point, the cob will contain 40-50% moisture, making the moisture content of the ear corn silage about 32%. Earlage must be ground before it is stored. The main objective is to break the kernels, so fine grinding is not necessary. Holes in the screens of hammer mills or recutters range in size from 1/2 to 1 inch.

Approximate Dry Matter Capacity of Upright Silos*

Depth of settled silage	Silo diameter, ft										
	10	12	14	16	18	20	22	24	26	28	30
ft	tons of dry matter										
20	8	12	16	21	27	33	40	47	56	65	74
22	9	14	19	24	30	38	48	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		34	47	61	77	95	115	137	161	186	214
44		37	50	65	82	102	123	146	172	200	229
46		39	53	69	88	108	131	155	183	212	244
48		42	56	74	93	115	140	166	195	226	260
50		44	60	78	99	122	148	175	206	239	274
52			64	83	105	129	157	186	219	254	291
54			67	88	111	137	165	197	231	267	306
56			71	93	117	144	174	207	243	282	324
58			74	98	123	151	183	218	261	297	339
60			78	102	129	159	192	228	273	309	357
62					135	167	201	239	287	324	374
64					142	174	210	250	301	339	391
66					149	182	219	260	314	354	407
68					155	190	228	271	328	369	424
70					162	198	237	282	342	384	441
72								293	356	400	458
74								305	371	415	476
76								316	385	431	493
78								328	400	446	511
80								339	414	462	528

To estimate tons of silage of various moisture contents, use the following formula:

$$\frac{\text{tons of dry matter}}{\text{estimated \% dry matter in silate}} \times 100 = \text{tons actual silage}$$

*From Dairy Housing and Equipment Handbook, Iowa State University.