

**NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD**

FORAGE HARVEST MANAGEMENT

**(ACRE)
Code 511**

DEFINITION

Forage harvest management is the timely cutting and removal of forages from the field as hay, green-chop, or ensilage.

PURPOSES

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

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to all land uses where machine harvested forage crops are grown.

CRITERIA

General criteria applicable to all purposes.

Forage will be harvested at a frequency and height that will maintain a desired healthy plant community through its life expectancy and maximize dry matter at

the yield and quality desired for the intended use.

a. Stage of Maturity.

Harvest forage at the stage of maturity that provides the desired quality and quantity of forage for the livestock being fed. Early cutting produces higher quality but lower quantities. Delayed harvests will usually increase yield but lower quality. This lower quality forage is still appropriate for some classes of livestock. See Table 2. Digestibility drops at a rate of approximately 0.5 percent per day for each day delay in harvest beyond the early flowering stage. A forage test is the most reliable method to determine forage quality and ensure that livestock nutrient needs are met.

When intended use is for livestock consumption, harvest at the maturity stage that maximizes digestible dry matter (DDM) yield and quality for the intended type of livestock. See Table 1 and Table 2.

<p>Conservation practice standards are reviewed periodically, and updated if needed. To obtain the current version of this standard, contact the Natural Resources Conservation Service.</p>
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Table 1 Quality standards for legume, grass, and grass and legume mixture.

Quality Standard		Analysis		
		RFV ^{1/}	ADF ^{2/}	NDF ^{3/}
% dry matter				
prime	pre-bloom	>151	<31	<40
1	early bloom	151-125	31-35	40-46
2	mid bloom	124-103	36-35	47-53
3	full bloom	102-87	41-42	54-60
4	rain damaged	86-75	43-45	61-65
5	sever damage	<75	>45	>65

^{1/}RFV=relative feed value; ^{2/}ADF=acid detergent fiber; ^{3/}NDF=neutral detergent fiber.

Forage quality is determined at the end of harvest and is based upon established quality standards. Use the RFV index to allocate the proper forage to the proper livestock class. Performance of high producing dairy cows is most limited by intake of digestible dry matter. Prime hay or haylage is recommended for them. Grade 1 is recommended for dairy cows after the first trimester, heifers, and stocker cattle.

When managing forage stands for multiple use objectives that include wildlife considerations and usage as livestock feed, harvesting at a later stage of maturity is acceptable. Feed to livestock class and type with lower nutritional needs or balance feed ration or both. See Table 2.

Delay harvest if prolonged or heavy precipitation is forecast that would seriously damage cut forage.

Where weather conditions make it difficult to harvest the desired quality of forage, use mechanical or chemical conditioners and/or ensile.

Base harvest of mixed grass-legume stands on the stage of maturity for legume forage quality except for birdsfoot trefoil, ladino, and white clover. On these base harvest on the grass component's stage of maturity.

Harvest before excessive leaf loss occurs if a foliar disease or insect infestation will lower forage quality below that needed for the intended livestock class or type by the time the proper stage of maturity is reached.

When green chopping summer annual grasses containing hydrocyanic acid (HCN), delay harvest until grass is greater than 18 inches tall. Test these forages and Johnsongrass, trefoil, and white clover for HCN if stressed by drought, frost, or other environmental conditions prior to green chopping.

When ensiled forages exhibit high levels (>2500 ppm) of nitrates delay feeding of silage for 6-8 weeks.

b. Moisture Content.

Harvest silage/haylage crops at the optimum moisture range for the type of storage structure(s) being utilized. The success of balage (ensilage bales of forage) varies depending upon moisture content and quality of air tight bale containment system. Air tight forage containment is a critical component for any silage system.

Treat direct cut hay crop silage (moisture content > 70%) with chemical preservatives or add dry feed stuffs to avoid fermentation, seepage, and digestible dry matter losses.

For optimal forage quality, rake, or invert swaths, and bale when hay has sufficient moisture to prevent leaf loss.

Bale at optimum moisture levels to preserve forage quality and quantity. Approximate percent moisture should be as follows:

- Bale field cut cured hay at 15 to 20 percent moisture.
- Bale forced air-dried hay at 20 to 35 percent moisture.
- Rake hay at 30 to 40 percent moisture.

- Invert swaths when moisture is above 40 percent.
- Bale balage at 50 to 70 percent moisture.

c. Length of Cut.

When harvested for ensilage, forage will be chopped to a size that allows adequate packing. This will produce the anaerobic conditions necessary to ensure the proper ensiling process.

d. Number of Harvests and/or Harvest Intervals.

Earlier and more frequent harvests increase forage quality. When harvested for animal consumption, base number of harvests and harvest interval on livestock nutritional needs while meeting the criteria that ensure desired forage stand life and vigor.

For other management goals or end uses, base number of harvests and harvest interval that are compatible with goals or use while ensuring desired forage stand life, species composition, and plant vigor.

e. Contaminants.

Forage shall not contain contaminants at levels injurious to the health of the livestock class and type being fed.

Contaminants are any objectionable matter or toxin that can cause illness, death, or rejection of the offered forage. For more information on contaminants and toxins see National Range and Pasture Handbook, Chapter 5, Section 2, pages 57-58.

Additional criteria to improve or maintain stand life, plant vigor, and forage species mix.

a. Stage of Maturity and Harvest Interval.

Cut forage plants at a stage of maturity or harvest interval range that will provide

adequate food reserves and/or basal or auxiliary tillers or buds for regrowth and/or reproduction to occur without loss of plant vigor. Harvesting early will improve quality but may reduce stand life if done continually. Harvesting a little later lowers quality, but increases yield, builds food reserves, allows basal buds to break dormancy, and increases stand life. More frequent harvests tend to decrease overall yield, reduce plant vigor, and lead to a progressive stand decline.

For winter dormant legumes (alfalfa, red clover, and most other legumes commonly grown in Iowa), maintain a harvest interval between the last cut and the first killing frost of at least 30 days. They can be harvested after a killing frost, but it may be beneficial to leave a longer stubble to catch snow and provide insulation during winter months.

When grasses and legumes are grown together, the legume stage of maturity is used to time the harvest except in the case of birdsfoot trefoil, ladino clover, and white clover. These two clovers and birdsfoot trefoil tend to maintain their quality because they are indeterminate in their growth habit.

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, management will be applied in a manner that ensures continued health and vigor of stand.

b. Stubble Height.

Cut forage plants at a height that will promote the vigor and health of the desired species. Appropriate cutting heights will provide adequate residual leaf area; adequate numbers of terminal, basal, or auxiliary tillers or buds; insulation

from extreme heat or cold; and/or unsevered stem bases that store food reserves needed for full, vigorous recovery. See Table 3.

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

c. End of Season and Harvest Regrowth Interval.

The end of the growing season harvest should be early enough for legumes to have 8-10 inches and grasses 6-8 inches of regrowth prior to a killing frost. This allows food reserves to replenish before going into winter. After a killing frost excess regrowth may be pastured or harvested if needed. Leaving unharvested regrowth may increase forage stand survival significantly depending upon the severity of the winter and the vigor of the stand going into winter. The regrowth can be left to provide insulation and cover for wildlife. The added insulation can reduce the chances of frost heave damage as well as winter killing.

d. Soil Fertility.

Adequate amounts of lime, nitrogen, phosphate, potash, and certain minor elements are needed for yield, quality, and to maintain stand life. Harvested forage removes large amounts of nutrients per acre. A soil test should be used as a guide in determining the amount of fertilizer and lime needed for sustainable hay production. Care should be taken to ensure nutrients are returned back on these lands in nearly the same proportion and amount as they were removed.

Additional information can be found in the National Range and Pasture Management Handbook, Chapter 5, Section 2, pages 54-83.

Additional criteria to use as a nutrient uptake tool. Employ a harvest regime that utilizes the maximum amount of available or targeted nutrients.

Test forages for mineral and heavy metal content. Balance feed rations accordingly when using forages produced on over-fertilized soils or on a high fertility/sludge application program.

Additional criteria to control disease, insect, and weed infestations. If a foliar disease, insects, or weeds threaten stand survival or production objectives, schedule harvest periods earlier as needed to control disease, insect, and weed infestations. When economic threshold is exceeded for alfalfa weevils, spittlebugs, or potato leafhopper within ten days of normal stage of maturity for harvest, mow early to remove their food supply.

Lessen incidence of disease, insect damage, and weed infestation by managing for desirable plant vigor.

Additional criteria to improve wildlife habitat values. Maintain appropriate harvest schedule(s), cover patterns, and plant height to provide suitable habitat for the desired specie(s).

Unharvested field edges, corners, or odd areas provide habitat for ground nesting wildlife within fields that are harvested in spring or early summer. Field edges, corners, or odd areas left unharvested throughout the growing season can provide critical brood rearing habitat for a variety of wildlife

CONSIDERATIONS

When pastures produce forage in excess of livestock demand during high growth rate periods, consider preserving forage quality by machine harvesting a portion of the standing crop. Coordinate this practice with Prescribed Grazing (528A).

Well-fertilized plants withstand more intense harvest schedules and may

produce a higher quantity and quality of forage. Coordinate this practice with Nutrient Management (590).

Select cultivars that are suitable for the harvest regime, species mix, climatic zone, and forage quality desired. For specific nutrient uptake, select species that can maximize uptake. See Pasture and Hayland Planting (512).

When insect and disease outbreaks exceed economic thresholds and are uncontrollable by harvest management, pesticide applications may be needed. Another option is to select a resistant cultivar when the stand is replaced. See Pest Management (595).

To control forage plant diseases, insects, and weeds, clean harvesting equipment after harvest and before storing. Do not cut forages until dew, rain, or irrigation water on leaves has evaporated.

When growing forages susceptible to frost heave on soils that have high frost action potential, leave stubble or unharvested regrowth that is at least six inches tall.

When weed infestation exceeds the economic threshold and is uncontrollable by forage harvest management alone, weed management should be planned and applied. See Pest Management (595).

Take care not to produce stored forages whose quality is not what is 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. Mold can be a problem, particularly for horses and may require disposing of the hay.

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

In conjunction with harvest options, explore storage and feeding options that

will retain acceptable forage quality and minimize digestible dry matter loss.

Where rainfall and/or humidity levels cause unacceptable forage quality losses in at least one harvest during the year, consider ensiling the forage to reduce or eliminate field drying time. Other options are: The use of desiccants, preservatives, conditioners, macerating implements, or barn-curing techniques to reduce field drying time, greenchopping, or grazing. These techniques can improve the timeliness of harvest and preserve forage quality.

To reduce safety hazards, avoid operating harvesting and hauling equipment on field slopes over 25 percent, particularly on cross slope traffic patterns.

During silo filling and for about two weeks after, take special care when entering or working around a silo. Protect yourself and your livestock from injury and death due to silo gas.

PLANS AND SPECIFICATIONS

Specifications for the establishment of forage harvest management shall be prepared for each site or management unit according to the Criteria, Considerations, Operations, and Maintenance described in this standard, and shall be recorded according to Documentation. Procedures, technical details, and other information listed below provide additional guidance for carrying out selected components of Forage Harvest Management. Place the detailed specifications in a site-specific job or design sheet, or in the practice narrative in the conservation plan.

OPERATION AND MAINTENANCE

Before forage harvest, clear fields of debris that could damage machinery, or if ingested by livestock, lead to sickness (for example, hardware disease) or death.

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

Inspect and repair harvesting equipment following manufacturer's preventative maintenance procedures.

All shields shall be in place during machine operation to prevent injury or death. Shut off machinery before working on or unplugging moving parts.

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

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

Set shear-plate on forage chopper to the proper theoretical cut for the crop being harvested. Keep knives well sharpened. Do not use recutters or screens unless forage moisture levels fall below recommended levels for optimum chopping action.

Regardless of silage/haylage storage method, ensure good compaction and an airtight seal to exclude oxygen and mold formation.

Clean harvesting equipment after harvest and before storing.

For control of forage diseases and insects: Do not cut forages until dew or rain on leaves has evaporated. Mow most recent seedings ahead of older stands. For potato leafhopper control in alfalfa, leave uncut alfalfa along field borders.

DOCUMENTATION

The following items shall be considered when developing a Forage Harvest Management Plan. The use of computer programs such as GLA is considered adequate documentation if they contain

information as outlined in the plan and documentation sections of this standard.

- *1. Soil Map
- *2. Plan Map
- *3. Acres
- 4. Pasture or Forage Balance worksheet
- 5. Soil Erosion Control
- 6. Pest and Nutrient Management Plan

*Those items marked with an asterisk shall be recorded as minimum documentation requirements.

REFERENCES

The following conservation practice standards and information is available at the Iowa NRCS Home page at <http://www.ia.nrcs.usda.gov>:

- Pasture and Hayland Planting (512)
- Prescribed Grazing (528A)
- Pest Management (595)
- Waste Storage Facility (313)
- USDA-NRCS National Range and Pasture Handbook
- USDA-NRCS Agriculture Waste Management Field Handbook

The following information on forages is available on the Iowa State University home page at <http://www.extension.iastate.edu/pubs/cr.htm>:

- Iowa Crop Performance Test – Alfalfa AG 84.
- Estimated Costs of Pasture and Hay Production - AG 96.
- Warm Season Grasses for Hay and Pasture - PM 569.
- Forage Testing Laboratories – PM 1098a.
- Forage Sampling and Sampling Equipment – PM 1098b.

The following information on forages is available from Penn State University at

<http://www.agronomy.psu.edu/Extension/Facts/AgFacts.htm>:

- Agronomy Facts 7 – Cutting management of alfalfa, red clover, and birdsfoot trefoil.
 - Agronomy Facts 9 – Large round bale silage.
 - Agronomy Facts 18 – Corn silage production and management.
 - Agronomy Facts 30 – Forage quality in perspective.
 - Agronomy Facts 32 – Pasture and Hay for Horses.
- <http://AgGuide.agronomy.psu.edu/pdf/htm>.
 - The Agronomy Guide.
 - Ball, D., Bade, D., Lacefield, G., Martin, N., Pinkerton, B., Minimizing Losses in Hay Storage and Feeding.
 - Ball, D., Collins, M., Lacefield, G., Martin, N., Mertens, D., Olson, K., Putnam, D., Undersander, D., Wolf, M., Understanding forage quality.

Table 2
Forage quality needs of cattle, sheep and horses.

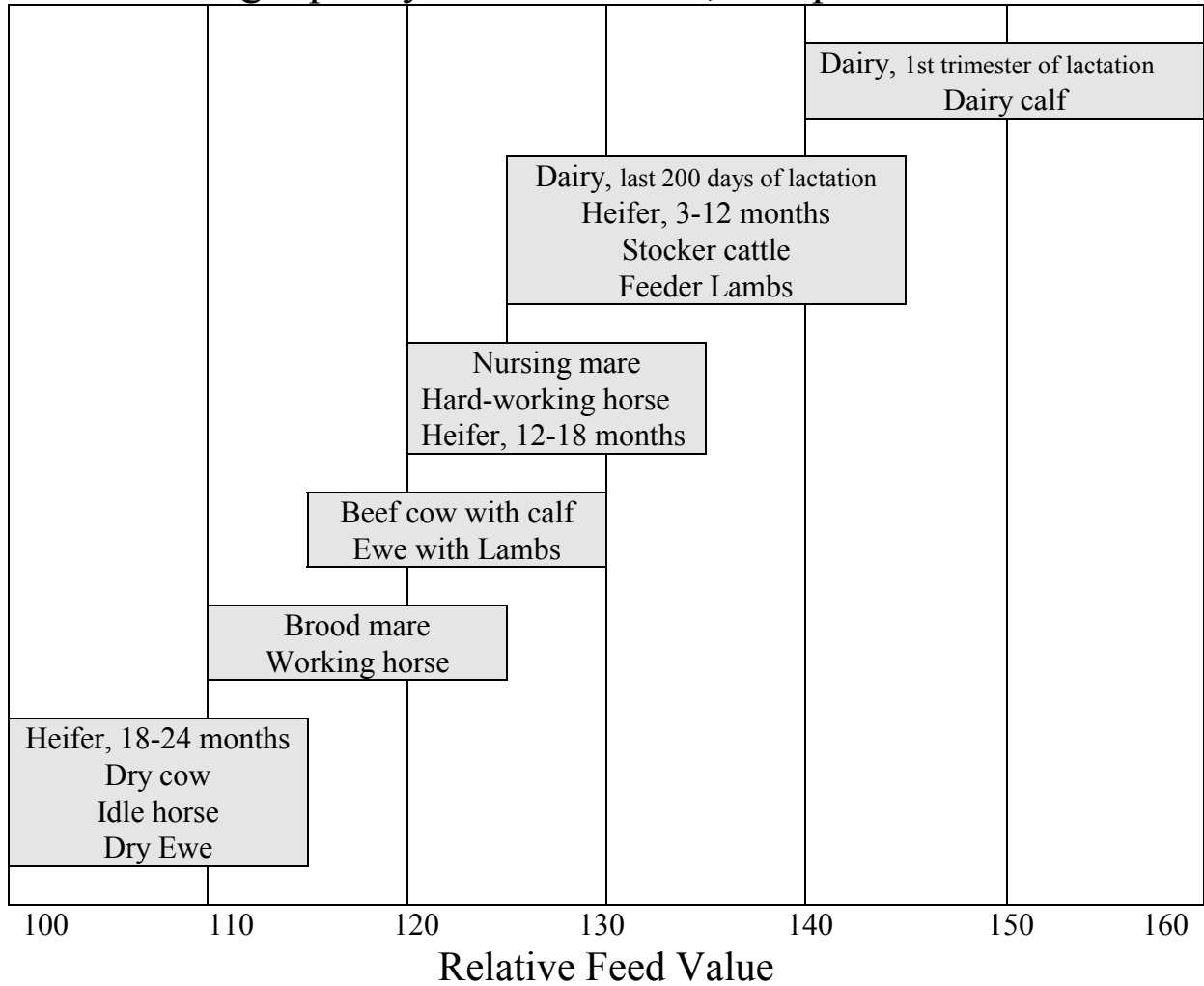


TABLE 3
Optimum Hay Harvest

Species	When to Cut	Height of Stubble to leave
Smooth Brome	<u>1st cutting</u> - medium to full head ^{1/} <u>2nd and succeeding cutting</u> - when basal sprouts appear	3 inches
Timothy	Early Head ^{2/}	3 inches
Orchardgrass	Boot ^{3/} to early heading: and when regrowth is 14-20 inches	3 inches
Reed Canarygrass	<u>1st cutting</u> - early boot. Later cuttings when basal sprouts appear	3 inches
Alfalfa	<u>1st cutting</u> - late bud to early flower 2nd, 3rd, 4th - 10% bloom	2 inches
Birdsfoot Trefoil	<u>1st cutting</u> - early flower to 1/4 bloom. Later cutting when 8-12 inches regrowth has occurred but 4-6 weeks before killing freeze.	3-4 inches
Red Clover	3/4 bloom to full bloom	2-3 inches
Crownvetch	When mixed with grasses, harvest when grass is ready. If harvested for hay, a Crimper is recommended.	2 inches
Switchgrass	Early head ^{4/}	3-4 inches
Big Bluestem	Boot ^{4/}	3-4 inches

1/ Full Head - Most heads fully emerged, but prior to flowering.

2/ Early Head - Tips of heads emerging on not more than 10% of the stems.

3/ Boot - Most heads in upper leaf sheaf but prior to emergence.

4/ Warm season grasses should not be hayed for the first time after August 1. Forage quality is low and regrowth is poor.