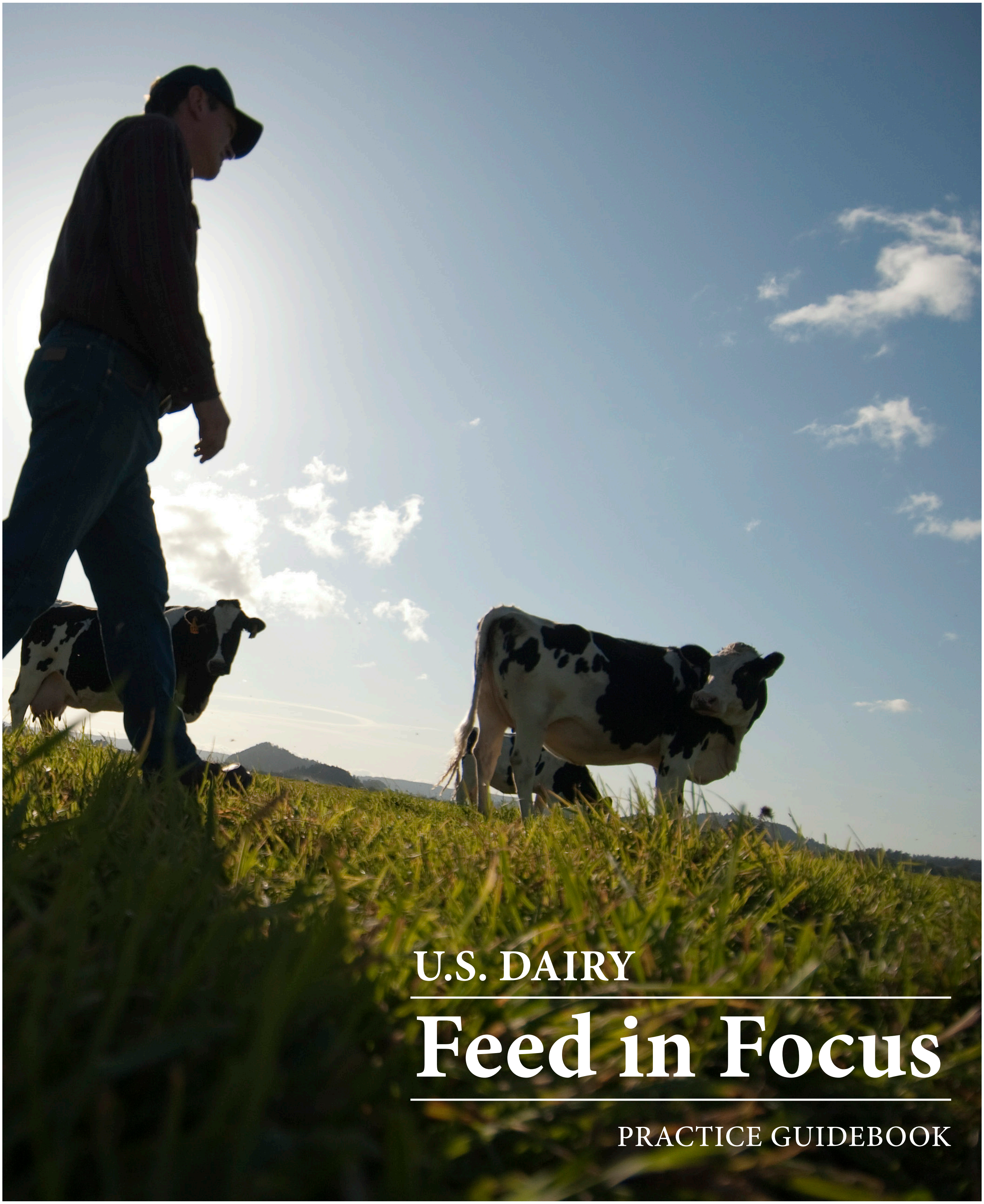

U.S. DAIRY

# Feed in Focus

PRACTICE GUIDEBOOK

syngenta

The Nature Conservancy

U.S. DAIRY NET ZERO INITIATIVE

## Purpose

This guide provides high-level information on the best management practices promoted through the U.S. Dairy Feed in Focus (FiF) program. It is intended to serve as a resource for producers and service providers, and includes clarifications on practice requirements and eligibility, potential environmental and production benefits, and considerations for successful implementation of practices. More detailed information can be found in the links and references provided.

*Cover image © Bridget Besaw/TNC; above, USDA Photo by Preston Keres*

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*Last updated January 2024*


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# Benefits Overview

| CATEGORY | PRACTICE | CLIMATE/ GHG | SOIL HEALTH | WATER QUALITY | WATER QUANTITY | BIO-DIVERSITY | ECON / OPS |
|---|---|---|---|---|---|---|---|
| **Continuous Cover** | Cover Crops – Single or Multispecies (340) or Interseeded Forage (e.g. alfalfa) | ● | ● | ● | | ● | ● |
| | Pasture and Hay Planting (512) | ● | ● | ● | | ● | ● |
| | Native Perennial Cover (327) | ● | ● | ● | | ● | ● |
| **Crop Residue Management** | Reduced Till (345) | ● | ● | ● | | ● | ● |
| | No Till (329) | ● | ● | ● | | ● | ● |
| **Crop Diversification** | Diversified Rotation (328) | ● | ● | ● | | ● | ● |
| **Grazing Management** | Prescribed Grazing (528) | ● | ● | ● | | ● | ● |
| **Edge of Field** | Non-native Vegetation Buffer (386, 390, 512) | ● | ● | ● | | ● | ● |
| | Native Buffer (386, 390) | ● | ● | ● | | ● | ● |
| | Tree/Shrub Buffer (380, 391, 422) | ● | ● | ● | | ● | ● |
| **Nutrient Stewardship** | Improved Nutrient Stewardship – Basic (590) | ● | | ● | | ● | ● |
| | Improved Nutrient Stewardship – Advanced (590) | ● | | ● | | ● | ● |
| **Feed Mgmt & Innovation** | First time use of commercially available, FDA approved or GRAS (Generally Recognized As Safe) status Feed Additives | ● | | | | | ● |
| **Irrigation Management** | Irrigation Water Management (449) | ● | | ● | ● | | ● |
| | Irrigation Package Upgrades / Retrofits | ● | | ● | ● | | ● |

# Continuous Cover

## PRACTICE DESCRIPTIONS

**Cover Crops *(Single, Multispecies, or Interseeded Forage)***

Vegetation planted to maintain soil cover and living roots throughout the year. Includes grasses, legumes, brassicas, or other broadleaves, planted as winter or summer cover crops, or perennial forages such as alfalfa interseeded into annual crops to maintain soil cover and jumpstart production in the following year (see NRCS Conservation Practice Standard (CPS) 340).

**Pasture and Hay Planting**

Establishment of perennial pasture and hay crops for forage production, including at least one perennial grass species. Note: not intended for planting alfalfa in regular rotation (see NRCS CPS 512).

**Native Perennial Cover**

Establishment and maintenance of cool or warm season, native, perennial vegetation primarily to protect soil and water and provide wildlife habitat. Includes prairie restoration, prairie strips, and other conservation cover (see NRCS CPS 327).

## MINIMUM REQUIREMENTS & VERIFICATION

**Cover Crops *(Single, Multispecies, or Interseeded Forage)***

- New cover crop acres only. Fields with cover crops planted in the previous year are not eligible, even if new or multiple species are introduced.

**Pasture and Hay Planting**

- Planting alfalfa in regular dairy feed rotation is not eligible for the incentive.
- Forage planting must contain at least 1 perennial grass species.
- Practice must be maintained through the duration of FiF agreement.

**Native Perennial Cover**

- Ensure proper site prep to increase the likelihood of establishment success.
- Appropriate native species must be used (verified by seed tag).
- Practice must be maintained through the duration of FiF agreement.

*Maintain records of the following for verification purposes:*

- Map(s) of fields/project area with practices implemented
- Seed tags (for purchased seed)
- Photos at planting
- Photos 3-4 weeks after planting showing establishment

## BENEFITS

**Soil Health**

- Reduce water and wind erosion by protecting the soil surface and promoting water infiltration.[1]
- Reduce compaction and/or crusting depending on species and root structure.[2]
- Improve chemical (total C and N; C and N in particulate organic matter; organic matter content; C mineralization rates; nutrient balances), physical (water holding capacity; water infiltration; cation exchange capacity; aggregate stability; bulk density; soil resistance to penetration) and biological (microbial biomass respiration; fungi/bacteria ratios) parameters of soil quality.[1]

### Climate

- Roots, leaf litter, and other plant tissues left in and on the soil following cover crops feed bacteria, fungi, earthworms and other soil organisms, which accumulate soil carbon over time.[3]
- Biological N fixation by legume cover crops can reduce the need for synthetic fertilizers, and associated GHGs from their manufacturing and use.[4]
- Well-managed perennial pasture can build soil C faster than row crops.[5]

### Water Quality

- Reduced erosion and increased water infiltration lead to decreased runoff, resulting in a reduction in nutrient, pesticide, and antibiotic loads to waterbodies, reducing water pollution.[1]

### Biodiversity

- Improved forage and habitat for overwintering birds.[6]
- Potential for improved floral resources and habitat structure for pollinators and other beneficial insects.[7]

### Economic & Operational

- Suppress soil diseases and reduce weed pressure.[8]
- N credits from legume cover crops can reduce the need for synthetic N.[9]
- Can be used as an additional feed source for livestock (see Grazing Management).[10]

## CONSIDERATIONS FOR SUCCESS

### Cover Crops

- Determine main objectives for cover crops to inform species selection (i.e., build fertility, reduce soil erosion or compaction, weed suppression, biodiversity, C sequestration, forage quality). The Midwest Cover Crop Selector tool is useful for this purpose.
- Consider how cover crops may fit into a broader conservation management system (diverse crop rotation, reduce or no-tillage).
- Other management decisions include: seeding rate, timing and method of planting (interseeding vs. post-harvest, drilling vs. aerial vs. broadcast); timing and method of termination (chemical vs. mechanical, planting green, etc).
- It is recommended to account for any nitrogen credit provided by cover crops when calculating next year's fertilizer needs.[4]

*Cover crops build soil organic matter and improve soil structure, which can help farm fields better withstand drought, floods, and other increasingly unpredictable and extreme weather. Credit: NRCS/SWCS photo by Lynn Betts.*

**Hay and Forage Planting**

- Consult with state-specific resources (University Extension, NRCS) to determine locally suitable species mixes to meet site conditions and nutritional needs of animals.

**Native Perennial Cover**

- Careful site prep and routine maintenance in the first 1-3 years are crucial for the establishment of native grasses and forbs on disturbed areas, as these species tend to be slow-growing and less competitive compared to introduced species. Consult with local experts (Extension, NRCS, native plant nurseries) for best establishment and maintenance practices to ensure success.

## ASSOCIATED COSTS

Cost estimates for establishment and management:

Cover Crops – SARE 2019

- Seed, seeding, and termination: $37/acre

Hay and Forage – Michigan State 2012

- Seed, inputs, labor: $407/acre

## ADDITIONAL RESOURCES

**Cover Crops**

- Midwest Cover Crop Council Selector Tool
- SARE: Creating a Baseline for Cover Crop Costs and Returns
- Cover Cropping for Pollinators and Beneficial Insects

**Hay and Pasture Planting**

- Hay and Pasture Seeding Rate Calculator
- MSUE Bulletin E-3309: Recommended Hay and Pasture Forages for Michigan

**Native Perennial Cover**

- Iowa STRIPS Management

*By planting winter cover crops, producers can build soil health and productivity, protect the the soil surface from erosion, and improve downstream water quality. © David Ike*

# Crop Residue Management

## PRACTICE DESCRIPTIONS

**Reduced Till**

Limiting soil-disturbance from tillage while managing a minimum coverage of residues on the soil surface year-round. Includes tillage methods where a majority of the soil surface is disturbed by noninversion tillage operations such as vertical tillage, chiseling, and disking. Includes strip tillage (see NRCS CPS 345).

**No-Till**

Limiting soil disturbance further by seeding directly into untilled soil and managing residues on the soil surface year-round (see NRCS CPS 329).

> ***Note: Incentive payments for reduced and no-till may be requested in advance of implementation, to allow for up-front investment in necessary equipment.***

## MINIMUM REQUIREMENTS & VERIFICATION

**Reduced Till**

- Maintain records of all field operations that affect soil surface disturbance and distribution of residue.
- At least 30% of soil residue cover in a field must be maintained.
- Inversion tillage methods may not be used.

**No-Till**

- Maintain records of all field operations that affect soil surface disturbance and distribution of residue.
- No full-width soil disturbance performed, regardless of the depth of the tillage operation.
- Soil disturbance may occur during the planting operation or to place fertilizer.

*Maintain records of the following for verification purposes:*

- Map(s) of fields/project area with practices implemented
- Photos before and after cash crop planting
- Receipts for rented or purchased equipment

## BENEFITS

**Soil Health**

- Increase water-holding capacity, infiltration, microporosity, and aggregate stability, and favors formation of more stable long-term humic compounds. [10]
- Maintain soils cooler in summer, reducing soil water evaporation and enhancing root growth and activity. [11]
- Potential to reduce soil compaction, erosion and organic matter mineralization. [12]

**Climate**

- Potentially lower carbon dioxide ($CO_2$) emissions with no-tillage than conventional tillage with incorporation due to slower decomposition of residue on soil surface, though this depends on specific practices, crop species and soil properties. [13,14]
- Increases rate of soil organic matter accumulation and carbon sequestration. [13]
- Reduces the number of passes over a field , decreasing fuel use and particulate matter emissions. [15]

**Water Quality**

- Reduces soil erosion and non-point source pollution. [15]

**Water Quantity**

- By increasing soil water-holding capacity, improve water availability in subsequent cash crops. [15]

**Biodiversity**

- No-tilled fields support higher bird abundance and diversity compared to conventionally tilled fields.[16]

**Economic & Operational**[15]

- Reduces overall machinery costs (reduces fuel, depreciation and repair, and operator costs)
- Reduces labor cost by reducing labor time.

## CONSIDERATIONS FOR SUCCESS

Determine which approach makes the most sense for your context:

- **No-tillage:** Seed directly into untilled fields, usually accompanied with herbicide application, with considerable reduction in labor, time and overall improvement of soil quality in the mid- and long-term
- **Reduced tillage:** Strip tillage, zone tillage, ridge tillage
- May be an attractive alternative or transition practices for operations not prepared to switch directly from conventional to no-till systems.
- **Zone tillage:** Targeted tillage in areas with poorly drained soils where appropriate.
- Use tillage methods that align with preferred methods for manure incorporation.
- Residue should not be shredded as it can make it more susceptible to movement by wind or water, and cause accumulation in areas than can impact the following crop.
- To alleviate potential long-term soil compaction in no-till soils, minimize field work when soil is wet and maintain proper tire inflation on implements.

## ASSOCIATED COSTS

- May require increased weed management costs (e.g., herbicide use, harvest weed seed control equipment, mowing operations, etc.).
- Potentially higher fertilizer needs short-term in no-till systems due to greater nutrient immobilization by soil microbes and lower soil mineralization.

## RESOURCES

University of Wisconsin: Strip Tillage - A conservation option for Wisconsin farmers

*Leaving crop residue on the surface through reduced or no tillage protects against erosion and can lead to increased carbon storage in soils and lower nitrous oxide emissions, all while saving on fuel and labor. Credit: USDA-RCS/Tracy Robillard*

# Crop Diversification

## PRACTICE DESCRIPTION

**Diversified Rotation**

Diverse dairy feed crop rotations including at least three different crops in three years, one of which must be new to the rotation (see examples in Considerations for Success). Diversification can occur spatially (e.g., strip-cropping) or temporally (seasonally). (see NRCS CPS 328).

## MINIMUM REQUIREMENTS & VERIFICATION

- Fields are eligible for incentive only if a *new* crop(s) is added to the rotation on that field.
- If alfalfa is already included in a dairy feed rotation, alfalfa may not count towards the diversification practice. A substitution for or an addition of a more diverse forage crop would count.
- If strip-cropping, at least 50% of the acreage must be in erosion-resistant crops or cover.

*Maintain records of the following for verification purposes:*

- Map(s) of fields/project area with practices implemented
- Seed tags (for purchased seed)
- Photo of each crop in rotation six weeks after planting

## BENEFITS [17-22]

**Soil Health**

- High-productivity crops and covers can reduce soil compaction and erosion, increase organic matter accumulation, conserve water, and increase overall soil health. [17,18]
- Alternating shallow and deep-rooted plants over time builds fertility at varying depths and avoids the buildup of compaction layers. [19]

**Climate**

- Decrease emissions associated with fertilizer and increase, depending on crop selection, diversity, climate, and soil type. [17]

**Water Quality**

- Rotations with hay and legumes can reduce need for fertilizer and pesticides inputs, reduce erosion, and increase water infiltration, leading to improved water quality. [18]

**Biodiversity**

- Crop diversity within and between years and across the landscape can create more habitat and food resources for wildlife. [20]

**Economic & Operational**

- Break pest and disease cycles, including weeds. For example, perennial weed problems in corn (even resistant weeds) can be controlled by rotating a field to small grains and controlling them in late summer, or to hay where frequent cuttings can be effective in control. [18,19]
- Can maintain or increase overall productivity. [17]
- Different crops allow for better distribution of labor and more efficient use of machinery across different crop growing seasons.[18]

© Alita Films

"Italian ryegrass is the most exciting change we've made. It's a plant that needs no commercial fertilizer or pesticides. We utilize it as a feed for one year, then leave it in place as a cover crop. We're trying to emulate nature in how we farm."

THEO SCHOLZE,
WISCONSIN DAIRY FARMER

- Diverse crops can allow access to new and specialty markets.[18]
- Diverse rotations reduce financial risk due to the "portfolio effect," as different crops respond differently to abiotic and biotic stresses. [19]
- Potential to reduce pesticide and fertilizer use.[17]

## CONSIDERATIONS FOR SUCCESS

**Examples of eligible crop rotations in dairy feed systems:**

- Incorporation of grain or forage sorghum/sudangrass into feed crop rotation

**If currently in a continuous corn system:**

- Adding a legume or cover crop to rotation
- Double-crop corn following hay, rye, triticale or barley

**If currently in a corn-alfalfa rotation:**

- Substituting or adding a hay or pasture mix that includes at least one grass
- Including oats followed by cover crop forages in rotation
- Choose a crop rotation system that considers the following: meets feed requirements, matches labor availability, makes use of nutrients from manure, breaks pest cycles, and minimizes soil erosion. Prioritize benefits that are the most meaningful for your operation and plan accordingly.
- Sequence crops to avoid any potential unwanted interactions (I.e., avoid alleopathic effects of cereal rye)
- If necessary, consider adjusting rations to take advantage of feedstuffs that can be produced economically in the rotation.
- Consider crops that are best matched to your soil's potential, and don't require unnecessarily high input costs. For example, corn grows better on poorly drained fields than alfalfa. Small grains, alfalfa, and soybeans may do better in droughty soils.
- Plan and account for nutrient credits from rotations (e.g., corn following soybean can produce yields about 8-10% greater than those planted following corn, and corn following hay can produce 1-15% greater yields with much less N and insecticide inputs.)
- If excess N from manure is an issue, double cropping rye with corn or sorghum can help remove large amounts.
- Maintain flexibility when planning a crop rotation and adapt to unexpected challenges in feed requirements or crop production.
- Proper crop rotation planning can enhance the effectiveness of no-till systems by managing residue over long-term periods.
- In strip-cropping systems, consider planting strips of erosion resistant crops, such as hay or legumes, perpendicular to the direction of most wind or water erosion potential.
- Perform annual soil tests for pH, organic matter, and nutrient status [20]

## ASSOCIATED COSTS

- More intensive machinery use, potentially additional machinery needed, if more crops are included in the rotation.
- Increased labor to manage additional crops.
- Cost of establishment and termination for cover crops if included in rotation.

## RESOURCES

Penn State Extension – Crop Rotation Planning for Dairy Farms
Wisconsin Integrated Cropping Systems Trial (WICST)

# Grazing Management

## PRACTICE DESCRIPTIONS

**Grazing Management Plan**

Developing a plan to graze livestock in a manner that provides quality feed for livestock while considering the optimal timing, duration, and intensity of grazing to promote vegetation regrowth, forage quality year after year, and protection of natural resources in and near grazing paddocks (see NRCS CPS 110).

**Prescribed Grazing**

Implementation of the Grazing Management Plan to enhance pasture condition and ecosystem function as well as optimize efficiency and economic return through monitoring and record keeping (see NRCS CPS 528).

**Grazing Infrastructure**

Infrastructure that enables livestock grazing to meet the desired outcomes in a Grazing Management Plan, including permanent or temporary fencing, water development, and other equipment or structures with demonstrated need (see NRCS CPS 382, 516, 614).

## MINIMUM REQUIREMENTS AND VERIFICATION

**Grazing Management Plan**

- Grazing Management Plan (GMP) should be developed in consultation with an approved, qualified expert (e.g. NRCS grazing specialist, Technical Service Provider (TSP), grazing consultant, or University Extension staff)
- GMP should include at minimum these 6 core components (from US Roundtable for Sustainable Beef):
    - Resource Inventory
    - Goals and Objectives
    - Stocking Rate
    - Pasture Utilization and Management
    - Wildlife Resource Inventory and Management
    - Contingency Plan

*Maintain records of the following for verification purposes:*

- Invoice from plan writer
- Digital copy of plan

**Prescribed Grazing**

- Eligibility requires documentation of an approved Grazing Management Plan
- Animals should be rotated through multiple paddocks based on nutritional demands and forage availability, allowing for adequate plant rest and recovery, and in a manner that protects natural resources.
- Short and/or long-term monitoring should be conducted (e.g. photo points, dry matter availability estimates, or forage clipping), and records of animal rotation should be kept (stocking density, dates).

*Maintain records of the following for verification purposes:*

- Record of stocking rate and dates of actual animal moves
- Photos documenting rotation

**Grazing Infrastructure**

- Eligibility requires documentation of an approved Grazing Management Plan.
- Evidence of need must be documented.
- All infrastructure should meet state-specific NRCS specifications or other pre-approved design.

*Maintain records of the following for verification purposes:*

- Receipts for infrastructure costs
- Photos of installed infrastructure

## BENEFITS

### Soil Health

- Well-managed grazing promotes soil structure, soil cover, and accumulation of organic matter that improves soil health.[21]

### Climate

- Soil carbon and nitrous oxide loss are reduced under rotationally grazed, perennial pastures compared to row crop production[22], and soil carbon sequestration is greater[5], however rations must be optimized to maintain milk production to achieve overall GHG reductions.[22]
- Higher pasture quality achieves a higher average metabolizable energy (ME) content, leading to higher feed efficiency and lower CH4 emissions. Feeding less, higher-quality forage requires less N-fertilizer, so GHG emissions from the fertilizer manufacturing process are also reduced.[23]

### Water Quality

- Improving pasture productivity and soil water infiltration through managed grazing can reduce erosion, runoff, and non-point source pollution.[22]

### Biodiversity

- Rested paddocks in rotational grazing provide undisturbed nesting habitat for birds.[24,25]
- Planting diverse pasture forages with forbs and legumes, and maintaining diversity through prescribed grazing, provides floral resources for pollinators and other insects.[25]

### Economic & Operational

- When properly managed, grazed forage is higher in feed value than hay or silage because harvesting is frequent and there are little or no harvest or storage losses.[27]
- Grazing animals on pasture can reduce the economic costs of feeding through savings on machinery cost, fuel, labor, purchasing supplemental feed and feed loss.[26]
- Maintaining high-quality pastures reduces herd health problems, lowering vet bills and animal replacement costs.[21]
- Well managed grazing can improve animal production per unit area of grazing land.

*Well-managed grazing on improved pastures can provide a valuable feed source, create new economic opportunities, and provide valuable habitat to wildlife and beneficial insects.Credit: Keith Weller/USDA*

## CONSIDERATIONS FOR SUCCCESS

- GMPs do not have to be lengthy or complicated to be effective. Improvement is a continuous process.
- GMPs and prescribed grazing should be flexible and adaptable, with decisions based on forage availability, plant growth stage, and nutritional demands of animals, rather than calendar days.
- Consider taking advantage of annual forage crops, crop residue, and cover crops as components of a grazing system, in order to maximize available forage and the economic potential of related conservation practices.
- Grazing replacement heifers can be an accessible introduction to incorporating grazing into farms of any size, reducing overall cost to raise replacements and improving animal health at calving.[26]

## ASSOCIATED COSTS

- May be more labor-intensive than a continuous stocking system.
- Requires more fencing and water infrastructure.

## RESOURCES

- SARE: Grazing Heifers: An Opportunity for Large Dairy Farms
- Green Lands Blue Waters: Managed Grazing for Dairy Profits

*Aged grazing promotes soil structure, soil cover, and accumulation of organic matter that improves soil health. © Patrick Flood*

# Edge of Field

## PRACTICE DESCRIPTIONS

**Non-Native Vegetation Buffer**

Composed of introduced (non-native), perennial species, a harvestable buffer that provides a transition zone between the crop field and a water feature to provide a number of beneficial ecosystem services (see NRCS CPS 386, 390, 393, 412).

**Native Vegetation Buffer**

Composed of native, perennial species, an area of non-crop vegetation on field edges, along waterways, or in pivot corners that provides a number of ecosystem services including wildlife habitat (see NRCS CPS 386, 390, 512).

**Tree/Shrub Buffer**

Buffers along field edges and waterways comprised of woody vegetation (trees and shrubs) that provides numerous ecosystem services, including wildlife habitat and carbon sequestration (see NRCS CPS 380, 391, 422).

## MINUMUM REQUIREMENTS & VERIFICATION

**Non-Native Vegetation Buffer**

- Buffer must be a minimum 30' width.
- Species selection and plan for establishment should be in consultation with qualified expert (e.g. NRCS Conservation Planner, University Extension, Restoration Contractor) to meet desired ecosystem and forage outcomes.
- Ensure proper site prep to increase likelihood of establishment success.
- Practice must be maintained through the duration of FiF agreement.

**Native Vegetation Buffer**

- Buffer must be a minimum 30' width.
- Species selection and plan for establishment should be in consultation with qualified expert (e.g. NRCS Conservation Planner, University Extension, Restoration Contractor) to meet desired ecosystem and forage outcomes.
- Ensure proper site prep to increase likelihood of establishment success.
- Appropriate native species must be used (verified by seed tag).
- Practice must be maintained through the duration of FiF agreement.

**Tree/Shrub Buffer**

- Species selection and plan for establishment should be in consultation with qualified expert (e.g. NRCS Conservation Planner, University Extension, Restoration Contractor) to meet desired ecosystem and forage outcomes.
- Buffer must be a minimum 30' width.
- Maximum size for Tree/Shrub Buffer incentive is 1 ac.
- Ensure proper site prep to increase likelihood of establishment success.
- Ensure appropriate spacing to account for requirements of fully grown trees and shrubs.
- Appropriate native species must be used (verified by seedling tags/receipts).
- Practice must be maintained through the duration of FiF agreement.

*Maintain records of the following for verification purposes:*

- Map(s) of fields/project area with practices implemented
- Seed/seedling receipts
- Photos of site prep and post-planting

## BENEFITS

### Climate

- Planting perennial vegetation, especially woody trees and shrubs, in edge of field and marginal land can increase net carbon storage in biomass and soil. [28]

### Water Quality

- Vegetation growing in the buffer slows surface runoff, filters out pollutants and reduces bank erosion.[29]

### Biodiversity

- Establishment of perennial vegetation, especially native species, creates food sources, shelter, and space for wildlife and beneficial insects in the agricultural landscape.[29]
- By improving water quality, in-stream and down-stream biodiversity can benefit.[29]

### Economic and Operational[30]

- By taking marginal land out of production, labor and inputs can be focused on acres with higher production potential, which can improve overall economics of operation.
- Non-native harvestable buffers can provide livestock forage, or sold as a direct source of income.

"On our farm, a harvestable buffer strip is a diverse species mix along a waterway or stream that we harvest to feed our cattle. Our harvestable buffer encompasses 2.25 linear miles of waterways on our farm, helping us reduce nutrients from entering our drainage system."

JAMES WEBER,
MICHIGAN DAIRY FARMER

© *Fauna Creative*

*Trees and shrubs, native vegetation, and harvestable buffers planted in field edges and other marginal land capture runoff to improve water quality, sequester carbon, and provide important habitat for wildlife in the agriculture landscape. Credit: Charlie Rahm/USDA-NRCS*

## CONSIDERATIONS FOR SUCCESS

- Consult with state specific resources (University Extension, NRCS) to determine locally suitable species mixes to meet site conditions and nutritional needs of animals.
- Careful site prep and routine maintenance in the first 1-3 years is crucial for establishment of native grasses and forbs on disturbed areas, as these species tend to be slow growing and less competitive compares to introduced species. Consult with local experts (Extension, NRCS, native plant nurseries) for best establishment and maintenance practices to ensure success.
- Protect woody seedlings with tube protectors or other means to shield against herbivory in establishment years.
- Install drip irrigation or sprinklers to water young seedlings for 1-3 years after establishment to ensure success even in unexpected drought conditions.

## ASSOCIATED COSTS

- Establishment and maintenance of edge of field buffers.
- Marginal land taken out of crop production.

## RESOURCES

Iowa Learning Farms – Edge of Field

# Nutrient Stewardship

## PRACTICE DESCRIPTIONS

**Nutrient Management Plan**

Creating a plan to optimize crop yields while reducing the amount of nutrients lost to the environment. The plan should incorporate the 4Rs of Nutrient Stewardship, ensuring nutrients are applied from the right **source**, at the right **rate**, right **time** and right **place**. (NRCS CPS 102, 590)

**Improved Nutrient Stewardship - Basic**

Implementing strategies and technologies from the Nutrient Management plan to improve nutrient use efficiency and minimize loss from soil on farm. The Basic scenario is based on a nutrient management budget developed for each field based on soil tests, crop removal rates, and recommended application rates. (NRCS CPS 590)

**Improved Nutrient Stewardship – Advanced**

Implementing strategies and technologies from the Nutrient Management plan to improve nutrient use efficiency and minimize loss from soil on farm. The Advanced scenario goes beyond Basic nutrient management to include precision management technology and practices that further maximize nutrient use efficiency and reduce loss to the environment. Zone based management decisions are based on advanced nutrient/soil tests such as PPSN (pre-plant soil nitrate test), PSNT (pre-side dress nitrogen test), or CSNT (corn stalk nitrate test). Precision nutrient application is achieved through practices such as manure incorporation, variable rate application, split applications, etc. (NRCS CPS 590)

**Nutrient Stewardship Infrastructure**

Infrastructure that enables improved nutrient stewardship is eligible for reimbursement to offset initial investment in management changes. This includes variable rate modeling software, yield monitor system components, manure constituent sensors, canopy sensors, Y-drop systems, irrigation flow meters (for fertigation), and other infrastructure approved case by case.

## MINIMUM REQUIREMENTS AND VERIFICATION

**Nutrient Management Plan**

- Development of an NMP is eligible for reimbursement if an NMP currently does not exist for the planned field(s), the existing NMP is more than 5 years old, or an existing plan needs to be updated to achieve a higher level of Improved Nutrient Stewardship (e.g. Basic to Advanced).
- NMP should be developed in consultation with an approved, qualified expert (e.g. Certified Crop Advisor, NRCS TSP or Conservationist, or University Extension staff).
- NMP should include at minimum:
    - Farmstead, Production Areas:
        - Manure Imports & Exports
        - Manure Transfer Plan
    - Crop and Pasture Production
        - Field Maps w/ Field Names
        - Map of sensitive areas with appropriate setbacks
    - Nutrient Management
        - Nitrogen & Phosphorus Risk Index
        - Soil Test Analysis
        - Manure Test Analysis
        - Crop Plan
        - Nutrient Application Plan

*Verification is required and may include one or more of the following:*

- Invoice/receipt from plan writer
- Digital copy of plan
- Lab invoices
- Evidence towards implementation

**Improved Nutrient Stewardship - Basic**

- Requires documentation of an approved, existing or new, NMP.
- Operations required by regulation to have an NMP are not eligible for Basic scenario.
- Fields are eligible for Basic incentive if nutrient management is implemented a higher level than is currently adopted.
- Maintain records demonstrating implementation of the 4 R's.
- Maintain records of current soil tests, application rates, and forms of nutrients for each field, including crop yields.

*Maintain records of the following for verification purposes:*

- Dates/records of nutrient application
- Receipts where applicable

**Improved Nutrient Stewardship – Advanced**

- Requires documentation of an approved, existing or new, NMP.
- All requirements in Basic scenario must be met (see above).
- Fields are eligible for Advanced incentive if precision nutrient management is implemented at higher levels than are outlined in the Basic scenario/currently adopted.
- Maintain records of advanced soil test results, application rates by management zone, application methods.

*Maintain records of the following for verification purposes:*

- Dates/records of nutrient application
- Receipts where applicable

**Nutrient Stewardship Infrastructure**

- Requires documentation of an approved, existing or new, NMP which demonstrates the need for requested infrastructure or equipment.

*Maintain records of the following for verification purposes:*

- Evidence of need
- Receipts for purchases/rentals

## BENEFITS

**Climate** [31]

- Reduce volatilization and denitrification losses from applied fertilizer.
- Potential to decrease the applied amount of synthetic N fertilizers through improved nutrient management.

**Water Quality**[32]

- Reduce nutrient concentration and loads in runoff water to waterbodies, reducing water pollution and algae blooms.
- Reduce movement of potential pathogens from manure to waterbodies and aquifers.

**Biodiversity** [32]

- Reducing movement of potential pathogens and high nutrient loads to waterbodies and aquifers can positively affect downstream biodiversity.

**Economic & Operational**[33]

- Implementing an NMP on acreage receiving excess nutrients results in a net savings of $23.77 to $49.76 per acre (average $29.28).
- Potential reduction in the number of applications needed during crop cycle, reducing fuel and labor costs.

## CONSIDERATIONS FOR SUCCESS

**Source**

- Supply nutrients in plant available forms or forms that will convert timely to plant available.
- Consider soil properties and their effects on nutrient source.
- Liquid vs. solid manure, liquid vs granular synthetic fertilizer.
- Determine manure composition before applying (e.g., % organic and inorganic, N, P, K, etc.).
- Consider using slow and controlled release fertilizers (urease and nitrification inhibitors) where applicable.

**Rates**

- Soil test annually when possible and consider plant tissue sampling to evaluate nutrient demands.
- Use nutrient mass balances, including micronutrient balancing to ensure good NPK plant uptake.
- Consider crops nutrient requirements, N credits from cover crops, soil nutrient availability, mineralization rates and potential nutrient losses when determining application rate.
- Use spatial yield and other data to inform variable rate application within a field (zone management).
- Use realistic yield targets and available information on nutrient use efficiency to aim for economically optimum application rates.

**Timing**

- Nutrients should be applied to match seasonal crop demands.
- Consider optimal timing for application: pre-plant, sidedress, foliar application, etc.
- Consider timing to avoid excess soil nutrient loss (ie. leaching likely to be greater in spring and fall).

**Place**

- Determine spatially explicit nutrient needs in fields or zones.
- Consider different application methods to position nutrient supplies where plant has access to them.
- Opportunities and potential tradeoffs of applying on surface vs. incorporation vs. injection.
- Subsurface placement should consider maintaining crop residue to conserve nutrients and water.
- For soil retained nutrients like P, consider band application to concentrate nutrients where they will be most available to crops.

*Effective management and application of essential crop nutrients can minimize input costs, reduce greenhouse gas emissions, and improve water quality of groundwater and nearby waterways. © Shutterstock/Fotokostik*

## ASSOCIATED COSTS

- More frequent and more advanced soil, manure, and plant tissue testing.
- Potentially additional manure transport on or off farm.
- Sensors and software to better inform demands and optimal application strategies.

## RESOURCES

4R Nutrient Stewardship – Principles, Benefits, Implementation, Resources
Nutrient Management Fact Sheet: Wisconsin [76]
SnapPlus Nutrient Management Software [14]

# Feed Management and Innovation

## PRACTICE DESCRIPTIONS

**Feed Management Plan**

Creating a plan with your nutritionist to balance the ration and control the quantity and quality of available nutrients, feedstuffs, or additives fed to livestock with a focus on feed efficiency optimization and GHG emissions reduction while maintaining animal health, well-being, and productivity (see NRCS CPS 592).

**Use of Feed Additives**

First time use of feed additives commercially-available in the U.S. that reduce enteric methane emissions and/or provide feed efficiency benefits. Such eligible products include products containing **tannins** (such as Silvafeed® ByPro), **essential oil blends** (such as Agolin® Ruminant), **ionophores** (such as Rumensin®), **and medium-chain or polyunsaturated lipids** (e.g. coconut, linseed and cottonseed oils).

> **Note:** While not eligible for incentives through Feed in Focus, it is recommended to consider including feed ingredients (improved hybrid varieties, alternate feedstuffs, etc.) in the ration that further improve feed efficiency and may lower the carbon intensity of milk production. These include but are not limited to feed ingredients with high nutrient digestibility (e.g., Enogen®, HarvXtra® alfalfa, Bovalta® BMR corn silage, etc.).
>
> **DISCLAIMER:** The Nature Conservancy does not endorse the use of any commercial products, nor is TNC making claims about their enteric emissions reduction, production or performance enhancement potential.

**Feed Management Enables**

Replacing, maintaining, or calibrating feed mixing, delivery and storage equipment, infrastructure, and products that enable precision feed management in accordance with the Feed Management plan above. This includes feed testing devices or analyzers, delivery management software, robotic feed pushers, forage inoculants, feed preservatives, oxygen barrier films for silage, and additional components approved on a case-by-case basis.

## MINIMUM REQUIREMENTS AND VERIFICATION

**Feed Management Plan**

- Feed Management Plans should be developed in consultation with qualified personnel such as a nutritionist, certified Professional Animal Scientists, or veterinarians with knowledge of feed management principles.
- The Feed Management Plan should optimize resource use by:
  - Balancing homegrown vs purchased forage/feed
  - Improving forage/feed ration quality
  - Encouraging precision feeding
  - Considering the use of feed supplements, additives, and/or alternative feed ingredients.

*Maintain records of the following for verification purposes:*

- Digital copy of plan, including ration formula
- Evidence towards implementation of plan

**Use of Feed Additives**

- First-time use of feed additives will be incentivized. Switching from one feed additive to another will be evaluated on a case-by-case basis.
- Feed additives must be commercially available, and FDA approved or GRAS (Generally Recognized As Safe).
- Feed additives must have literature supporting their potential to decrease enteric methane emission and/or improve feed efficiency.

*Maintain records of the following for verification purposes:*

- Receipts for purchase of feed additives

**Feed Management Enablers**

- To be eligible for reimbursement, components must directly support improved feed management.

*Maintain records of the following for verification purposes:*

- Evidence of need for repair, calibration or purchase of equipment
- Receipts for new equipment, parts, and labor

## BENEFITS

**Climate**

- Improved feed efficiency (increased milk yield without any change in feed intake or no change in milk yield with a decrease in feed intake) will reduce methane production (kg CH4 per day) and/or emission intensity (kg of CH4 per kg of milk).[35]
- High-concentrate diets have a higher digestibility compared to forage–based diets, supporting higher milk yield and thus reducing enteric methane emission intensity (kg of CH4 per kg of milk).[34,35]
- Use of certain feed ingredients or additives or supplements have direct or indirect impact on CH4 emissions with additional benefits to animal health.
- Optimization of dietary crude protein and amino acids requirements improves N use efficiency, reducing the potential of nitrous oxide emissions via reduction in the excretion of fecal and urinary N.[34,36]
- Certain feed additives could reduce the ratio of urinary N:fecal N, reducing the formation and potential emission of nitrous oxide. [34,37]

**Water Quality**[38]

- Reduced excretion of nutrients in manure prevents excess nutrient loading in surface and groundwater.
- Water quality is improved through reduction in pathogens and chemicals from manure, biosolids or compost applications.

**Economic and Operational**

- Optimized feed management can increase farm profitability.[39]
- Feed management can reduce odor and particulate matter from feeding operations.
- Feeding high-quality (highly digestible) feed (usually forages) will minimize the amount of feces (and thereby manure) generated, reducing the acres of land required to spread manure.[40]
- Certain feed additives improve gut as well as overall animal health, minimizing the use of antibiotics in addition to improving feed and nutrient use efficiency, and improving animal welfare.

*By optimizing feed rations, using appropriate feed additives, and improving feed storage and delivery, the GHG footprint of dairy operations can be greatly reduced. © Paige Frautschy/TNC*

## CONSIDERATIONS FOR SUCCESS

- Use professional animal scientists or nutritionists or other certified personnel to develop, update, and review Feed Management Plans. Some considerations to discuss with consulted experts:
  - Target optimization of feed and nutrient use efficiency as a farm goal (too high efficiency is not always good and low is not always bad - look for economic sustainability)
  - Efficiency can be improved by feeding cows to more precisely meet their nutrient requirements during different stages of growth and production
  - Modify diets to adjust dietary nutrient levels to meet specific genetic potential, environmental demands, and requirements to ensure health, well-being, and productivity
  - Use of improved varieties of forages that can increase whole plant digestibility
  - Regular analysis of feed to adjust diets for changes in chemical composition of the feeds being fed
  - Follow a feeding recommendation such as National Research Council (NRC), National Academics of Science, Engineering, and Medicine (NASEM), and Cornell Net Carbohydrate and Protein System (CNCPS)
- Consider one or more of the following feed management practices and/or diet manipulation technologies to optimate environmental, animal, and economic outcomes:
  - Precision feeding (i.e. feeding to closely match animals' nutrient requirements)
  - Consider group feeding: animals are grouped based on their physiological or production stages
  - Implement phase feeding based on animals' lactation status
  - Reduce phosphorus content of the diet of ruminants when phosphorus is being overfed
  - Reducing or eliminating phosphorus supplements
  - Use feed ingredients which are low to moderate in phosphorus concentration
  - Reduce protein (usually crude protein) in ruminant diets by formulating rations to meet rumen nitrogen and amino acid requirements
  - If possible, formulate diets to meet metabolizable protein requirements (may not be always possible or feasible)
  - Use feed (primarily forages but concentrates as well) grown on the farm to promote a closed nutrient cycle
  - Use highly digestible feeds and forages, as appropriate, in the diet
  - Use selected scientifically supported enzymes or other products, such as seed technologies, to enhance feed digestibility or feed use efficiency
  - Increase the proportion of concentrates in the diet (usually works when inclusion rate is >40% of dry matter intake
  - Add or increase dietary fat (need to make sure that it does not lead to depressed feed intake and this practice could be expensive)
  - Use dietary supplements such as ionophores and plant bioactive compounds e.g. tannin and saponin
- Optimize feed management and delivery by:
  - Monitoring and adjusting stocking density (number of freestalls per cow) to avoid overcrowding
  - Delivering fresh feed more frequently (two times a day or more) to stimulate eating behavior, reduce sorting and avoid slug feeding (rapid consumption of large amounts of concentrate in one meal)
  - Frequent feed push-up (pushing feed closer to animals between feedings to provide continuous access) also stimulates eating but to a lower extent than fresh feed delivery
  - Accurately measuring feed ingredient weights and following mixing equipment directions (for example, mixing time, mixer load capacity limits)
  - Establishing a routine or procedure for consistently mixing and delivering feed every day
  - Examining feed refusals for evidence of extensive feed sorting and selective consumption of concentrate
  - Maintaining an abundant supply of clean, cool, and pure water and analyze water to determine nutrient content in and take into consideration when formulating diet to meet animals' nutrient requirement.
  - Providing sufficient bunk space, preferably with a physical partition (for example, headlocks) to allow animals to eat simultaneously
  - Designing bunks and feeders to reduce feed waste
  - Use feed management software and equipment to monitor and evaluate: Feed delivery and refusals by pen
  - Monitor and implement solutions to reduce feed shrink in stored feed ingredients
- Measure/estimate the impact of feeding management practice/strategy:
  - Determine nutrient use and excretion using manure analyses or calculated nutrient intake and excretion rate.
  - Calculate nutrient mass balances at the farm level.

## ASSOCIATED COSTS

- Feed and manure analysis to support management plan and precision feeding.
- Purchase of potentially more expensive feed ingredients and additives.
- Potential for increased labor for precision feed management.

## RESOURCES

- Feed Management Plan Development and Implementation Flow Chart
- Dairy Extension Resources. University of Wisconsin-Madison
- Opportunities to Improve Starch Digestibility. University of Wisconsin-Madison
- Feed Management Plan Checklist
- Wisconsin Procedures for Soil Testing, Plant and Feed & Forage Analysis


*Producers can increase farm profitability through optimized feed management. © Alisha Staggs/TNC*

# Irrigation Management

## PRACTICE DESCRIPTION

**Irrigation Water Management (IWM)**

Developing and implementing a precision irrigation plan to match irrigation supply to crop demands, by defining the timing and application rate of irrigation events (see NRCS CPS 449).

**Irrigation Package Upgrades/Retrofits**

Updating, repairing, and retrofitting existing irrigation systems to increase water and energy efficiency. Includes low pressure nozzles, LEPA, LESA packages, components of Variable Rate Irrigation systems, and additional upgrades as approved (see NRCS CPS 442).

**Irrigation Water Management (IWM) Facilitating Infrastructure**

Infrastructure that enables improved Irrigation Water Management as described in the plan above, including soil moisture sensors, flow meters, pump timers, pivot controllers, data loggers, software, and additional components with demonstrated need.

## MINIMUM REQUIREMENTS & VERIFICATION

**Irrigation Water Management**

- If an IWM plan exists, must demonstrate an improvement or more advanced plan to be eligible for incentive.
- IWM plans should include, at minimum:
  - Map of irrigation system, planned crops, pipelines, pivots, location of soil moisture sensors, gauges, or other sensors.
  - Methods to determine flow rate and amount of water applied.
  - Methods to determine timing and amount to apply in each irrigation event.
  - If soil moisture sensors are used, explanation of how data will inform irrigation decisions.
  - Planned and actual water volumes used by field per season.

*Farmers can incorporate a precision irrigation management plan into their operations to achieve economic and environmental benefits. © John Finnell*

- Irrigation timing must be based on one or more of the following:
  - Evapotransportation of the crop using appropriate crop coefficients.
  - Soil moisture monitoring.
  - Local and real-time weather data, including automatic scheduling systems (e.g., remote telemetry systems).
  - Monitoring of plant water status (e.g. leaf water potential).
  - Other recommendation from qualified expert.
- Irrigation amount must be based on one or more of the following:
  - Computerized irrigation scheduling recommendation.
  - Current soil moisture and water holding capacity of the soil at relevant depth.
  - Current crop growth stage.
  - Other recommendation from qualified expert.
- If variable rate application is available, adjust rate based on spatially explicit recommendations.

*Maintain records of the following for verification purposes:*

- Digital copy of plan
- Irrigation records
- Evidence towards implementation

### Irrigation Package Upgrades/Retrofits

- Must be implementing IWM to be eligible for Irrigation Package Upgrades/Retrofits.
- This practice covers upgrades/retrofits that directly improve water or energy efficiency in irrigation systems.
- Maintain documentation of expected water or energy savings resulting from upgrades.

*Maintain records of the following for verification purposes:*

- Documentation for expected water or energy efficiency improvement
- Receipts for new equipment / parts/ labor

### IWM Facilitating Infrastructure

- Must be implementing IWM to be eligible for IWM Facilitating infrastructure.
- To be eligible for reimbursement, components must directly support improved irrigation water management (scheduling).

*Maintain records of the following for verification purposes:*

- Evidence of need
- Receipts for new equipment / parts/ labor

## BENEFITS

### Soil Health

- By avoiding the application of excess irrigation water, and timing application with crop needs, surface erosion potential is reduced.[41]

### Climate

- Irrigation scheduling can save 550 kWh per acrea in fuel alone, avoiding emissions equal to driving a passenger vehicle 1000 miles. [42,43]
- Upgrading to more efficient irrigation packages can save up to 770 annual kWh per acre.[44]

### Water Quality

- In conjunction with proper nutrient management, irrigation water management improvements can improve water quality by reducing overland runoff and leaching of excess nutrients and contaminants. [41]

### Water Quantity

- Irrigation water management and high efficiency irrigation systems can greatly reduce groundwater extraction in sensitive basins without impacting crop productivity.[45]

**Economic** [42]

- Both water and energy savings achieved through improved irrigation efficiency can translate into economic savings.
- Adoption of automated irrigation scheduling can save labor.

## CONSIDERATIONS FOR SUCCESS

- Residue management practices (reduced and no-till), as well as Cover Crops, can be complementary to IWM, further enhancing water savings by increasing water holding capacity of soil.
- Irrigation should be applied at a rate to create uniformity and minimize soil erosion.

## ASSOCIATED COSTS

- Some irrigation scheduling techniques may be more data or labor intensive.

## RESOURCES

- For Idaho farms: Additional support is available through Idaho Power


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*Team members of the multi-partner Dairy Feed in Focus program visit a farm in Idaho. Courtesy of Alisha Staggs/TNC*

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