



United States
Department of
Agriculture

Natural Resource Conservation Service Minnesota Range and Pasture Technical Note 3: *Grazing Management*



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Grazing Management Technical Note

Section 1: Introduction

This technical note provides planners with the information necessary to successfully plan 528 Grazing Management to meet the conservation practice standard. It also provides an overview of basic grazing management principles and references that planners can refer to for more in-depth grazing management information.

Prior to planning grazing systems, thoroughly read the 528 Grazing Management Conservation Practice Standard (CPS) and ensure you understand all of the general criteria requirements as well as the additional criteria requirements for the practice purposes. Also read the Statement of Work to understand the deliverables that planners need to provide to the customer.

Most grazing plans rely on several other conservation practices to support grazing management. As part of developing a grazing plan, provide the producer with all the necessary specifications and designs for the planned supporting practices prior to the producer implementing the practices. Refer to the Grazing Management Plan Checklist for items to be provided to the producer.

As part of the planning process, select the practice purpose that most closely fits the goals/objectives of the producer and resource concerns addressed within the grazing plan. Ensure any requirements listed in the additional criteria are followed for the selected practice purpose. Refer to the 528 Grazing Management conservation practice standard for the applicable practice purposes.

To successfully plan this practice, the grazing plan must also address all items listed in the Plans and Specifications and Operation and Maintenance sections. Refer to the 528 Grazing Management conservation practice standard for details.

Several other technical notes and resources are referenced within this technical note to provide more resources and information for conservation planners. These resources can be found in the following locations within the Field Office Technical Guide (FOTG):

- Range and Pasture Technical Notes and References folder located in Section 1.
- Agronomy Technical Notes and References folder located in Section 1.
- Engineering Tools folder located in Section 4.
- Conservation Practice information can be found in the Conservation Practice Standards and Supporting Documents folder located in Section 4.

Refer to Appendix A for a list of all documents referenced within this technical note and where they are located within the FOTG.

Section 2: Collecting Site Inventory Data

Collect sufficient inventory data to ensure that you provide quality technical assistance to the customer, develop grazing plans that address resource concerns, and meet their goals/objectives.

Inventory Tools

Several options are available to assist with collecting inventory data. Utilize any of these tools as needed to gather inventory data. Other pertinent tools not included in this section may also be used.

528 Grazing Management On-Site Inventory Form

The inventory form identifies the basic information that will be needed to develop a grazing plan. Additional information may be needed based upon the goals/objectives of the producer, their planned management strategies, and site-specific characteristics.

Plan maps of the area:

Ensure you have access to clear plan maps for all lands that the producer wants to include in the plan, which may include perennial pasture as well as cropland. Ensure any printed maps are clear so that any landscape features, such as wooded areas, wetlands, field/pasture boundaries, etc. are as easy to identify as possible. Mapping apps available on smart phones, tablets, etc. may also be used. Identify the following information on plan maps:

- Existing fences: Note the type and condition.
- Existing water sources: Note type and any other pertinent information.
- Existing power sources if new wells will be planned.
- Sensitive areas.
- Locations of identifiable resource concerns, such as trailing, erosion, livestock concentration areas, etc.
- Any wintering, supplemental feeding, or sacrificial areas.
- Notes of pertinent inventory information may be taken on printed maps or within electronic mapping apps.
- Topographic maps and soils maps with soil map unit descriptions for the area may be useful on site visits.

Pasture Condition Scoresheet (PCS)

PCS is designed to be a quick assessment tool to assess pasture management at a point in time. It ranks 10 indicators on a 1-5 scale with 1 being the poorest condition and 5 being the best condition. The indicators can be used to objectively assess and document whether numerous resource concerns exist within the pasture and their potential causes. Consider completing a PCS early in the planning process on pastures and idle grasslands being converted into pasture to establish a benchmark condition prior to initiating management changes. The PCS is not applicable for heavily wooded pastures, native rangelands, or high diversity native restorations.

Determining Indicators of Pasture Health (DIPH)

DIPH is used to assess several ecosystem attributes: biotic integrity, soil/site stability, hydrologic function, and livestock management. The assessment provides information regarding how well the water cycle, energy flow, and nutrient cycle are functioning on pasture lands to assess overall pasture health. DIPH can also be used to identify and document the presence of resource concerns in the pasture. The DIPH is applicable on all pasture types.

Describing Indicators of Rangeland Health (DIRH)

This protocol is most appropriate for native rangelands and high diversity native restorations.

Photos/Establishing Permanent Photo Monitoring Points

Photos can be an excellent monitoring tool to provide a visual assessment of pasture condition. Consider taking photos of key areas within the pasture so that they can be re-visited in the future. Key areas may include livestock concentration areas, locations where erosion is present, areas of brush/tree encroachment, invasive species populations, general landscape photos, etc.

Estimating Forage Production by Clipping and Weight Plots

When feasible, consider clipping plots to estimate yield potential for the area. Find locations within the pasture where vegetation may be ungrazed or lightly grazed. These areas may be located furthest from water and/or shade sources. Also, consider clipping in areas adjacent to fence lines where the vegetation may be un-grazed, such as an adjacent road ditch. In heavily over-grazed pastures, clipping may not be practical or feasible. Also, clipping data may not be representative of site potential. Further adjustments to production may be needed based on current condition and management of the pasture, soil fertility, and planned management strategies. Refer to the Estimating Forage Production and Carrying Capacity Technical Reference for more information regarding clipping.

Pasture Wildlife Habitat Evaluation Guide

If wildlife habitat is a goal of the producer, consider assessing the habitat quality by completing the Pasture Wildlife Habitat Evaluation Guide (WHEG). Species-specific WHEGs are also available that may pertain to species present in the pasture.

Inventory Data

The following provides a summary of inventory data that may be needed to develop the grazing plan. The Grazing Management On-Site Inventory form is a useful tool for collecting the necessary data.

Producer Goals and Objectives

Obtain the goals and objectives from the producer. It is the planner's job to develop a grazing plan that reflects the goals and objectives of the producer to ensure that they take ownership in their plan. The producer will be responsible for managing the land and livestock, so it is imperative that the plan meets their goals and objectives.

Animal Inventory

Gather the following animal inventory information from the producer:

- Kind of livestock (beef cattle, dairy, buffalo, sheep, goats, etc.).
- Classes (cow/calf pairs, yearlings, dry cows, etc.).
- Average weights.
- Number of herds.
- Number of animals within each herd during the planned grazing season.
- Pastures for each herd (if multiple herds are planned).
- Planned grazing season (estimated start and end dates).
- Breeding season.
- Calving dates.
- Weaning dates.

Gather accurate livestock information for all kinds and classes of animals that will graze on the land included in the management plan. Include current numbers as well as any planned herd expansion. In addition to livestock numbers, also gather accurate weight information. For mature animals (such as cows, ewes, etc.), gather the average weight. For growing animals, such as yearlings and heifers, gather the weight at the start of the grazing season as well as the target weight at the end of the grazing season (or end weight and date when the animals will be removed from pasture). This information will be needed to accurately assess livestock forage needs when developing the livestock forage balance.

In instances where the producer has not grazed the land before, such as new land acquisitions or when converting CRP or cropland into pasture, you may need to provide them with an estimated carrying capacity based on the estimated production potential of the land, planned grazing management, and planned length of the grazing season.

Breeding (if applicable)

- Determine whether breeding will occur with bulls (natural) or through artificial insemination (AI)?
- The number of males needed for breeding.
- Breeding Dates.

Birth and Weaning (if applicable)

Gather information regarding birthing and weaning. This information is necessary to accurately assess livestock forage needs for the planned grazing season.

- Gather the target birthing start and end dates. Also obtain the average weight of the young animals at the start of the planned grazing season.
- Gather the target weaning date. Also obtain the estimated weight of the livestock at weaning.
- Use the starting and ending weights on the livestock forage balance worksheet to determine forage needs.

Grazing Season

Document when livestock are typically turned out to pasture in the spring and when the animals will stop grazing in the fall.

Winter Livestock Management

Gather information about where livestock are wintered. Evaluate the current winter-feeding strategies and their impact on natural resources. Discuss alternatives to address resource concerns as needed. An alternative may include moving livestock winter feeding areas strategically across pastures or cropland to address any resource concerns associated with current feeding locations, to avoid creating new resource concerns, to better utilize nutrients deposited by livestock, and to improve soil fertility in strategic locations. Utilize the 827 Strategic Harvested Forage Management conservation practice to assist with planning winter feeding strategies on pasture and cropland.

Sensitive Areas

Manage livestock to improve ecosystem function, maintain vegetative cover, and address any resource concerns present within sensitive areas. While conducting site visits, identify locations on plan maps of sensitive areas that are found on lands included in the grazing plan.

Sensitive areas may include:

- Hydric Soils.
- Wetlands.
- Seeps/springs.
- Riparian Areas (rivers and streams).
- Woodlands.
- Droughty Soils.
- Steep Slopes.
- Native rangelands/prairies.
- Restored rangelands/prairies.
- Sinkholes.
- Others: Include any other sensitive areas not listed above.

Take notes on the current condition of any sensitive areas and consider applicable resource concerns that may exist within those sensitive areas.

Facilitating Practice Inventory and Assessment

Identify the location, type, and condition of existing infrastructure that will be relied upon to facilitate grazing management and mark their locations on plan maps (either paper copies or through electronic mapping apps). Also work with the producer to identify the type and location(s) of planned infrastructure that may be discussed during site visits.

The remainder of this section provides a list of common practices and installation methods that may be utilized on grazing lands. Other installation methods and conservation practices may also be applicable that are not listed below. For more information regarding specific conservation practices listed in this section, refer to the practice information located in the Conservation Practice Standards and Supporting Documents folder in Section 4 of the FOTG.

Fence (382): Identify all existing fences and assess their condition. Identify any fences that are no longer functional that may need to be replaced. For any planned fences, discuss with the producer what type of fencing they plan to install. Types of fencing may include high tensile electric, barbed wire, woven wire, portable/temporary, and virtual fence. Consider potential fence locations when conducting site visits.

- Obstruction Removal (500) may be used to remove existing fences that need to be replaced.
- If the best planned fence location travels through wooded areas, consider Land Clearing (460) to assist with tree removal.

Livestock watering systems: Identify all existing water sources on plan maps. Note any existing wells that could be used as a water source and any power sources if new wells are needed (existing power services, powerlines, etc.).

- Existing water sources may include ponds, wetlands, rivers, streams, wells, pipeline, tanks, rural water connections, etc.
- Consider what planned livestock water sources will be most feasible for the site.

- **Water Wells (642):** Assess the feasibility of utilizing any existing wells that could supply water for livestock. Collect water flow data using a flow meter to determine the gallons per minute that the well/pumping system can produce. Also gather the pressure settings of the system. This information will be needed to determine if the current well and pumping system can adequately supply water to the livestock when using a pipeline delivery system.
- **Livestock Pipeline (516):** Identify any existing pipelines that are used or could be used to supply water to livestock. These may be pipelines and hydrants located within the farmstead or may be part of existing livestock watering systems already available in the pasture. Identify the locations and how the pipelines are installed (surface, shallow-buried, or deep-buried). For planned pipelines, consider what type of installation methods may be best to meet the goals/objectives of the producer, season of use, and site characteristics.
- **Watering Facilities (614):** Identify on plan maps or within inventory notes the locations, size, and type of all existing watering facilities. Identify whether they are permanent, portable, or winter watering facilities. Assist the producer with identifying any planned watering facility needs. If needed, utilize the Livestock Pipeline design tool to assist with properly sizing watering facilities (also rely on producer input).
- **Heavy Use Area Protection (561)** may be needed beneath permanently placed watering facilities. Gravel pads are common beneath tanks used only in the summer while concrete pads are recommended beneath winter water facilities. The type will be determined based on producer input and site characteristics.

Livestock Shelter Structures (576): Identify any existing man-made wind or shade shelters and their condition. Identify any naturally occurring windbreaks or shade sources that livestock may also utilize, such as wooded areas. If the producer plans to feed livestock on pasture or cropland during the winter, discuss with the producer whether additional windbreaks may be needed and identify possible locations.

Stream Crossings (578): Identify any existing stream crossings and the type of crossing. Common crossing types include rock-surfaced crossings or culverts. If new crossings are needed, identify potential locations.

Trails and Walkways (575): Identify any travel lanes present or whether they may be needed. Also consider whether additional reinforcement utilizing the Trails and Walkways (575) conservation practice is needed to facilitate livestock movement within the grazing system. These are commonly necessary in dairy operations where livestock need to return to the milking facility multiple times per day. Several options for reinforcement are available, but gravel over geotextile is the most common.

Existing Forages and Forage Management

Identify the current condition of the pasture and the dominant forage species present. Consider collecting a Pasture Condition Score to assist with assessing current condition. Assess the vigor of the dominant species to assist with determining production potential. Ask the producer if they manage soil fertility through fertilization or manure application. Also, request access to any soil tests they may have collected in the past for the planned grazing area. This information may help assess forage productivity and health. If feasible, consider clipping plots in un-grazed or lightly grazed portions of the pasture to assist with determining site production potential. Refer to the Estimating Forage Production and Carrying Capacity Technical Reference for more information.

Identify any invasive, noxious, or unwanted vegetation (herbaceous or woody) that may be present and their location(s) within the pasture. Also consider whether any of the species may be toxic to the type of livestock that are planned, especially if the producer or type of livestock are new to the pasture. Refer to the Range and Pasture Technical Note 2: Poisonous Plants for more information.

Consider the dominant species and functional groups that will be managed for in the grazing plan. Functional groups include introduced cool season grasses, native cool season grasses, native warm season grasses, legumes, native forbs, and woody vegetation. Develop grazing plans to manage for the desired vegetation.

Identify any resource concerns associated with the condition of the pasture. Common plant resource concerns that may be present include Plant Productivity and Health, Plant Structure and Composition, and Plant Pest Pressure.

Identify whether the vegetation is pre-dominantly native or introduced species because the management strategies will be different based on the differences in vegetation type.

Note any areas that may need to be renovated or re-seeded as well as any cropland that will be converted into pasture. Inter-seeding legumes may be a common approach to improve nutrient cycling and forage quality in pastures dominated by cool season grasses. Inter-seeding legumes is not applicable on native rangeland. If seeding is planned, refer to the 512 Pasture and Hay Planting conservation practice and the Pasture and Hay Planting Seed Tool. Also, refer to Technical Note 31: Herbaceous Vegetation Establishment Guide.

Current Grazing Management

Document the current grazing management practices and the grazing intensity of the pasture. Identify whether the pasture is continuously grazed or if any pastures are rotated. If pastures are rotated, obtain the average grazing and rest period lengths from the producer.

To assess the current grazing management and help guide future management decisions, ask the producer several questions about their current and planned management. Discuss with the producer appropriate grazing and rest period lengths based on their goals/objectives, the vegetation that is present/planned, and site characteristics (size of pasture, proximity to the farm, ease of infrastructure installation, etc.). To assist producers in their decision-making process, you will likely need to make recommendations to the producer regarding appropriate grazing management strategies.

Determine if winter feeding activities occur or will occur in the grazing area. Winter feeding activities may affect the grazing system layout and the type of planned infrastructure, such as needing winter watering facilities.

Determine from the producer if any of the pastures will be used for hay production. If so, determine how many cuttings of hay will be harvested, the date of last harvest and when grazing will be utilized. This information will assist with developing a livestock forage balance.

Determine if the producer plans to stockpile perennial forage for fall and winter grazing. Two methods are commonly used for stockpiling:

- Stockpiling forage on pasture: Determine the target grazing season end date to estimate the carrying capacity necessary to achieve the target end date.
- Stockpiling forage on hay land: Determine from the producer the number of mechanical harvests planned and when the last mechanical harvest will occur. Determine how much forage may be available for grazing and document on the livestock forage balance worksheet.

Determine if cropland is currently grazed or if it will be incorporated into the grazing system to graze crop residue, cover crops, or annual forages.

- If so, document the crop rotation and potential crop residues available for grazing.
- If cover crops are planned, work with the producer as needed to develop seed plans and select appropriate species based on their goals, timing of planting, and soil conditions in the field. For assistance with planning cover crops, refer to the Cover Crop (340) conservation practice and Technical Note 33: Cover Crop Seeding Guide.
- If annual forages are planned, work with the producer as needed to develop seed plans. Select appropriate species based on their goals, timing of planting, and soil conditions in the field. For assistance planning the use of annual forages, refer to the Annual Forages for Grazing Systems (810) conservation practice and Technical Note 34: Annual Forages for Grazing Systems.
- Refer to Soil Health Technical Note 470-09: Cover Crop and Crop Aftermath Grazing for more information on estimating forage production and carrying capacity when grazing cover crops and crop residues.

Discuss and evaluate with the producer any other management practices that may be needed to address resource concerns and achieve their goals/objectives. Other common management practices on pastureland include:

- Access Control (472): Plan Access Control as necessary to limit grazing activities within sensitive features, such as wetlands and streams, to address resource concerns. Grazing may still be used within the access control area but is generally restricted to short duration (a few days or less) and low frequency (once or twice per year). Refer to the Access Control (472) conservation practice for more information. To properly address resource concerns, develop site-specific plans that consider local conditions.
- Brush Management (314): Plan Brush Management as necessary to assist with managing invasive, noxious and unwanted brush populations that may be present in grazing lands. Refer to the Brush Management (314) conservation practice for more information.
- Herbaceous Weed Treatment (315): Plan Herbaceous Weed Treatment as necessary to assist with managing invasive, noxious, and unwanted herbaceous weed populations that may be present in grazing lands. Refer to the Herbaceous Weed Treatment (315) conservation practice for more information.
- Strategic Harvested Forage Management (827): Plan Strategic Harvested Forage Management as necessary to improve winter feeding strategies on pasture and cropland to better manage fertility and minimize impact to sensitive areas. Refer to the Strategic Harvested Management (827) conservation practice for more information.
- Silvopasture (381): Silvopasture is most used when producers want to plant trees on open land to establish a new silvopasture system or in existing grazed forestlands where the producer wants to better manage the forest and forage resources together. If you do not possess Job Approval Authority for this practice, consider consulting a forester early in the planning process to assist with developing the forest management plan, especially when removing trees in an existing wooded pasture. Also consult a Grazing Specialist for assistance with developing the grazing management plan. Refer to the Silvopasture (381) conservation practice for more information.
- Other conservation practices may also be applicable.

Section 3: Grazing Management Plan Development

This section covers the information that needs to be provided to the producer as part of the grazing management plan. Refer to the Grazing Management Plan Checklist for a list of necessary information to provide the producer.

Plan Maps

Develop plan maps that are easy to read for the producer and that clearly show locations of existing and planned practices. If necessary, develop multiple maps to show locations of planned conservation practices. Pastures and fields should be labeled with the acres for each management unit (paddock, field, etc.). Also include the extent of planned conservation practices with a text box, callout, or within the legend (such as feet of fence and pipeline planned, size of water tanks, acres of seeding, etc.). At a minimum, planners should provide producers with three plan maps: (1) A grazing plan map that shows all existing and planned infrastructure, (2) soils map, and (3) topographic/contour map.

The remainder of this section provides information regarding required maps and optional maps that may be needed:

Grazing Plan Map

This map should show the location of all existing and planned infrastructure pertinent to managing the grazing system, such as fences, watering systems, stream crossings, etc.

- Pastures/paddocks should be labeled with a name or number as well as the acres for each. If needed, use the paddock name or number as a reference or identifier within the grazing plan and livestock forage balance.
- As needed, create practice-specific maps for fencing systems and watering systems if the planned and existing practices are not easily seen together on one plan map.

As needed, develop additional maps for seeding and other practices that may be necessary to manage grazing lands. Maps should include the location and the extent of each practice. Combine practices together on the same map if the locations of the practices can be easily seen together. Additional maps may include:

- Seeding Map: Show locations and number of acres of Pasture and Hay Planting (512), Cover Crops (340), Annual Forages for Grazing Systems (810) and any other seeding practices.
- Access Control (472).
- Brush Management (314).
- Herbaceous Weed Treatment (315).
- Forage Harvest Management (511).
- Strategic Harvested Forage Management (827).
- Silvopasture (381).

Soils Map

Provide a soils map unit description with the soils map. Utilize soils information to assist with planning infrastructure locations and estimating forage production. Other soils-related maps may also be provided to the producer as needed. Use GIS or Web Soil Survey to obtain soils information.

- Drainage Class Map (if needed): When developing seed plans for Pasture and Hay Planting (512), utilize soil drainage classes to determine the species adaptability to the site. Develop a drainage class map as needed to assist with species selection.
- Forage Suitability Group Map (if needed): Consider utilizing Forage Suitability Groups to assist with estimating forage production and developing the livestock forage balance.
- Ecological Site Description Map (if needed): Consider utilizing Ecological Site Descriptions (ESD) to assist with estimating forage production on native rangeland and developing the livestock forage balance. Refer to the Ecosystem Dynamics Interpretive Tool (EDIT) website for ESD information. Note that most ESDs in Minnesota are in provisional status and may not have detailed plant community or production information available.

Topography/Contour Map

Topography may influence locations of planned infrastructure (fence lines, watering systems, etc.). Topographic/contour maps may not be needed in flat terrain.

Livestock Forage Balance

A livestock forage balance is required to assess the livestock demand and forage supply. To develop a livestock forage balance, use the Livestock Forage Balance worksheet located within the 528 Grazing Management conservation practice in Section 4 of the FOTG. The forage balance worksheet provides a monthly estimate of the livestock forage needs and the total estimated forage production available for the livestock.

Livestock Summary

Account for the total number and average weights for all livestock included in the grazing management plan. Refer to Section 2: Collecting On-Site Inventory Data for more information regarding collecting livestock information.

Forages Summary

Determine an estimated forage production in pounds per acre based on your on-site inventory, current forage condition, planned grazing management, site characteristics, and soil characteristics. Consider developing two livestock forage balances: one for the current condition and a second that estimates future production potential based on the planned grazing management.

Estimating forage production may be the most difficult task in developing a grazing plan. Several tools exist to assist with developing sound forage production estimates:

Forage Suitability Groups (FSG): Forage Suitability Groups are groupings of soils that have similar production potential and site limitations. Each forage suitability group contains production estimates that may be used in conjunction with other observations and inventory tools for determining forage production. Appendix D provides forage production estimates by forage suitability group. Forage Suitability Groups are most applicable to pastureland. The production estimates may not be applicable to native rangeland or high diversity native grassland restorations.

- Use GIS or Web Soil Survey to assist with identifying forage suitability groups for the pasture. If needed, refer to Appendix F: Find Forage Suitability Groups in Web Soil Survey for assistance with identifying FSGs within Web Soil Survey.

Ecological Site Descriptions (ESD): ESDs are a good resource for native rangeland sites. Refer to the Ecosystem Dynamics Interpretive Tool (EDIT) website for ESD information. Most ESDs in Minnesota are in provisional status and may not have detailed plant community or production information available. ESD development is ongoing, and sites will be updated to include production data as that information becomes available.

- Use Web Soil Survey to assist with identifying ecological sites located in pasture.

Clipping data: Utilize any clipping data you may have obtained during on-site inventory to assist with estimating forage production. Refer to the Estimating Forage Production and Carrying Capacity Technical Reference for more information. Consider the current condition of the sampling areas and whether it is representative of the whole pasture. Adjust production estimates accordingly. Also consider current growing conditions and adjust accordingly (for example, consider the impact drought conditions may have on forage production).

Utilizing Hay Yields: Hay yields from adjacent hay land with similar soils may also provide useful estimates. Assess the current management of the hay land and pasture to determine if the hay yields are representative for the pasture area. Consider if either the hay land or pasture has fertility additions, such as commercial fertilizer or manure applied (other than directly from the grazing animal). Adjust production estimates accordingly based on management and condition. For example, the hay land may be soil tested and fertilized regularly while the pasture may be over-grazed without fertilizer applications. In this instance, the hay land likely will be yielding more than the pasture, so production estimates may need to be reduced for the pasture compared to the hay land.

Assess Current Carrying Capacity: Determine from the producer the number of days of grazing they usually obtain without supplemental feeding. With that information, the livestock forage balance worksheet could be used to estimate the forage production from the pasture for the grazing season. The total forage needs of the livestock for the current length of the grazing season can be divided by the number of pasture acres to determine an estimated pounds per acre of grazable production. This method works best when animal numbers and acres of grazing land are consistent from year to year. This method does not work well in situations where the producer is supplemental feeding on pasture for extended periods of time during the grazing season. If the producer is using supplemental feed while grazing, determine from the producer how many days of feeding are typical during their grazing season and the estimated pounds of dry matter fed per day. Subtract the amount of supplemental feed supplied from the livestock demand to determine pounds of forage harvested from the pasture.

Local Knowledge of Management and Soils: As you gain more experience, local knowledge of soils in your work area will become assist you with determining forage production. Consider following up on past grazing plans that have been implemented in your work area to determine the carrying capacity of those systems and use that information to assist with estimating forage production on future grazing plans with similar soils and management styles.

Forage Growth Curves

Determine the dominant forage species and functional groups present and utilize an appropriate growth curve. Refer to Appendix B: Forage Growth Curves within the FSG information located in Section 2 of the FOTG for common growth curves in Minnesota.

Animal Demand versus Forage Supply

For the grazing plan to be successful, the animal demand should match the forage supply for the planned grazing season. If it does not, discuss the forage deficiencies with the producer and present options to alleviate the issue:

- Provide an estimate of the number of days of grazing that the planned herd size will obtain from the pasture based on the estimated forage production. If the estimated number of days of grazing does not meet the producer's goals, work with the producer to determine what management options are most feasible to prevent damage to the forage resources. Some options include increasing pasture acres, converting cropland into pasture, incorporating hay fields, planting annual forages on cropland, or moving animals into a feeding or sacrificial lot when forage is not available to continue grazing.
- Consider providing the producer with estimates on the number of additional acres that may be needed to support the planned herd size for the planned grazing season.
- Consider providing an estimated carrying capacity that the pasture could support for the desired length of the grazing season. As per the National Range and Pasture Handbook, *"NRCS does not establish grazing capacities. Neither does it require an agreed upon stocking rate in conservation plans. NRCS assists land users in making their own decisions concerning the number and kinds of animals to ensure economic and ecological sustainability. A beginning stocking rate is normally suggested, based on inventories."* Your job as the conservation planner is to present the producer with an estimated carrying capacity and appropriate alternatives that may meet their goals and objectives, but it is ultimately the producer's decision to establish the stocking rate.

Grazing Plan

A written grazing plan must be developed that includes the following items:

- Client's goals and objectives.
- Identifies sensitive areas and any management considerations for those sensitive areas.
- Grazing Plan Facilitating Practices
- Summary of livestock information.
- Summary of forage information.
- Grazing Management recommendations.
- Contingency plans.
- Monitoring plan.

A Grazing Management Plan template is available in the 528 Grazing Management folder within Section 4 of the FOTG. If other templates are used, the plan must include the information listed above. The remainder of this section will provide more details regarding the items required in the grazing management plan.

Client's Goals and Objectives

Planners need to consider the goals and objectives of the producer to ensure that the plan will meet their needs as well as address resource concerns. List pertinent goals and objectives of the producer within the grazing plan.

Sensitive Areas Management

Identify and describe all sensitive areas and summarize any pertinent management recommendations for those areas. Refer to Section 4: Grazing, Forage and Livestock Management for more information regarding management considerations for the common types of sensitive areas.

Grazing Plan Facilitating Practices

Document all existing and planned infrastructure within the grazing plan that will be needed to facilitate grazing management. Include extent (number of feet, acres, etc.) for each planned practice. As needed, provide a summary of what will be installed. For example, describe within the grazing plan the type of fence, number of wires planned, etc. Facilitating practices that may be pertinent to grazing management include:

Fence (382) Systems: Include all permanent, temporary or virtual fencing. Fencing must be adequate to contain the livestock within the desired management unit. The plan will identify the locations of the fences, the type of fence, and extent. Provide the producer with the appropriate specifications for the type of fence that is planned. Refer to the Fence (382) conservation practice for more information.

Livestock Watering Systems: Include information about all existing and planned water sources. Include extent (number of wells, feet of pipeline, etc.) for each planned practice. As needed, provide a summary of the planned livestock watering system.

Planned livestock watering systems require engineering designs to ensure that the system will work. Ensure any design plans are completed prior to installation of the system. When planning wells, livestock pipeline, and watering facilities, refer to the Livestock Pipeline design tool.

Common practices associated with livestock watering systems:

- Water Wells (642): Refer to the Water Wells (642) conservation practice for more information.
- Livestock Pipeline (516): Refer to the Livestock Pipeline (516) conservation practice for more information.
- Watering Facility (614): Refer to the Watering Facility (614) conservation practice for more information.
- Note: other conservation practices may also be needed to develop a livestock watering system.

Heavy Use Area Protection (561: HUAP): Identify areas where HUAPs may be required, such as beneath permanent water tanks and winter water facilities. For permanently placed summer water tanks, consider gravel material over geotextile. Consider concrete pads beneath winter water facilities. HUAPs are usually not planned for temporary and portable water tanks.

- Include all planned HUAP types as well as the number and size of each type. As needed, provide a summary of the planned HUAPs.
- HUAPs are an engineering practice that require design plans to be developed prior to installation. Refer to the Heavy Use Area Protection (561) conservation practice for more information. Refer to the Livestock Pipeline design tool for information regarding designing HUAPs.

Forage Plantings: Summarize any forage plantings that are needed. List the type of planting, dominant species or functional groups, acres to be seeded, and location (paddock or field ID). Common seeding practices include Pasture and Hay Planting (512), Range Planting (550), Annual Forages for Grazing Systems (810), and Cover Crop (340). Develop seed plans for all applicable seeding practices. Refer to the appropriate specifications for each practice:

- Pasture and Hay Planting (512): Refer to the Pasture and Hay Planting (512) conservation practice for more information. The Pasture and Hay Planting Seed Tool that is used to develop seed mixes is located within this folder. Also refer to Technical Note 31: Herbaceous Vegetation Establishment Guide for further seeding specifications.
- Range Planting (550): Refer to the Range Planting (550) conservation practice for more information.
- Annual Forages for Grazing Systems (810): Refer to the Annual Forages for Grazing Systems (513) conservation practice for more information. The Annual Forages for Grazing Systems Design Workbook is used to develop seed mixes. Technical Note 34: Annual Forages for Grazing Systems provides further practice specifications.
- Cover Crop (340): Refer to the Cover Crop (340) conservation practice for more information. The Cover Crop Design Tool is used to develop seed mixes. Technical Note 33: Cover Crop Seeding Guide provides further practice specifications.

Trails and Walkways (575): Identify the type, location and extent of any planned animal trails and walkways. Several options are available, with the most common being gravel over geotextile.

- Trails and Walkways is an engineering practice that require design plans to be developed prior to installation. Refer to the Trails and Walkways (575) conservation practice for more information regarding this practice. Refer to the Trails and Walkways design tool for more information.

Stream Crossing (578): Identify and summarize any stream crossings that are needed. List the type, quantity, and planned dimensions of the stream crossings.

- Stream Crossing is an engineering practice that requires design plans to be developed prior to installation. Refer to the Stream Crossing (578) conservation practice for more information.

Livestock Shelter Structures (576): Describe any shelters needed, such as wind protection during winter grazing and feeding activities. Describe how the shelter will be used and any pertinent management information. Also list the type, location(s) where they will be used, configuration, orientation, and extent of the practice (such as total length of each wing of a windbreak).

- Livestock Shelter Structure is an engineering practice that requires design plans to be developed prior to installation. Refer to the Livestock Shelter Structure (576) conservation practice.

Summary of Livestock Information

Include animal inventory information.

- Kind/class of animals.
- Number of animals.
- Average weight.

Summary of Forages Information

- Provide an overview of the dominant vegetation that is available for grazing. Summaries should include dominant functional groups and may also include dominant species as needed. Common functional groups include:
 - Introduced cool season grasses.
 - Legumes.
 - Native cool season grasses.
 - Native warm season grasses.
 - Native forbs.
 - Shrubs/trees.
 - Cover crops: List dominant functional groups or species.
 - Annual forages: List dominant functional groups or species.
 - Crop residues: List the crop residues available for grazing.
- Complete a livestock forage balance.
- If needed, include additional information within the grazing plan to describe any pertinent information needed by the producer, such as when a livestock/forage imbalance for the grazing season exists and what management options are available to alleviate the issue.

Grazing Management Recommendations

Summarize the pertinent information that the producer needs to know to successfully manage the grazing system. Refer to Section 4: Grazing, Forage and Livestock Management for more in-depth information regarding the items listed in the remainder of this section.

- Intensity: Recommended minimum stubble heights or percent utilization.
- Timing: Grazing season and rest periods. If needed, include specific recommendations for the timing of grazing events for certain paddocks where specific timing may be needed to achieve management objectives.
- Duration: Length of grazing periods.
- Frequency of grazing: How often will pastures be grazed within the season.
- Include any information regarding integrating livestock onto cropland to graze cover crops, annual forages, crop residues, etc.
- Summarize any other management practices necessary to facilitate grazing management, which may include:
 - Winter Livestock Management
 - As needed, utilize the Strategic Harvested Forage Management (827) conservation practice to plan winter feeding activities on pasture and cropland.
 - Soil Fertility and Nutrient Management.
 - Brush and Herbaceous Weed Management.
 - Access Control.
 - Forage Harvest Management.
 - Summarize any mechanical forage harvest that may be planned on the pastures.
 - Silvopasture.
 - Others as needed.

Contingency plans

Contingency plans serve as a guide for adaptive management decisions to minimize or mitigate resource or economic impacts. List and summarize any contingency plans that may be pertinent to the operation. Common contingency plans include:

Emergency livestock watering plan

If relying on surface water, describe how the livestock will obtain water during drought conditions when surface water may be inaccessible or unavailable. Options may include hauling water to the pasture if the producer has the necessary equipment or moving animals to other pastures/sites with reliable water.

When implementing pipeline delivery systems, describe how the animals will obtain water if water becomes unavailable due to power outages, leaks in the pipeline, etc. Options may include hauling water to the pasture if the producer has the necessary equipment or moving animals to other paddocks with reliable water (such as paddocks containing surface water or pipeline systems in working condition). Also determine whether a system to monitor water levels in tanks is necessary. Monitoring water levels may be especially important for paddocks without alternative surface water sources and in situations where the producer does not visit the pasture frequently. Options may include automated systems that monitor water use and water tank levels or installing cameras that can periodically send pictures of the water tank levels to the producer via the cellular network.

Drought

Summarize management activities that may be enacted during drought conditions when insufficient forage is available to continue grazing, such as (1) moving animals into a sacrificial paddock or feedlot, (2) moving animals to other pastures, hay land, cropland, or (3) de-stocking. Longer rest periods will be needed between grazing events during drought conditions to ensure adequate plant recovery and to maintain long-term plant health and productivity.

Wet weather conditions

Summarize management activities that may be enacted during wet weather conditions, such as:

- Moving animals from paddocks containing saturated soils or that are flooded into paddocks with better drainage.
- Move animals into a sacrificial paddock or feedlot until conditions improve.
- Reduce the grazing intensity and utilization by reducing the length of the grazing periods.
- Provide extended rest to areas damaged by livestock during wet conditions and renovate pastures as needed.

Sacrificial paddocks

Sacrificial paddocks may be needed as part of contingency plans. Identify paddocks that are best suited for use as sacrificial areas as well as paddocks that should not be used as sacrificial areas. Locate sacrificial paddocks on areas with soils that can withstand heavy livestock traffic, have low risk of soil erosion, and may be renovated as needed. Avoid using native rangelands and areas restored to native prairie as sacrificial areas because feeding activities and heavy livestock traffic will be detrimental to most native species. Supplemental feeding will likely take place in these areas, so extended rest may be needed before grazing the paddock again.

Monitoring plan

A monitoring plan is required to document resource conditions and to assess whether the grazing management is addressing the identified goals and objectives. Record keeping will be maintained and short and/or long-term monitoring will be conducted to support timely adaptive management. As per the Operation and Maintenance section of the Grazing Management (528) conservation practice standard, Grazing Records are required.

Grazing Records

Provide the producer with the Livestock Grazing and Forage Utilization Record available in the Grazing Management (528) conservation practice folder in Section 4 of the FOTG. The producer may also use their own record keeping format and provide that information to NRCS. Other formats may include records kept on a note pad, writing turn in and turn out dates on a plan map, keeping records on a smart phone or spreadsheet, or using a record-keeping app on their phone. The paddock identification, animal type, number of animals, date in, date out, average forage height when the animals are moved, and the days of grazing for each grazing period should be documented.

Grazing Management Assessment Form

Complete the form to assess the applied grazing management and whether it meets the grazing management plan and conservation practice standard. This form is required to certify the Grazing Management (528) conservation practice and will fulfil the monitoring requirement.

Several other monitoring options exist that may be needed to assist the producer with managing their grazing lands and livestock. Assist the producer with implementing these monitoring options as needed. Note: Other monitoring options may also be utilized that are not listed below. If needed, contact a Grazing Specialist or Area Resource Conservationist for assistance.

Pasture Condition Score

PCS can be used on an annual basis to help establish long-term trend in pasture condition. Take the PCS at a similar time every year. Note the growing conditions prior to and at the time of data collection.

Determining Indicators of Pasture Health

DIPH can be used on an annual basis to help establish long-term trend in pasture condition.

Photos/Establishing permanent photo monitoring points

Establishing permanent photo monitoring points from set locations can be an effective long-term monitoring tool to provide basic documentation of pasture condition. Consider taking photos of key areas within the pasture that can be revisited in the future. Key areas may include livestock concentration areas, locations where erosion is present, areas of brush/tree encroachment, invasive species populations, general landscape photos etc. Refer to the Permanent Photo Point Monitoring Form for guidance on establishing photo points.

Annual Production

Clip plots in the pasture to estimate total annual production. Grazing exclosures may be used to establish clipping plots or clip un-grazed/lightly grazed areas in the pasture to re-construct total yield. Refer to the Estimating Forage Production and Carrying Capacity Technical Reference for more information regarding clipping.

Body Condition Scoring (BCS)

BCS is a rating of the fatness or body composition of livestock. Livestock are rated on a point scale with each type of livestock possessing its own scoring system. Body condition scoring can allow the producer to assess their livestock nutrition program and determine whether the nutritional needs of their livestock are being met. Refer to Subpart H in the National Range and Pasture Handbook for more information regarding body condition scoring.

Nutrition (fecal analysis)

The Forage Sampling and Nutritional Analyzer (NUTBAL) is a fecal analysis-based program used to determine the nutritional status of the pasture. NUTBAL relies on fecal analysis to determine if the pasture is supplying adequate nutrition for the livestock to meet the producer's performance goals. For more information, please visit the Forage Sampling and Nutritional Balance Analyzer (NUTBAL) website.

Visual Obstruction: Robel Pole

Assessing visual obstruction may be beneficial for determining the quality of habitat for grassland birds. A Robel Pole may be used to assess vertical cover, production and structure of the plant community. For more information regarding this sampling method, refer to Technical Reference 1734-4 Sampling Vegetation Attributes.

Pasture Wildlife Habitat Evaluation Guide

Complete the Pasture WHEG to assess the general habitat quality of the pasture. Species-specific WHEGs are also available that may pertain to species found in the pasture.

Describing Indicators of Rangeland Health (DIRH)

This protocol is most appropriate on native rangelands and high diversity native restorations.

Soil Aggregate Stability

Soil aggregate stability may be beneficial for producers interested in improving soil health. Refer to the Rangeland Soil Quality-Aggregate Stability publication and to the Soil Aggregate Stability Test record keeping form for more information.

Stream Visual Assessment Protocol Version 2 (SVAP2)

SVAP2 is a rapid, visual, qualitative assessment of 15 elements to provide an evaluation of the overall condition of wadable streams and their instream habitats. Consider this assessment if streams are present in the pasture and the producer or landowner is interested in its condition. Refer to the Stream Visual Assessment Protocol Version 2 Technical Reference for more information.

Other Monitoring Tools

Other monitoring tools may exist to assess grazing management.

- Monitoring specific plant community attributes: Refer to the Technical Reference 1734-4 Sampling Vegetation Attributes.
- Wildlife Habitat: Other monitoring techniques may be necessary to assess specific species or groups of species. Consult a Wildlife Biologist or Grazing Specialist to identify monitoring tools that may be most appropriate for the site and species of interest.

Section 4: Grazing, Forage, and Livestock Management

Grazing management is a dynamic process of managing timing, duration, intensity, and frequency of grazing to properly manage the plant community to ensure its long-term health, productivity, and ecosystem services that pastures and rangelands can provide. Adaptive management is key to successfully managing pastures due to the variability in soils, plant communities, weather, and the response of the plant community to management. To ensure that the grazing plan meets the producer's goals and objectives and accomplishes the applicable purpose(s) for applying grazing management, the producer should make modifications to the plan as needed based on the plant community response, changes in plant health and productivity, changes in soil health, changing weather conditions, and any other factors that may affect the pastures and rangelands.

Resources

In addition to what is provided in this technical note, several other resources exist to assist planners with developing grazing plans. The following resources can be found in the Range and Pasture Technical Notes and References folder located in Section 1 of the FOTG.

- Technical Reference BU_07606_S: Grazing Systems Planning Guide.
- Improving and Sustaining Forage Production in Pastures.
- Technical Reference R1707: Ranchers Guide to Grassland Management.
- Technical Reference Title 190_Handbook_Number_645: The National Range and Pasture Handbook (NRPH). The NRPH contains many helpful sections:
 - Subpart D- Conservation Planning on Grazing Lands.
 - Subpart E- Inventory, Assessment and Monitoring for Grazing Lands.
 - Subpart F- Management of Grazing Lands.
 - Subpart H- Livestock Nutrition, Husbandry, and Behavior.
 - Subpart L- Grazing Land Economics.
 - Other sections contain valuable information as well.
- Technical Reference Title_190_Part_520: The National Range and Pasture Manual
- Prescribed Grazing and Feeding Management for Lactating Dairy Cows.
- Managing Grazing in Stream Corridors.
- Landowner's Guide to Prairie Management in Minnesota.
- Extending Grazing and Reducing Stored Feed Needs.
- Technical Reference 08569: Managing Soils for Greater Grazing Productivity.

Refer to these and any other useful resources as needed for assistance with planning grazing management.

Grazing Management Principles

A properly planned grazing system will (1) meet the producer's goals and objectives, (2) address resource concerns, (3) maintain or improve the plant community through managing the timing, intensity, duration and frequency of grazing, (4) promote ecological and economic sustainability, (5) sustain the resource base, and (6) meet the nutritional needs of the livestock. Plans will be developed on a site-specific basis to meet those needs. This section provides information regarding how to apply the grazing management principles to Minnesota pastures and rangelands based on our growing conditions.

Timing

Managing the timing of grazing is crucial for maintaining or improving plant diversity, productivity, and health. Timing consists of managing when pastures will be grazed based on plant growth stage and condition, forage quality, and allowing for adequate rest for plant recovery before the pasture is grazed again. As much as possible, base the timing of grazing and livestock movement on plant growth and utilization, not on calendar dates.

Whenever feasible, alter the timing of when pastures are grazed from year to year to maintain or enhance plant diversity and productivity. Producers should avoid grazing in the same sequence every year and should strive to start grazing in a different paddock every season. Altering the timing of grazing from year to year will ensure that plant species in the pasture receive rest during their critical growth periods. If the same sequence is used year after year, plant productivity, health, and diversity may decline in paddocks that are consistently grazed during critical timeframes (seed stalk elongation through seed development).

Plan the length of rest periods so that plants receive adequate time to replenish their leaf area and carbohydrate reserves. Rest periods will vary based on time of year, growing conditions, soil type and fertility, livestock forage needs as well as other factors. Rest periods may also vary based on the type of vegetation present, such as introduced species versus native rangeland. Refer to Table 1 for average rest periods:

Table 1: Estimated Rest/Recovery Periods by Vegetation Type

Vegetation Type	Estimated Rest Period Range	Average Rest Period
Introduced Grasses/Legumes	20-75+ Days	30-40+ Days
Native Rangeland	30-75+ Days	40-50+ Days
Restored Native Species	30-75+ Days	40-50+ Days

Table 1 is meant to serve as a guide. Actual rest periods need to be based on plant recovery and maintaining adequate plant residual. Rest periods for each vegetation type will vary throughout the grazing season based on the time of year, moisture availability, and temperatures. Shorter rest periods are applicable when growing conditions are ideal (adequate moisture and temperatures for the dominant vegetation). Longer rest periods will be needed during more stressful growing conditions (drought conditions, excessively hot temperatures, etc.). Rest periods may be shorter during ideal growing conditions and may need to be longer during stressful conditions than what is shown in Table 1 above. Rest periods during drought conditions may be 90 days or more.

Intensity

Grazing intensity is the measure of the amount of forage the livestock ate, trampled, or defecated on while grazing. Measuring the stubble height and managing the percent utilization are the most common methods for determining the grazing intensity. The intensity should be appropriate for the dominant vegetation present within the pasture. Also consider the goals and objectives of the producer. The minimum residual stubble heights or percent utilization should match the vegetation type.

Table 2. Recommended Residual Stubble Heights Based on Vegetation Type

Vegetation Type	Minimum Stubble Height to Begin Grazing	Minimum Residual Stubble Height
Introduced Grasses/Legumes	8-15+ Inches	4-6+ Inches
Native Rangeland: Tall Grass Dominated	8-15+ Inches	6-8+ Inches
Native Rangeland: Mid-Height Grass Dominated	6-15+ Inches	4-6+ inches
Seeded Tall Native Grasses and Forbs	8-15+ Inches	6-8+ Inches
Seeded Mid-Height Native Grasses and Forbs	6-15+ Inches	4-6+ inches

In many cases, pastures and rangelands consist of a diverse mixture of species. If the pastures will be managed for a single species, refer to Table 5 on Page 14 of the Technical Reference BU_070606_S Grazing Systems Planning Guide for stubble height recommendations.

Stubble heights may vary throughout the pasture. Some areas may be shorter or taller than other areas. Consider the entire pasture or paddock and determine the average stubble height for that area.

Managing on a stubble height basis works well for pastures that are vegetative through the boot plant growth stages and with plants that are less than 18-20 inches tall. For pastures that are grazed at maturity, producers should also consider managing the percent utilization to ensure that livestock maintain adequate nutrition. See the Utilization section below for more information.

Introduced Grasses/Legumes

Common species include brome grasses, orchardgrass, timothy, fescues, intermediate and tall wheatgrasses, reed canary grass, Kentucky bluegrass, quackgrass, redtop, alfalfa, red clover, white clover, alsike clover, birdsfoot trefoil, and many others. Grazing may be initiated in the spring when the plants reach 6-8 inches tall. These are cool season species that prefer cooler temperatures and adequate moisture. Their ideal growing conditions typically occur in the spring through the early part of the summer until the plants reach maturity. Most of their growth for the year occurs by early-mid July. Rest periods may be as short as 20-30 days early in the season (or possibly less). Growth slows after maturity and during the heat of the summer, especially if dry or drought conditions occur, as such, rest periods need to lengthen (30-75+ days). As temperatures cool in the fall, forage growth rates may improve.

Native Rangeland: Tall Grass Dominated

Consult a grazing or rangeland management specialist for assistance with planning grazing systems on native rangeland. These systems are very dynamic and specific management practices should be developed based on the plant communities and ecological sites present in the pasture. Follow similar management recommendations as native rangeland for grasslands restored with high plant diversity and where restoration of natural ecological processes is a goal.

Dominant vegetation consists of tall warm season grasses. Several forb species may also be present. Species include big bluestem, Indiangrass, or switchgrass. Minimum stubble heights are generally 6-8". Initiate grazing at 8-15+ inches.

For most rangelands, rest periods need to be longer than introduced cool season species to maintain the productivity and health of the species as well as the plant diversity of the site. Also, the remaining native rangeland in Minnesota usually occurs on challenging sites due to prolonged periods of saturated soil conditions, very steep slopes, or very dry, coarse textured soils. In these instances, long rest periods will be needed to allow for adequate plant recovery.

Depending on the producer's goals and objectives, consider managing native rangelands and high diversity restorations by managing the percent utilization in conjunction with the stubble height of the vegetation, especially if the areas will only be grazed once or twice during the season.

Native Rangeland: Mid-Height Grass Dominated

Consult a grazing or rangeland management specialist for assistance with planning grazing systems on native rangeland. These systems are very dynamic and specific management practices should be developed based on the ecological sites present in the pasture. Follow similar management recommendations as native rangeland for grasslands restored with high plant diversity and where restoration of natural ecological processes is a goal.

Dominant vegetation consists of short or mid-height grasses. Several forb species may also be present. Species may include sideoats grama, little bluestem, porcupine grass, native wheatgrasses, and sedges found in wet meadows. Upland rangeland sites are typically associated with coarse-textured soils and may contain restrictive layers. Wet meadows usually consist of saturated soil conditions for at least part of the growing season. Vegetation generally consists of short or mid-statured native grasses and forbs. Common associated ecological sites include Very Shallow, Shallow Gravel, Thin Upland, Sandy, Sands, Wet Meadow.

Maintain minimum stubble heights of 4-6+ inches. Initiate grazing at 8-15+ inches.

For most rangelands, rest periods may need to be longer than introduced cool season species to provide adequate recovery to maintain the diversity of native warm and cool season species. Also, the remaining native rangeland in Minnesota usually occurs on challenging sites due either to prolonged periods of saturated soil conditions, very steep slopes, or very dry, coarse textured soils.

Depending on the producer's goals and objectives, consider managing native rangelands and high diversity restorations by managing the percent utilization in conjunction with the stubble height of the vegetation, especially if the areas will only be grazed once or twice during the season.

Seeded Tall Native Grasses and Forbs

Common species include big bluestem, indiangrass, and switchgrass, which are all warm season grasses. Native cool season grasses and forbs may also be present. Warm season species do not start growth as soon in the spring as cool season species. Prime growing months are June-August. Growth starts slowly in the spring and reaches their peak during the summer months. Growth slows quickly with cooler weather later in the summer and fall.

Areas seeded only to warm season grasses may be prone to invasion by weedy species and introduced cool season grasses. Adjust grazing management as necessary to maintain the desired plant community and control unwanted vegetation.

Seeded Mid-Height Native Grasses and Forbs

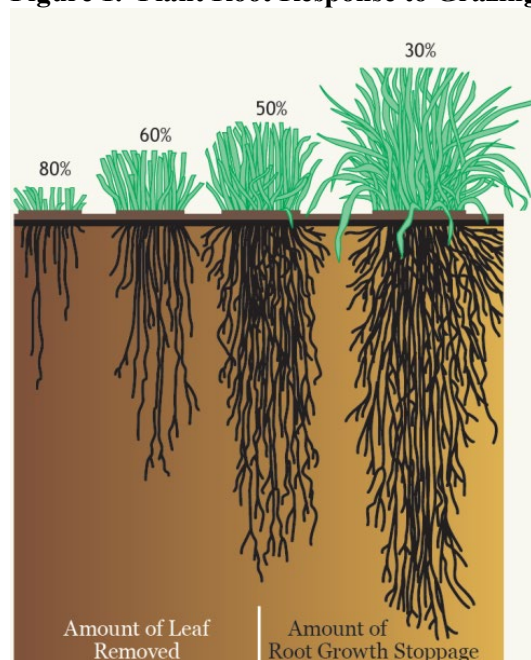
Common species may consist of a mix of warm and cool season grass and forb species. Common warm season species include sideoats grama and little bluestem. Common cool season species include porcupine grass, western wheatgrass, slender wheatgrass, Canada wildrye, and Virginia wildrye. Minimum stubble heights are similar for all species, although the timing and amount of rest will vary based on whether they are warm or cool season. Cool season species will start growth early in the spring and favor cool temperatures. Warm season species will break dormancy later in the spring and reach their peak growing periods in June through August. Rest periods will be shorter during peak growing conditions and longer during slower growing periods (such as sub-optimal temperatures, after maturity, or dry/drought conditions).

Utilization

Utilization is usually measured as the percent of the plant that was either grazed, trampled, or defecated on. Utilization may be an appropriate measure for low frequency grazing systems where pastures are only grazed once or twice per season or when livestock are grazing mature vegetation (especially if the mature vegetation is over two feet tall). When grazing mature vegetation, the overall forage quality may be lower and contain higher amounts of lignified plant material. Managing grazing by stubble height alone may result in animal performance that does not meet the goals and objectives of the producer. As plants reach maturity, the amount of stem and lignin in the plant increases, as such, the utilization may need to decrease to meet livestock production goals. The target utilization may range between 20-50% depending on forage quality, plant height and production, and production goals of the producer.

Managing residual stubble height also involves managing the percent utilization of the plant. Over-utilization within a single grazing period and for the entire season impacts the root system and long-term health and productivity of the plants. In most situations, utilization of 50% or less is desired; however, higher levels of utilization may be applicable to address specific management objectives or with very intensive grazing management. Determine the appropriate degree of utilization necessary to maintain the target/dominant forage species and meet the goals and objectives of the producer. Note that utilization levels over 50% for a single grazing period may have detrimental impacts to the root system and long-term productivity and health of the plant community. Utilization levels in an intensively managed grazing system where paddocks are grazed multiple times during the grazing season may result in total utilization levels for the season of higher than 50%. It is crucial to maintain minimum stubble heights and manage utilization within each grazing period to avoid long-term negative impacts to plant productivity and health.

Figure 1. Plant Root Response to Grazing Based on the Percent of Leaf Material Removed



Percent Leaf Volume Removed	Percent Root Growth Stoppage
10-40%	0%
50%	2-4%
60%	50%
70%	78%
80%	100%

(National Range and Pasture Handbook, 2022, Crider 1955, Dietz 1989, USDA-NRCS 2016)

The percentage of the height of the plant that was removed during grazing does not equal the same percentage of the biomass (weight) of the plant that was removed. For grasses, more biomass (weight) is located near the base of the plant and reduces as the plant gets taller. Managing for minimum stubble heights on forages that are less than 18-20 inches tall will usually result in utilization levels of less than 50% utilization on a dry weight basis for individual grazing periods. Refer to Table 3 for the Height to Weight Utilization Chart for common species found in MN.

Table 3. Height to Weight Utilization Chart*

	Percent of Height Removed						% Weight Removed
Percent Height Removed	65	70	75	80	85	90	
Introduced Cool Season Grasses ¹	37	38	45	53	61	70	
Tall Native Grasses ²	41	46	54	62	71	79	
Mid-Height Native Grasses ³	35	40	47	54	63	72	

1: Species may include smooth brome grass, meadow brome grass, tall fescue, meadow fescue, timothy, orchard grass, intermediate wheatgrass and other cool season grasses.

2: Species may include big bluestem, Indiangrass, switchgrass.

3: Species may include little bluestem, sideoats grama, slender wheatgrass, western wheatgrass, other native cool season species.

*Information adapted from North Dakota NRCS Appendix A: Prescribed Grazing Monitoring.

The bold numbers across the top of the table represent the percentage of height removed by grazing. The estimated percentage of the amount of weight removed are listed adjacent to each cover type. Actual percentages will vary based on individual species, site and soil conditions, and overall growing conditions.

Duration

Duration is the length of the grazing period. Grazing periods should be kept as short as practical to provide adequate rest for plant recovery. Keeping grazing periods short, especially during periods of fast growth, will minimize the opportunity for livestock to graze new growth prior to plant recovery. Adjust grazing and rest periods throughout the season to ensure that plants have adequately recovered prior to being grazed again.

Re-grazing the same plants shortly after they have initiated re-growth but before they are fully recovered can be detrimental to long-term productivity and health because the plant is not provided sufficient opportunity to replenish energy reserves. Re-growth may start within 3-10 days (or more) after being grazed, depending on growing conditions. Livestock will start to graze re-growth within 7-9 days after initially grazing the plant (assuming the pasture is not overstocked). To prevent re-grazing prior to adequate plant recovery, consider average grazing periods of one week or less. Longer average grazing periods may be appropriate based on site-specific factors. Consider shorter grazing periods during optimum growing conditions. Longer grazing periods may be applicable during stressful growing conditions if the pastures are not over-utilized. For example, an introduced grass/legume pasture that is subdivided into 6 paddocks may have an average grazing period of one week per paddock. During the early part of the grazing season when ideal growing conditions are present, the plants may re-grow quickly and need minimal rest, so a grazing period of 3-4 days with 15-20 days of rest may be appropriate. During the summer, plant re-growth may start later after being grazed due to heat and possible water limitations and longer rest periods may be needed. The same pasture may have a grazing period of 7-14 days later in the season provided that the pasture contains enough forage to support the herd for that length of time.

Consider shorter grazing periods to increase utilization for the season. Utilization rate for individual grazing periods and for the season may be 20% higher for grazing periods of 1-2 days compared to grazing periods of 7-10 days.

Table 4. Grazing Period and Grazing Season Utilization Based on the Length of the Grazing Period*

Grazing Period	Grazing Period Utilization Rate	Grazing Season Utilization Rate
>21 Days	35%	40-45%
7-10 Days	40%	50%
3-5 Days	50%	65%
1-2 Days	60%	70+%

*Data from research conducted by Missouri University. The chart shows the utilization achieved above the recommended minimum residual. Gerrish, J.R. and Roberts, C.A. Missouri Grazing Manual. Missouri University, College of Agriculture, Food and Natural Resource.

High producing and growing animals may benefit from grazing periods of 4 days or less to allow the producer to better manage the forage quality that livestock consume and to reduce variability in forage quality that may be associated with longer grazing periods. In long grazing periods, livestock will seek out the most nutritious plants early in the grazing period and will be grazing lower quality vegetation later in the grazing period. Shorter grazing periods may yield more consistent forage quality intake. Examples of livestock that may benefit from intensive rotations include grass-finishing animals, stockers/yearlings, and dairy cattle.

For best results, ensure that the forage quantity is adequate to meet the livestock demand for the grazing period as well as the grazing season.

Frequency

Frequency is how often a pasture or paddock is grazed within the season. Frequency of grazing directly relates to the planned length of the grazing season, length of the rest periods, and the goals/objectives of the producer:

- If the producer's goals and objectives are to manage for optimum forage quality, they may be managing with shorter rest periods (30 days of average rest) and be grazing plants in the vegetative phase as much as possible. In this scenario, paddocks may be grazed 3-5+ times during the season.
- If the producer's goals and objectives are to optimize forage production and longevity, longer rest periods may be desired (30-60+ days of average rest). Each pasture may be grazed 1-3 times during the season.
- Native and restored rangelands: To maintain plant productivity, health, and diversity, consider grazing each paddock no more than twice during the season. Three or more grazing periods may be applicable to meet land management objectives in specific situations.

Considerations for Number of Paddocks and Paddock Layout

The number of paddocks will depend on the average length of the grazing and rest periods needed to properly manage the forage resources as well as to meet the producer's goals and objectives. Plan the number of paddocks accordingly.

Additional considerations for planning the number of paddocks:

- The desired level of management by the producer.
- Labor resources of the producer. To help determine when they may be available to move livestock, consider what other farm commitments (crops, feeding livestock, etc.) are needed as well as if they work off the farm
- Livestock performance goals.
- Distance the pasture is from the producer's residence and how often they will be able to check or move livestock. Pastures located next to the farmstead provide more opportunities for intensive management than pastures that may be located several miles away.
- Carrying capacity of the pasture. From an economic standpoint, more intensive rotations with larger herd sizes may be more feasible because the labor cost is spread across more animals. Also rely on producer input.
- Assess the feasibility of installing and maintaining infrastructure based on site-specific factors. Large expanses of wetlands and wooded areas may be challenging for installing and maintaining fence and water infrastructure. Whenever possible, consider locating infrastructure in paths of least resistance while still addressing resource concerns and meeting management objectives.
- As much as practical, paddocks should contain similar soils, slope, topography, and vegetation types.
- Consider square or uniformly shaped paddocks as much as possible to promote even grazing distribution.

Sensitive Areas Management

This section discusses common sensitive areas found in pasture and general grazing management considerations. Develop site-specific management recommendations based on condition, presence of resource concerns, and any other factors that may affect sensitive areas.

Hydric Soils:

- Adjust the timing and duration of grazing to minimize livestock impacts. Avoid using during saturated soil conditions.
- Consider providing alternative water sources other than surface water that may be located within hydric soils. Locate alternative water sources outside of hydric soils if possible.
- Avoid feeding in these areas when soils are saturated or when it may cause environmental damage. Utilize soils layers available in GIS or Web Soil Survey to identify hydric soils.

Wetlands:

- Wetlands may be grazed as separate units or as components within larger paddocks.
- Avoid feeding near wetlands. Maintain adequate setbacks to reduce the potential for run-off into wetlands. Refer to the Strategic Harvest Forage Management (827) conservation practice and planning workbook for more information regarding feeding management near wetlands.
- Adjust timing and duration of grazing to match environmental conditions. To prevent compaction, avoid grazing during excessively wet periods.
- Note the type of wetlands present in the pasture. Seasonal wetlands may be wet during the spring but provide ample forage later in the season once conditions dry out. Permanent wetlands may provide grazing only along wetland fringes or during times of dry/drought conditions.

- Note the vegetation present within the wetland. Native wetland grasses, creeping foxtail or reed canary grass can provide good grazing opportunities. Sedge meadows will provide less opportunities as sedges are not preferred. Cattails provide very minimal grazing opportunities and should not be accounted for in a livestock forage balance.

Seeps and Springs:

- Seeps and springs may be components within a pasture. These areas are often small components within a pasture, and as such, are grazed as part of a regular rotation within the grazing system.
- Livestock may need to be fenced out of these areas if they are causing compaction and other resource concerns.

Riparian Areas:

- Riparian Areas consist of areas adjacent to streams and rivers.
- Riparian areas may be included as parts of larger paddocks and grazed as part of a regular rotation throughout the season.
- Riparian areas may be fenced separately and grazed either as part of a regular rotation or when conditions and management objectives dictate.
- Riparian areas may be fenced as separate units and grazing may be applied on a limited basis for a short duration to manage the vegetation.
- Deploy fencing to avoid uncontrolled livestock access, avoid open feeding near riparian areas, manage proper timing and duration of grazing events, and maintain proper vegetation residual to minimize soil or stream bank erosion. Refer to the Strategic Harvest Forage Management (827) conservation practice and planning workbook for more information regarding feeding management near riparian areas.

Woodlands:

Many pastures may contain grazed woodlands that are not part of a silvopasture system. These areas may provide shade as well as foraging opportunities. The amount of grazing available in woodlands is highly dependent on canopy cover and vegetation present. When tree canopy cover is greater than 50%, forage production in the under-story drops significantly due to the lack of sunlight reaching the herbaceous under-story, and the species composition may shift to woodland species instead of grasses, legumes, and forbs that may be found in open pasture. Woodlands may be grazed as separate paddocks within a grazing system or as components of larger pastures containing both woodland and open grassland cover.

- Adjust the timing and duration of grazing to minimize livestock impacts.
- Avoid use during saturated soil conditions to minimize soil compaction near the root systems.
- Avoid feeding within the dripline of trees to prevent excessive nutrient build-up and soil compaction, which may be detrimental to the trees.
- Monitor browse use of the desired trees and move animals prior to detrimental impacts.
- Consider utilizing wooded paddocks during times of hot/humid weather to provide shade for the livestock.
- Heavily wooded pastures may need extended rest for plant recovery. Depending on the tree canopy cover, wooded areas may be grazed less frequently than open pastures due to limited re-growth and long recovery periods.

Droughty Soils:

- Droughty soils often consist of coarse textured soils with low water holding capacity.
- Adjust the timing and duration of grazing to maintain adequate residues. Longer rest periods may be needed compared to finer textured soil types, especially during periods of low rainfall. Average rest periods may need to be 40-75+ days on average unless timely rainfall is received throughout the growing season.
- Manage winter feeding conducted in these areas to avoid over-applying nutrients, which could result in nutrient leaching. Refer to the Strategic Harvest Forage Management (827) conservation practice and planning workbook for more information regarding feeding management on coarse-textured soils.

Native Rangeland and High Diversity Native Restorations:

- Pastures may contain areas of native rangeland or areas restored with high diversity seed mixes to promote natural ecological processes.

- Adjust timing and duration of grazing to enhance grassland diversity. Many native rangeland sites contain a mix of native cool and warm season grasses and forbs. To maintain plant diversity and productivity, consider longer rest periods and less grazing frequency compared to what is typically recommended for introduced cool season forages. Provide at least 40-75+ days of rest between grazing periods. Consider limiting grazing frequency to 1-3 times during the grazing season.
- Monitor existing vegetation components. If introduced cool season grasses are a concern, match the timing of grazing to impact the introduced cool season species and promote native species. In upland areas, the best time to graze for introduced cool season grass management is early in the season prior to many native species breaking dormancy (early to mid-May, depending on location within the state). Grazing in the fall can also provide a window for control after most native species have gone dormant but before introduced cool season species have reached dormancy.
 - Note that early season grazing may not be practical or feasible in wetland/hydric areas containing reed canary grass due to potentially saturated soil conditions. Graze these areas when conditions allow and monitor grazing use to avoid over-grazing desirable plants.
- Avoid using these areas as sacrificial areas or for winter feeding activities because those activities may be detrimental to maintaining the desired native plant species.

Sinkholes/Karst Topography:

- Sinkholes/Karst may be present in pastures, particularly in Southeast Minnesota.
- These areas are typically included as small components within larger paddocks. Monitor locations to ensure livestock do not become entrapped within these areas.
- Consider fencing livestock out of these areas if they have become entrapped in the past.
- Avoid feeding within close proximity to these areas to prevent nutrient run-off/leaching into ground water. Refer to the Strategic Harvest Forage Management (827) conservation practice and planning workbook for assistance when planning winter feeding activities near sinkholes/Karst topography.

Steep Slopes:

- Steep slopes may be present and prone to over-grazing and soil erosion.
- Adjust timing and duration of grazing to maintain adequate soil cover and stubble height to minimize soil erosion. Longer rest periods may be needed to allow for adequate forage recovery, especially on south and west facing slopes.
- Monitor any feeding activities closely to avoid over-application of nutrients, which could expose the soil to erosion and lead to high rates of run-off. Refer to the Strategic Harvest Forage Management (827) conservation practice and planning workbook for assistance when planning winter feeding activities on steep slopes.

Soil Fertility and Management

Managing soil fertility can be overlooked by producers, especially on seeded and naturalized cool season grass/legume pastures. The livestock provide natural nutrient cycling through deposition of manure and urine. 70-90% of the Nitrogen, Phosphorus, and Potassium that a grazing animal eats is redeposited on the pasture (Silveira et al. 2022). 10-30% of the nutrients are removed by the livestock, which means that those nutrients may need to be replaced over time depending upon the goals and objectives of the producer, site-specific characteristics, soils, and intensity of grazing management. Refer to the University of Minnesota's Fertilizer Guidelines for Agronomic Crops in Minnesota for more information regarding fertilizer recommendations for hay and pasture.

Manure Distribution

Grazing management can have a direct effect on manure distribution in the pasture. Intensive grazing systems with shorter grazing periods and more/smaller paddocks may result in better manure distribution than grazing systems with longer grazing periods and larger paddocks. Also, consider the shape of the paddock. Paddocks that are square may result in more even manure distribution compared to other configurations.

Livestock will deposit more manure by water, shade and any salt, mineral or supplemental feeding sites located within the paddock. Consider locating water sources away from wooded or shade sources to minimize excessive nutrient build up. Consider locating salt, mineral or supplemental feeding in areas of low fertility to attract livestock (salt or mineral can also be used to attract livestock to lightly grazed areas of the pasture or into patches of undesirable vegetation to increase impact). Also consider locating salt and mineral supplements away from water and shade sources.

Figure 2: Effect of increased management intensity on manure distribution (Rhinehart, 1997).

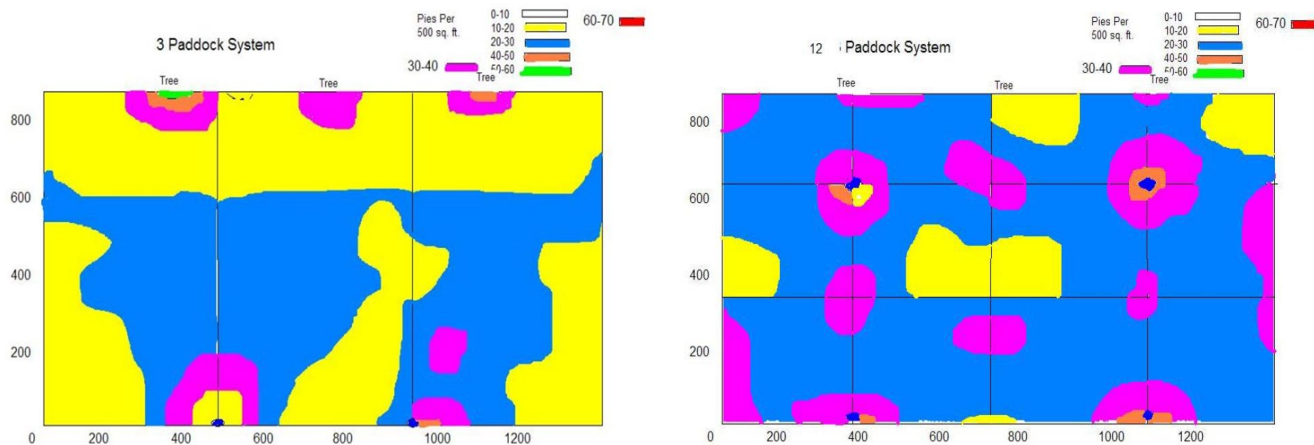


Figure 2 shows the impact of grazing management on manure distribution. It shows the number of cow pies per 500 square feet for a three-paddock versus a 12-paddock grazing system. As the number of paddocks increases and the paddock size decreases, the livestock density increases, and manure is more evenly distributed across the pasture.

Soil Testing

Producers should consider soil testing every 3-5 years (or more often), especially if their goals involve optimizing forage production or if the pastures are not meeting realistic production goals for the site based on the soils and planned grazing management. The main components to test for include Nitrogen (N), Phosphorus (P), Potassium (K), Sulfur (S), pH, and Organic Matter. Other elements may also be beneficial depending on the goals/objectives of the producer.

Options to Manage Soil Fertility

- Apply sound grazing management practices to ensure that plants are in good health, which will optimize their capture and uptake of water and nutrients needed for plant growth.
- Consider adding legumes to grass pastures. Nitrogen-fixing legumes may assist with providing nitrogen for other plants in the pasture.
- Consider applying commercial fertilizer or manure if needed. Any fertilizer or manure applications should be based on soil test results.
- Utilize strategic winter or supplemental feeding to introduce fertility into low fertility areas and to prevent excessive nutrient build-ups associated with feeding in the same locations every year. Refer to the Strategic Harvested Forage Management (827) conservation practice for assistance planning winter or supplemental feeding activities.

Strategic Winter Feeding on Pasture and Cropland

Winter feeding may be a useful tool for improving or maintaining long-term productivity of pasture and cropland. Consider current or planned winter-feeding activities. If applicable and as needed, discuss with the producer opportunities to utilize winter feeding as a method to improve long-term productivity by strategically placing feed in areas that need fertility and minimize feeding in areas of high fertility. Additional considerations for planned winter feeding on pasture or cropland include:

- Producers should consider obtaining soil tests to assess current nutrient needs, and to assist with developing a plan that will best utilize the livestock's manure generated while feeding.

- Consider sensitive areas located within the pastures and what management strategies may be necessary to minimize impact on those areas.
- Consider the spring thaw and potential impacts on feeding areas. Livestock may need to be moved to sacrificial areas or feedlot settings during this time, especially if soil compaction is a concern.
- Pastures may need extended rest during the next growing season to allow pastures to fully recover. Wintering paddocks may need extended rest early in the grazing season to allow additional rest for plant recovery. Pasture forages usually fully recover within 1-2 growing seasons. Renovate and reseed areas as necessary if pastures are excessively damaged or the existing forages do not adequately recover.
- Move feeding areas every year to avoid excessive nutrient build-ups.
- It is the producer's responsibility to follow any local, state, or federal ordinances related to livestock feeding and feedlots.

Refer to the Strategic Harvested Forage Management (827) conservation practice and the Planning Workbook for technical guidance and assistance with planning winter feeding activities.

Extending the Grazing Season

This section provides an overview of common strategies producers could consider for extending the grazing season. If applicable, discuss appropriate strategies with the producer to determine if any of these options fit their goals and objectives. Refer to the Extending Grazing and Reducing Stored Feed Needs technical reference for more information.

Stockpiling Pasture

Pastures may be stockpiled for late fall or winter grazing. Stockpiling forage involves not grazing pastures during the summer and fall for the purpose of grazing later in the fall or winter. Consider the current or planned stocking rate and whether it will allow for pastures to receive extended rest for forage to accumulate. Note that many operations may be stocked too heavily to allow pastures to rest long enough to build forage biomass for later in the season without over-grazing other pastures. Match livestock demand to the forage supply for the planned grazing season.

Integrating Livestock onto Cropland

If applicable, consider opportunities to integrate livestock onto cropland to increase grazing opportunities and improve soil health. Assess the feasibility of grazing cropland. Identify any existing infrastructure as well as any planned infrastructure necessary to support grazing. If grazing occurs in the winter, ensure adequate winter water sources are available. Also, consider the proximity of the fields to summer pasture or winter-feeding areas. Work with the producer to determine which crop fields may be feasible to incorporate into the grazing system.

Stockpiling Hay Land

Consider the age and composition of the hay land. New or young plantings may not be appropriate for grazing. Precautions to manage bloat may be needed for stands containing high amounts of legumes.

Grazing Crop Residues

Consider the type of crop residues present and any grazing opportunities they may provide. High residue crops, such as corn, can provide significant grazing opportunities. Low residue crops, such as soybeans, provide limited grazing opportunities.

Refer to Soil Health Technical Note 470-09: Cover Crop and Crop Aftermath Grazing for assistance with calculating forage availability and carry capacity when grazing crop residue and cover crops.

Grazing Cover Crops

Consider the crop rotation, how cover crops may fit into the rotation, and opportunities to incorporate cover crops. Cover crops for grazing are most easily utilized when small grains (oats, wheat, barley, etc.) or short season canning crops (such as peas or sweet corn) are part of the crop rotation. These crops have longer timeframes after harvest to allow for cover crops to establish and produce biomass for grazing.

Incorporating cover crops for grazing into a corn-soybean rotation may be difficult due to the narrow window for cover crop establishment. Planting cover crops after crop harvest may not provide many grazing opportunities without adjustments to the cropping system. Producers may need to consider changing to shorter-season corn and soybean varieties to allow more time for cover crop growth and establishment. Producers may also consider early-season inter-seeding into corn to provide more time for cover crop growth and production (inter-seeding into corn with row spacings less than 30 inches may not be feasible due to plant competition).

When incorporating cover crops, producers also need to consider the herbicides used within their cropping system. Many herbicides used in cropping systems carry residuals that may prevent cover crop establishment or may have grazing and forage harvest restrictions. **Producers should always check the herbicide labels for planting, harvesting, or grazing restrictions.**

Refer to Technical Note 33: Cover Crop Seeding Guide for more information regarding establishment and grazing management for cover crops. Refer to Pages 10 and 11 for Cover Crop Grazing Recommendations. Maintain minimum recommended stubble heights to ensure other practice purposes are met for the cover crop.

Table 5. Forage Grazing Height Recommendations for Cover Crops and Annual Forages.

Dominant Species	Start Grazing Height	Stop Grazing Height
Cool Season Annual Grasses	8+ Inches	4 Inches
Warm Season Annual Grasses	24+ Inches	8+ Inches
Millet and Teff	8+ Inches	4-6 Inches
Legumes	8+ Inches	4 Inches
Diverse Cool/Warm Season Mixes	16-24+ Inches	6-8+ Inches

Refer to Soil Health Technical Note 470-09: Cover Crop and Crop Aftermath Grazing for assistance with calculating forage availability and carry capacity when grazing cover crops.

Annual Forages

If applicable, discuss annual forages with producers and how they may be incorporated into their operations.

Opportunities to incorporate annual forages:

- Consider annual forages as an option to address forage deficiencies for the planned grazing season. Assess current forage resources and whether they will provide enough grazing opportunities to meet the goals of the producer. If not, assess where forage deficiencies may occur and how annual forages can fill those gaps.
- Consider annual forages to extend the grazing season. They may be stockpiled for fall and winter grazing to increase the length of the grazing season.
- Annual forages may also be planted to improve soil health by diversifying the crop rotation, integrating livestock onto cropland, and addressing other resource concerns associated with improving soil health.

When planning annual forages, match species to the planned seeding date, soils and growing conditions. Also, producers need to consider herbicides used within their cropping system. Many herbicides used in cropping systems carry residuals that may prevent cover crop establishment and/or may have grazing and forage harvest restrictions. **Producers should always check the herbicide labels for planting, harvesting, or grazing restrictions.**

Refer to Technical Note 34: Annual Forages for Grazing Systems for more information regarding establishment and grazing management for annual forages. Refer to Table 5 above for annual forage stubble height recommendations.

Soil Health Technical Note 470-09: Cover Crop and Crop Aftermath Grazing may be a useful reference to assist with calculating forage availability and carry capacity when grazing annual forages.

Livestock Water

Water is critical to the success of grazing management. Ensure adequate water quantity and quality is supplied to the livestock and that it is properly distributed across the pastures to facilitate grazing management and meet the producer's livestock management goals.

Water must be available in sufficient quantity for the kinds and classes of livestock being grazed. The quality of water must be such that it is potable for livestock and does not spread diseases and parasites. Refer to North Dakota State University's Livestock Water Quality technical reference for more information regarding water quality requirements for livestock. Water must be adequately distributed to encourage uniform grazing patterns. Each paddock in a grazing system must have an adequate water source. When natural water sources or constructed ponds are used, the grazing management plan must also include contingency plans in case the water sources cannot provide adequate quantities throughout the grazing season, such as during drought conditions.

When planning livestock watering systems, use 2% of the average body weight for each kind and class of livestock included in the grazing plan to calculate the gallons per day the herd will consume and to ensure that enough water will be available during peak use. Water needs increase as temperatures rise and as the forage dry matter increases during the summer.

Ensure every paddock has a reliable water source. To improve grazing distribution, reduce the travel distance to water within paddocks as much as feasible for the site. Consider keeping the travel distance to water under a quarter mile. Travel distances of less than 800 feet are the optimum.

When planning pipeline watering systems, consider an appropriate size of tank based on the producer's goals, the herd's livestock water needs, landscape and topography characteristics, and the output of the water source (gallons per minute). Watering systems must be engineered to ensure that the system will operate as planned and supply sufficient water to the herd in a timely fashion. Refer to the Livestock Pipeline design tool for more information.

Considerations for planning livestock watering systems:

- Consider how the producer plans to manage the pasture and whether they plan to utilize temporary or permanent tanks.
- In many cases, one water tank can service multiple paddocks. Up to four permanent paddocks may be able to water from one location. Avoid creating pie-shaped pastures back to a central water source because it may cause over-grazing near the water point and poor manure distribution.
- In intensively managed grazing systems that utilize temporary fencing to further subdivide pastures into smaller paddocks, livestock may be able to walk back to water across previously grazed areas for up to a week before switching to a new water source. Move animals to a new water source before they start grazing new re-growth on previously grazed areas. Water tanks may be permanent or portable.
- Consider the landscape in the pasture and any visual or physical obstructions, such as wooded areas, wetlands and hills. Visual and physical obstructions may cause the livestock to come to water in large groups. Larger tank sizes may be needed to provide additional storage and allow more animals to drink at one time.
- Consider the planned travel distance to water. Longer travel distances may result in livestock coming to water in large herds. Shorter travel distances may result in livestock coming to water in smaller herds. For long travel distances, larger water tanks may be needed to provide additional storage and allow more animals to drink at one time.
- The output of the water source (such as a well) may dictate water tank size. Larger herds and wells that produce low volumes of water may need large water tank sizes to ensure adequate water is available to the livestock.
- Significant increases in elevation may require higher pressures, increased pipeline size, and bigger water tanks.

Livestock Nutrition and Forage Quality

Consider livestock nutritional needs and forage quality when developing grazing plans.

Forage Quality

Grazing management should be applied in accordance with forage quality and quantity criteria that best meets the production requirements for the kind and class of livestock as well as to meet the producer's livestock production goals. For more information on forage quality, refer to the Technical Reference 1-01 Understanding Forage Quality. Forage quality considerations for the producer include:

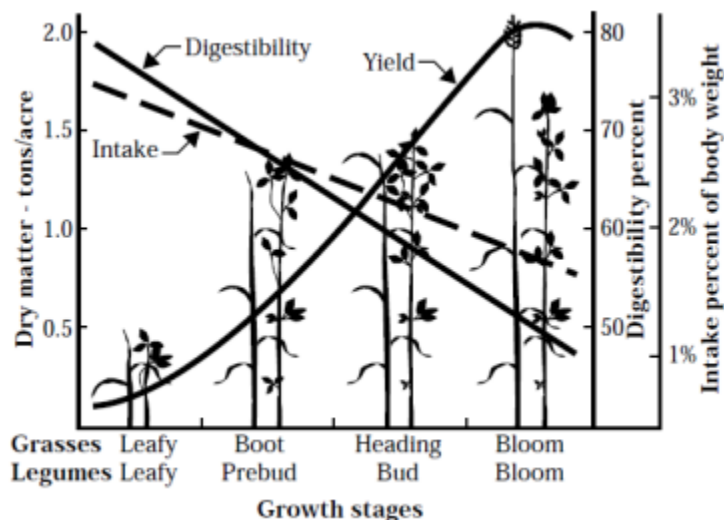
- Forage quality is most influenced by soil fertility and the plant growth stage at the time of grazing. Grazing when plants are vegetative through the boot stage (early seed head formation) manages the plants for highest relative nutritional quality.
- Vegetative plants usually offer the highest forage quality, and overall quality declines as the plants reach maturity.
- Leaves are higher in forage quality than stems.
- Producers should obtain forage tests as necessary to assess forage quality. To more accurately estimate what livestock are intaking in a pasture setting, observe what species and plant parts (leaves, stems, seedheads, etc.) that the livestock are grazing or will graze based on the planned grazing intensity and utilization. Proportionally select species and plant parts for analysis based on what the livestock are grazing. Avoid selecting species and plant parts that the livestock are avoiding.
- Adjust grazing intensity as needed to increase the quality of forage intake. If provided the opportunity, livestock may select for plants and plant parts they need to balance their diet. As grazing intensity and utilization increase, diet selectivity may decrease. When grazing mature forages, consider reducing the grazing intensity and utilization to provide more opportunities for livestock to select plant species and parts higher in forage quality to meet their nutritional needs.
- Provide supplemental protein and energy as needed if forage quality does not meet the nutritional needs of the livestock.
- Consider the presence of toxic plants and if any action is necessary to mitigate toxicity issues.

Table 6. Forage Quality Based on Plant Parts for Alfalfa and Timothy (Ball, 2001).

Species	% of Plant	CP	NDF	ADF
Alfalfa				
Upper Leaf	30.7	23.9	27.7	18.5
Lower Leaf	12.8	21.8	25.9	16.6
Upper Stem	6.5	13.4	52.6	38.6
Lower Stem	50	9.6	67.8	52.9
Timothy				
Leaf	29.6	18.3	49.1	25.5
Stem	70.4	5.8	72.5	42.6

Table 6 shows the Crude Protein (CP), Neutral Detergent Fiber (NDF), and Acid Detergent Fiber (ADF). Crude protein is the highest while the fiber is lowest in the leaves compare to the stems of alfalfa and timothy.

Figure 3. Growth stages of grasses and legumes and their effect on intake, digestibility, and dry matter production (Blaser et al. 1986).



Livestock Nutrition

Consider livestock nutritional requirements while grazing. Producers should consider monitoring livestock health and nutritional status throughout the year. Several tools are available to assist with monitoring livestock health and nutritional status, which include livestock fecal sampling, forage testing/sampling, Nutritional Balance Analyzer (NutBal), body condition scoring, as well as other options. Refer to Subpart H-Livestock Nutrition, Husbandry, and Behavior in the National Range and Pasture Handbook (NRPH) for more information regarding livestock nutrition, maintenance, growth and production for various types of livestock, information on body condition scoring, and maintaining a balance between livestock numbers and available forage.

Considerations for producers:

- Avoid over-stocking pastures, which may limit intake and affect the livestock's ability to meet their daily nutritional requirements.
- Utilize monitoring tools as necessary to assess livestock health and nutritional status.
- Provide supplemental protein or energy as needed if livestock are not meeting their nutritional requirements and production goals.
- Adjust grazing management as needed to ensure livestock will meet their daily intake and nutritional requirements (as much as the available forage will allow).

Livestock need to consume 2-4% of their body weight every day in dry matter to meet their nutritional needs. For planning purposes, use 4% when calculating a livestock forage balance to account for livestock intake as well as trampling loss and leaving adequate residual forage. The actual forage required will vary considerably based on forage quality, physiological stage of the grazing animal and climatic conditions. Females have their highest nutritional requirements during peak lactation. Growing and lactating animals generally have higher nutritional requirements than mature animals or non-lactating animals. Producers should continually monitor livestock condition and health to ensure that the animals are meeting their nutritional requirements.

Figure 4. Nutritional Requirements for Beef Cows (Mousel, 2013).

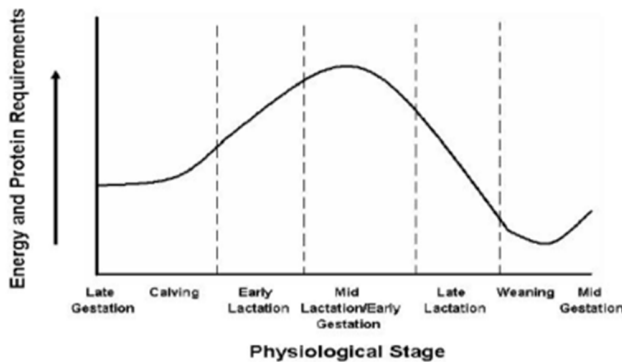


Figure 4 depicts the relative nutritional requirements for beef cows based on their physiological stage. As nutritional requirements change, the amount of dry matter necessary to meet nutritional requirements may also change depending on the forage quality.

Salt and mineral supplements are usually supplied to livestock. Locate salt and mineral feeding areas away from water and shade to improve grazing and manure distribution. Consider placing salt and mineral in areas of unwanted vegetation to attract livestock activity into those areas. Avoid areas with high populations of toxic plant species. Refer to the Range and Pasture Technical Note 2: Poisonous Plants for more information.

Animal Husbandry

Consider any animal husbandry requirements, such as breeding programs, birthing periods, and animal health activities, that may impact the planned grazing management and layout of infrastructure within the grazing system (such as fence placement). For example, if the livestock will be bred by Artificial Insemination during the grazing season, the layout may need to accommodate access to the farmstead or animal handling facilities to complete those tasks.

Livestock Handling Facilities

Producers may inquire about assistance with designing animal handling facilities. Refer to the Livestock Handling Facilities Designs technical reference for a fact sheet that can be provided to producers if needed.

Refer to Technical Note 190_BIO_94: Conservation Planning with Bison Producers for more information regarding corrals and handling facilities for bison.

Grazing Economics

Producers make choices from a range of alternatives for the survival and prosperity of their operation. The planner's duty is to present ecologically and economically sound management plans to the producer to assist them with their decision-making process. Farm-scale economics can be a sensitive subject because it involves personal information about costs, returns, and production. As such, it is not the planner's responsibility to make economic decisions for the producer, but to assist the producer with assessing the feasibility of the management plan. Producers need to decide what management actions are best for their operation.

Improvements to grazing management will influence the economics of the operation. Consider the economic impact that changes to grazing management plan may have on the operation. Improved grazing management practices may increase forage production, the length of the grazing season, and possibly stocking rate. To achieve those benefits, there are usually costs associated with installing additional infrastructure and potentially increased labor for managing the system. Encourage producers to get material and/or installation bids for any planned infrastructure so that they can more accurately assess the economics of their grazing management plan. As needed, provide a cost estimate for any planned infrastructure to assist the producer with understanding costs.

A range of tools are available for planners to assist producers with assessing the economics of grazing management plans:

- Refer to Subpart L- Grazing Land Economics of the National Range and Pasture Handbook for more information.
- Conservation Effects Decision Making Talking Points are available in the Economics Benefits folder located in Section 5 of the FOTG. The talking points are available for most conservation practices that are utilized to support grazing management and provide a starting point for discussing economics of a practice.

Section 5: Grazing Management Practice Certification

This section outlines the required documentation to certify grazing management:

- Conduct a site visit to the grazing system and complete the 528 Grazing Management Assessment Form.
- Collect photo documentation.
 - Use established photo points if present or take at least two photos to document the applied grazing management. Use a grazing stick or other measuring tool as a reference in at least one photo to document that the applied grazing management met the minimum stubble heights or desired utilization level specified in the grazing plan. The second photo can be a general landscape photo. The photos should be representative of the average grazing management for the areas where the photos were taken. Take more photos as needed to document the applied grazing management.
- Obtain grazing records from the producer to verify that the applied grazing management for the grazing season that is being certified.
 - Providing grazing records may be optional if the planner determines that the applied management met the recommendations of the grazing plan, the Grazing Management (528) conservation practice standard, and all criteria for the applicable practice purpose (the 528 Grazing Management Assessment Form and photo documentation are still required). Refer to the site-specific grazing management plan as needed.
- Ensure sensitive areas are managed based on the site-specific grazing management plan.

Photo 1. Photo showing grazing stick as a reference for height.



Timing of Practice Certification

Ideally, grazing management certification should occur as close to the end of the grazing season as possible, however, potential winter weather and other workload priorities may necessitate conducting certification site visits earlier in the grazing season. Practice certification may start as early as mid-August. Consider conducting multiple site visits for producers in their first year of grazing management to provide them with feedback and opportunities to make grazing management adjustments before the end of the grazing season if needed based. Consider completing all evaluations by the end of October to ensure that site visits are conducted prior to significant snow cover.

If needed, contact a Grazing Specialist or Area Resource Conservationist for assistance with certifying the practice, to address any questions about whether the applied grazing management meets the conservation practice requirements, or for assistance to work with the producer to address any management issues identified while completing grazing management assessments.

Additional Certification Considerations

- Producers may utilize a sacrificial paddock during times of adverse weather conditions and during periods of forage deficiencies. Consider the management and condition of the other paddocks for practice certification. Ensure that the sacrificial paddock did not adversely affect any sensitive areas.
- Producers may use pastures as winter feeding or calving areas. Consider the management and condition of the other paddocks for practice certification. Ensure that the wintering and calving areas did not adversely affect any sensitive areas.
- Consider weather events, such as extreme drought or flooding, and their effect on grazing management. In general, pasture conditions may be poorer during these situations compared to normal growing conditions. Producers may need to use sacrificial areas during these times. The vegetation appearance may be poor due the effects of prolonged drought or flooding. Assess whether adequate rest and proper utilization (minimum stubble heights) were applied. The producer may have decided to remove animals from the grazing system for extended periods of time to minimize the negative impact of the adverse weather event. Refer to the producer's grazing records for support of the applied grazing management. As needed, refer to a Grazing Specialist or Area Resource Conservationist for assistance.

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Appendix A: Locations of Reference Materials within the Field Office Technical Guide

Section 1: General Resource References

Engineering Resources> Computer Aided Design> Minnesota Standard Drawings>Miscellaneous Structures

- Livestock Shelter Structure permanent and portable windbreak designs.

Agronomy Technical Notes and References by Discipline Folder

- Agronomy Technical Note 31: Herbaceous Vegetation Establishment Guide
- Agronomy Technical Note 33: Cover Crop Seeding Guide
- Agronomy Technical Note 34: Annual Forages for Grazing Systems

Range and Pasture Technical Notes and References by Discipline Folder

- Describing Indicators of Pasture Health (DIPH)
- Describing Indicators of Rangeland Health (DIRH)
- Extending Grazing and Reducing Stored Feed Needs
- Improving and Sustaining Forage Production in Pastures
- Landowner's Guide to Prairie Management in Minnesota
- Livestock Handling Facilities Designs
- Livestock Water Quality
- Managing Grazing in Stream Corridors
- Prescribed Grazing and Feeding Management for Lactating Dairy Cows
- Range and Pasture Technical Note 2: Poisonous Plants
- Rangeland Soil Quality-Aggregate Stability
- Soil Aggregate Stability Test
- Soil Health Technical Note 470-09: Cover Crop and Crop Aftermath Grazing
- Stream Visual Assessment Protocol Version 2
- Technical Note 190-BIO-94: Conservation Planning with Bison Producers
- Technical Reference 08569: Managing Soils for Greater Grazing Productivity
- Technical Reference 1-01: Understanding Forage Quality
- Technical Reference 1734-4: Sampling Vegetation Attributes
- Technical Reference BU_07606_S: Grazing Systems Planning Guide
- Technical Reference R1707: Ranchers Guide to Grassland Management
- Technical Reference Title_190_Part_520: The National Range and Pasture Manual
- Title 190 Handbook Number 645: National Range and Pasture Handbook
- University of Minnesota's Fertilizer Guidelines for Agronomic Crops.

Section 2: Natural and Cultural Resources Information

Soils- Statewide Official Data and County Reports

- Forage Suitability Groups

Section 3: Resource Concerns and Planning Criteria

Resource Concerns and Planning Criteria Folder

- Pasture Condition Scoresheet (PCS)

Wildlife Habitat Evaluation Guides (WHEG)

- Pasture WHEG, which is located within the General Land Use WHEGs.

Section 4: Practice Standards and Supporting Documents

Conservation Practice Standards and Supporting Documents Folder

Cover Crops (340)

- Cover Crop Design Tool
- Technical Note 33: Cover Crop Seeding Guide

Pasture and Hay Planting (512)

- Pasture and Hay Planting Seed Tool

Grazing Management (528)

- 528 Grazing Management On-Site Inventory Form
- Clipping Production and Data Record Keeping Worksheet
- Estimating Forage Production to Calculate Carrying Capacity
- Grazing Management Assessment Form
- Grazing Management Plan Template
- Livestock Forage Balance Worksheet
- Livestock Grazing and Forage Utilization Record
- Permanent Photo Point Monitoring Form

Annual Forages for Grazing Systems (810)

- Annual Forages for Grazing Systems Design Workbook
- Technical Note 34: Annual Forages for Grazing Systems

Ecological Sciences Tools

- Strategic Harvested Forage Management Planning Workbook

Engineering Tools

- Livestock Pipeline design tool
- Trails and Walkways design tool