

USDA
NATURAL RESOURCES
CONSERVATION SERVICE
DELAWARE CONSERVATION
PRACTICE STANDARD
**FORAGE HARVEST
MANAGEMENT**
CODE 511
(Reported by Acre)

DEFINITION

The timely cutting and removal of forages from the field as hay, green-chop, or ensilage.

PURPOSES

This practice may be applied for one or more of the following purposes:

- Optimize the economic yield of forage at the desired quality and quantity;
- Promote vigorous plant re-growth;
- Maintain the life of the stand for the desired time period;
- Manage the desired species composition;
- Control insects, diseases, and weeds;
- Use forage plant biomass as a soil nutrient uptake tool;
- Maintain or improve wildlife habitat.

**CONDITIONS WHERE PRACTICE
APPLIES**

This practice may be applied on all lands where machine-harvested forage crops are grown. This practice may be used in combination with Prescribed Grazing (Code 528) in fields where forage is harvested both mechanically and by grazing animals. This practice may also be used in combination with Conservation Crop Rotation

(Code 328) in fields where hay is grown in rotation with other crops.

This practice does not apply to establishing forage crops. Refer to the conservation practice standard for Pasture and Hay Planting (Code 512).

CONSIDERATIONS

When plants are growing rapidly, pastures may produce forage in excess of livestock demand. Consider machine-harvesting a portion of the standing crop to retain forage quality and properly store excess forage production.

In conjunction with harvest operations, consider storage and feeding options that will retain acceptable forage quality and minimize loss of digestible dry matter, such as storing the bales off the ground, covering the bales, or wrapping large, round bales.

When rainfall and/or humidity levels are high, consider ensiling cut forage to reduce forage quality losses and eliminate field-drying time. Other options include: (1) the use of desiccants, preservatives, conditioners, macerating, and fine-chopping implements, or barn-curing techniques to reduce drying time, or (2) the use of green-chopping or grazing to improve the timeliness of harvest and maintain forage quality.

Direct-cut grass and legume silage can produce silage leachate (seepage). Consider the need for collection, storage, and disposal of this leachate as part of an agricultural waste management system.

To control forage plant diseases, insects, and movement of weeds, clean harvesting equipment after harvest and before storing. Cut forages after dew, rain, or irrigation water on leaves has evaporated.

Care should be taken to produce stored forages of the quality needed for optimum performance of the animal being fed. For instance, immature legume forages can be too low in fiber and lead to metabolic disorders in ruminants and an economic loss to the producer due to lowered animal performance.

Conservation practice standards are reviewed periodically, and updated if needed. To obtain the current version of this standard, contact the Natural Resources Conservation Service.

When nutrients or other soil amendments are applied, coordinate this practice with the current NRCS conservation practice standard for Nutrient Management (Code 590), and Waste Utilization (Code 633), as appropriate. An excess or improper balance of nutrients such as nitrogen can produce plant material that causes toxicity in some animals.

Where applicable, coordinate this practice with the current NRCS practice standard, Pasture and Hay Planting (Code 512), Prescribed Grazing (Code 528), and Pest Management (Code 595), as applicable.

Take note of other constraints such as economic feasibility, available equipment, access, capacity of storage areas, cost-share or program requirements, social effects, and visual aspects.

CRITERIA

Criteria Applicable to All Purposes

Forage shall be harvested at a frequency and height that will accomplish the intended purpose of the practice and the objectives of the client. Delaware Cooperative Extension forage harvest recommendations shall be used to meet the following criteria:

Stage of Maturity. Harvest forage at the stage of maturity that provides the desired quality and quantity. Most forage crops decline in nutritive value as they mature. If harvested at a later stage of maturity, use the forage for livestock that have lower nutritional needs or balance the feed ration by using supplements.

Harvest new seedings when sufficient growth is present and plant roots are established well enough to ensure adequate food reserve storage for overwintering and vigorous spring growth. Avoid fall harvest of late season plantings because adequate re-growth will not occur before the first killing frost.

Harvest established stands according to the guidelines in Table 1. For grass-legume mixtures, harvest at a time that will favor the desired species. For other hay harvest recommendations, refer to published agronomy guides (e.g., the Penn State Agronomy Guide) or other recognized references.

Avoid harvesting forage whose quality is not suitable for optimum health and productivity of the livestock being fed. For instance, immature legume forages can be too low in fiber and may lead to metabolic disorders in ruminants and an economic loss to the producer.

Delay harvest if prolonged or heavy precipitation is forecast that would significantly damage cut forage. When weather conditions make it difficult to harvest the desired quality of forage, use mechanical or chemical conditioners or ensile the forage to maintain quality.

Moisture Content. Harvest silage and hay crops at the ideal moisture range for the type of storage structure(s) being utilized.

When direct-cut hay crop silage is harvested at moisture content greater than 70 percent, treat with chemical preservatives or add dry feedstuffs to avoid fermentation and loss of digestible dry matter due to seepage.

For optimum forage quality, rake, ted (spread out), or invert swaths when cut hay has reached an appropriate moisture level to prevent leaf loss, as follows:

1. Rake hay when the moisture content is 30 to 40 percent;
2. Ted or invert swaths when the moisture content is above 40 percent.

Bale at appropriate moisture levels to retain forage quality and quantity. Use the guidelines in Table 2 to determine the moisture content for various storage methods.

Length of Cut. When harvested for ensilage, chop forage to a size appropriate for the type of storage structure (high moisture wrapped or tube bales) that allows adequate packing to produce the anaerobic conditions necessary to ensure the proper ensilage process.

Contaminants. Forage shall not contain contaminants at levels injurious to the health of the livestock being fed. Contaminants are any objectionable matter or toxin that can cause illness, miscarriage, death, or rejection of the offered forage.

Additional Criteria to Promote Plant Re-Growth and Maintain Stand Life and Species Composition

Soil pH and Fertility Levels. Based on soil test results, apply lime and fertilizer to forage crops to meet desired yield goals, promote plant regrowth, and help maintain the life of the stand. The use of commercial fertilizer and other forms of plant nutrients must be in compliance with Delaware nutrient management regulations, as applicable, and shall meet the requirements of the Delaware conservation practice standard for Nutrient Management (Code 590).

Harvest Interval. Cut forage plants at a harvest interval that will provide adequate plant reserves and/or basal or axillary tillers or buds for regrowth and/or reproduction to occur without loss of plant vigor.

Cut reseeding annuals at a stage of maturity and frequency that ensures the production of viable seed or ample carryover of hard seed to maintain desired stand density.

If plants show signs of short-term environmental stress, adjust management to ensure the continued health and vigor of the stand.

Stubble Height. Cut forages at a height that will promote the vigor and health of the desired plant species. Use cutting heights that will provide adequate residual leaf area; adequate numbers of terminal, basal, or axillary tillers or buds; sufficient insulation from extreme heat or cold; and/or unsevered stem bases to store food reserves needed for full, vigorous recovery. Leave a 2-3" stubble height for Kentucky Bluegrass; 3-4" for other perennial cool season grasses and legumes; and 4-6" for perennial warm season grasses.

Manipulate timing and cutting heights of harvest to ensure an establishment of reseeding or seeded annuals.

Additional Criteria to Control Disease, Insect, Weed, and Invasive Plant Infestations

Schedule harvest periods as needed to help control disease, insect, and weed infestations.

To reduce damage due to outbreaks of insects or foliar diseases, manage the stand to maintain plant vigor.

To the extent feasible, manage the stand to encourage plant diversity in order to minimize problems due to species-specific pests.

When insect, disease, or weed infestations exceed the economic threshold and cannot be controlled by forage harvest management alone, use appropriate integrated pest management techniques. Refer to the conservation practice standard for Pest Management (Code 595).

For specific pest management recommendations, contact the appropriate specialist from Delaware Cooperative Extension, the Delaware Department of Agriculture, or a licensed commercial pest management consultant. Adhere to the specific days to harvest period stated on the pesticide label.

Additional Criteria to Improve Water Quality by Harvesting Plant Biomass

Use a harvest regime that utilizes the maximum amount of available or targeted nutrients from the site.

For fields with one or more nutrients testing in high or excessive amounts, harvest as needed to bring accumulated soil nutrients within the agronomic optimum soil test range. Also, when practical and consistent with the producer's objectives, replant with species that require high levels of targeted nutrients. Refer to the Agricultural Waste Management Field Handbook for information concerning plant nutrient uptake by forage crops.

Forage testing is recommended for forages that are harvested from fields with high to excessive nutrient levels. As appropriate based on test results, balance feed rations by using the actual nutrient content of the forage instead of "assumed" or "average" values.

Additional Criteria to Maintain or Improve Wildlife Habitat

Use appropriate harvest schedules and maintain plant heights to provide suitable habitat for the desired species. Refer to the conservation practice standard for Upland Wildlife Habitat

Management (Code 645) and the Maryland Wildlife Biology and Management Handbook for additional criteria and wildlife species information.

Mechanical harvesting schedules and wildlife nesting schedules are often incompatible. Generally, the longer the intervals between harvest, the better. It usually is not economically feasible to leave forage unharvested for long periods. Therefore, habitat for ground-nesting birds and other wildlife is best provided in production hayfields by leaving field edges unharvested and undisturbed during the primary nesting season (April 15 to August 15). Optimum results can be achieved by leaving an unharvested strip at least 50 feet wide along field edges.

Infrequent grazing may be allowed during the primary nesting season, provided the area is not grazed below 6 to 8 inches. Most grassland wildlife can co-exist with grazing livestock if stocking levels are kept low, minimum plant height is maintained, and plant re-growth is allowed before grazing is resumed.

When feasible, manage the stand to favor a diverse mix of grasses, forbs, and legumes to provide food and cover for wildlife.

Specific program requirements may dictate criteria in addition to those specified above.

SPECIFICATIONS

Plans and specifications for forage harvest management shall be prepared in accordance with the previously listed criteria. Plans and specifications shall contain sufficient detail concerning forage management to ensure successful implementation of this practice. Documentation shall be in accordance with the section "Supporting Data and Documentation" in this standard.

OPERATION AND MAINTENANCE

An operation and maintenance (O&M) plan shall be prepared for each management unit. Appropriate job sheet(s), fact sheets, or other information sheets may be used to serve as the management plan as well as supporting documentation and shall be provided to the

client. These sheets shall be referenced in the conservation plan narrative.

Stand Management and Storage. To insure adequate root reserves, allow plants to reach an appropriate height (see Table 1) before the first killing frost.

When the quantity and quality of the forage decreases to unacceptable levels, stand renovation may be necessary.

Manage grazing to limit damage to the forage crop. This is especially critical during periods when fields are wet and compaction can occur, such as during late winter. Remove livestock from hay fields before plants begin spring growth.

Monitor weather conditions and take action accordingly before and after cutting to optimize forage wilting or curing time, maintain forage quality, and prevent forage swaths or windrows from smothering underlying plants.

Do not cut forage until dew, rain, or irrigation water on leaves has evaporated.

Minimize the time large or small bales of cured forage is allowed to remain drying in the field. This will prevent smothering of underlying plants and subsequent weed invasion of the damaged areas.

Regardless of silage storage method, ensure good compaction and an airtight seal to exclude oxygen and mold formation. Do not seal hay, because it can result in heat build-up, moisture, and mold problems.

Control noxious weeds as required by state law.

Equipment and Safety. Select equipment sizes and capabilities that will handle the acreage normally harvested in a timely and economically feasible manner.

Operate all forage harvesting equipment at optimum settings and speeds to minimize loss of leaves.

Set the shear plate in a forage chopper to the proper cut for the crop being harvested. Keep knives well sharpened. Do not use re-cutters or screens unless forage moisture levels fall below

recommended levels for optimum chopping action.

To control the spread of forage plant diseases and weeds, clean harvesting equipment after harvest and before storing.

Before forage harvest, clear fields of debris that could damage equipment or, if ingested by livestock, lead to sickness or death.

Inspect and repair harvest equipment following the manufacturer's preventive maintenance schedule.

Keep all shields in place during machine operation to prevent injury or loss of life. Shut off machinery before working on or detaching moving parts.

Record Keeping

Producers' records should include soil test results and the rate and timing of nutrients applied, plus the following:

- a. Crop planted;
- b. Harvest dates;
- c. Stubble height following harvest, if applicable;
- d. Moisture content at time of harvest;
- e. Storage method;
- f. Length of cut when harvested for ensilage.

SUPPORTING DATA AND DOCUMENTATION

The following is a list of the minimum data and documentation to be recorded in the case file:

1. Extent of planting in acres, field number, and the location of the practice marked on the conservation plan map;
2. Assistance notes shall include dates of site visits, name or initials of the person who made the visit, specifics as to alternatives discussed, decisions made, and by whom;
3. Completed copy of the appropriate job sheet(s) or other specifications and management plans. Specify the following by forage crop:
 - a. Purpose of forage production;
 - b. Forage harvest guidelines that include stage of maturity for harvest and average number of cuttings expected per year (Refer to Table 1);
 - c. Stubble height following harvest;
 - d. Moisture content goal at harvest (Refer to Table 2);
 - e. Storage method.

REFERENCES

1. Hall, Marvin, and Jerry Cherney, 2003. Agronomy Fact Sheets 20-28. Penn State University, College of Agricultural Sciences.
2. Myers, R. David, 1988. Forage Production Fact Sheet 470, Maryland Cooperative Extension.
<http://www.agnr.umd.edu/MCS/Publications>
3. Penn State University, 2003. The Agronomy Guide. College of Agricultural Sciences.
<http://AgGuide.agronomy.psu.edu/pdf.htm>
4. USDA, Natural Resources Conservation Service. Conservation Practice Standard for Nutrient Management, Code 590. Delaware Field Office Technical Guide, Section IV.
5. USDA, Natural Resources Conservation Service. Conservation Practice Standard for Pasture and Hay Planting, Code 512. Delaware Field Office Technical Guide, Section IV.
6. USDA, Natural Resources Conservation Service. Conservation Practice Standard for Pest Management, Code 595. Delaware Field Office Technical Guide, Section IV.
7. USDA, Natural Resources Conservation Service. Conservation Practice Standard for Prescribed Grazing, Code 528. Delaware Field Office Technical Guide, Section IV.
8. USDA, Natural Resources Conservation Service. Conservation Practice Standard for Upland Wildlife Habitat Management, Code 645. Delaware Field Office Technical Guide, Section IV.
9. USDA, Natural Resources Conservation Service, 1994. Grass Varieties in the United States. Agricultural Handbook 170, Washington D.C.
10. USDA, Natural Resources Conservation Service. Maryland Wildlife Biology and Management Handbook.
11. USDA, Natural Resources Conservation Service, and Ducks Unlimited Canada. Vegetating with Native Grasses in Northeastern North America.

TABLE 1: Forage Harvesting Guidelines for Established Stands ^{1/}

Plant Species	Harvest Period	Growth Stage for Harvest ^{2/, 3/}	Average Number of Cuttings ^{4/}	Minimum Height at First Killing Frost
LEGUMES				
Alfalfa	1 st cut	Late bud to early bloom	3 – 5	Final cutting of legumes should have at least 45 days of growth and be harvested just before or immediately after the first killing frost.
	2 nd & successive cuts	Early bloom		
Birdsfoot Trefoil ^{5/}	1 st cut	Early bloom	3 – 4	
	2 nd cut	Mid to late bloom		
Ladino Clover	All cuts	Early to mid bloom	3 – 4	
Red or Alsike Clover	1 st cut	First bloom to early bloom	3 – 4	
	2 nd cut +	Late bud to early bloom		
Annual Lespedeza	All cuts	Mid to full bloom	2	
COOL-SEASON GRASSES				
Orchardgrass, Fescue, and other non-jointed grasses	1st cut	Boot stage	3	5 to 6 inches
	Successive cuts	After 8 to 10-inch recovery		
Smooth Brome, Timothy, Reed Canarygrass, and other jointed grasses	1st cut	Smooth Brome – early to full head; All others – early to full head	3	5 to 6 inches
	Successive cuts	Wait 6 weeks and cut again. Timothy usually won't produce a second cut until fall.		
WARM-SEASON GRASSES				
Eastern Gama Grass	1st cut	Late boot stage	3	8 to 10 inches
	Successive cuts	Add N and cut again in 6 – 8 weeks.		
Switchgrass, Big Bluestem, Caucasian Bluestem	All cuts	Late boot stage <u>Caution:</u> leave 4 to 6-inch stubble	Usually only one cutting per season	8 inches
Summer annual grasses (Sudan Grass or Sudan/Sorghum crosses)	All cuts	Sudangrass: 18-24 inches tall. Sorghum x sudangrass: typically 24 to 30 inches for hay. Leave 4 to 6-inch stubble for fast recovery. <u>Caution:</u> Delay green-chopping until grass is 18 inches in height or taller to avoid adverse effects of prussic acid.	2 – 3 (Sorghum only once)	Frosted forage should not be grazed for at least a week after frost to allow prussic acid content to dissipate.

See next page for footnotes.

TABLE 1 NOTES:

1. For additional hay harvest recommendations, refer to published agronomy guides or other recognized references.
2. Definitions of developmental stages of forage grasses and legumes (Source: The Penn State Agronomy Guide):

Stage of Maturity	Definition*
<i>Legumes</i>	
Late vegetative	No visible buds, flowers or seed pods. Stems at least 12 inches tall.
Early bud	Visible flower buds on at least one stem (1%).
Mid bud	50% of the stems have at least one bud.
Late bud	75% of the stems have at least one bud, no visible flowers.
First bloom	Flowers on at least one stem. (1%)
Early bloom	10% of the stems have at least one flower.
Mid bloom	50% of the stems have at least one flower.
Full bloom.	75% of the stems have at least one flower, no visible seed pods
<i>Grasses</i>	
Vegetative	Leaves only, stems not elongated (specify height).
Stem elongation	Stems elongating. Specify early or late jointing.
Boot	Flowers head is enclosed in a flag leaf sheath and not showing.
Heading	Flower head emerging or emerged from flag leaf sheath, but not shedding pollen.
Anthesis	Flowering stage, anthers shedding pollen.
Milk stage	Seed immature, endosperm milk.
Dough stage	Well-developed seed, endosperm doughy.
Ripe seed	Seed ripe, leaves green to yellow brown.

*Randomly select 100 stems from the field and determine the percentage of stems at the most mature stage of development.

3. Harvesting of legume-grass mixes:

Alfalfa-grass mixes should be cut based on the maturity of the alfalfa, when alfalfa is in late bud to early bloom stage.

All other **legume-grass mixes** should be cut based on grass maturity.

4. The actual number of cuttings per year will depend on temperature, rainfall, and other site-specific conditions.
5. For birdsfoot trefoil, maintain a cutting height of 3 inches or more to maximize yields and the longevity of the stand.

TABLE 2: Optimum Moisture Levels for Storing Forage		
Storage Method	Percent (%) Moisture for:	
	Hay	Corn
Upright or tower, conventional	60 – 65	63 – 68
Upright or tower, oxygen limit	40 – 55	55 – 60
Bunker or horizontal	65 – 70	65 – 70
Bag silo (plastic tube)	50 – 60	65 – 70
Baleage (plastic-wrapped round bale)	50 – 60	N/A
Field-cured hay	15 – 20	N/A
Forced-air dried baled hay	20 – 35	N/A