Sprinkler System

Conservation Practice Job Sheet *442*

Purpose:
The purpose of this memo is convey information and requirements pertaining to Variable Rate Irrigation (VRI) and its relationship with NRCS standard requirements

Background and Uses:
Variable Rate Irrigation (VRI) (in the context of this memo), is a method that varies irrigation application depth from a sprinkler distribution system. This is accomplished one of two ways:

1) VRI Speed Control – the speeding up or slowing down of a system to vary application depth. In the case of center pivot, the circular path of is broken up into various areas based on radial degrees. The speed at which the pivot moves through an area is controlled by the drive motors and control panel with typical input data from a GPS system to determine the pivots location in a field. Number and size of area varies depending on pivot manufacturer.

2) VRI Zone Control – is the pulsing or turning on and off individual sprinklers or a bank of sprinklers to vary the application depth. Controlling sprinklers for application depth results in the ability to control up to 5400 individual areas. The pulsing of the sprinklers is controlled by hydraulic valves and zone control boxes which receive information from the primary control panel and GPS position receives.

A third form of VRI has existed since the mid 1990's called Sector control, which is a form of speed control that varies the percent timer up to nine times throughout a field. Sector Control, while a form of VRI, is not eligible for cost share due to limited control available.

VRI can be used on any type of automatic moving sprinkler system. The most common sprinkler systems will be linear move and center pivot sprinklers. These systems are typically Low Pressure in Canopy (LPIC), Mid-Elevation Spray Application (MESA), low pressure nozzles mounted on drops above crop canopy, or top of manifold and impact sprinklers mounted on top of manifold. .

Whether a VRI is speed or zone controlled, a software prescription plan is required created to control hardware components as to when to turn on or off and at what speed to travel. These prescriptions can be written by the primary center pivot manufacturer/installer or by a third party entity. Prescription plans are based on soils properties, crop water use, well/pump properties as well as system hydraulics. Prescriptions plans should be considered adjustable and modified throughout the growing season to account for environmental and crop conditions.

Soils information and maps can be found in NRCS Soil Survey and the Web Soil Survey website. Required soil information is: available water holding capacity and soil intake rate. Alternate to existing published soils information, an electromagnetic (EM) soil survey can be done by a third part vendor that more accurately surveys the area under consideration. NRCS soils maps have been found to have acceptable detail for VRI prescription. Producers may also use choose to base these prescriptions on yield map data that is acquired during harvest.

Hardware and Software components of VRI can be installed on any existing or new center pivot. Depending on the existing components, additional hardware components such as control panels, control boxes, valves, tubing and GPS receivers with appropriate software can be installed for either speed or zone VRI. Almost all new center pivots are capable of speed control VRI, additional hardware components would be required and a software upgrade to achieve Zone VRI.

VRI is a form of precision agriculture that includes variable rate fertilizer.

Soil Moisture probes can be used in conjunction with VRI to monitor soil moisture levels for irrigation water management purposes and prescription adjustments during the growing season.

Water/Energy Conservation and Vegetative Potential:
The primary purpose of VRI is to increase the irrigation efficiency of the system. By definition the irrigation efficiency is the ratio of irrigation water beneficially used to the average depth applied. It should be emphasized that irrigation efficiency does not include water or energy conservation, only that the system distributes water to the desired area more efficiently.

VRI allows a producer to shut down or limit the depth of water applied to non-cropped (ditches, creeks, waterways, etc.) areas, which would increase the irrigation efficiency. It also has the capabilities to increase depth of water applied to soils that have higher intake rates and likely lower available water holding capacities compared to other soils.

Conventional water application depth decisions are based on the most restrictive soil in order to minimize runoff. With VRI the application depth will vary dependent on soil intake rate and crop available water deficit. With that in mind, VRI has both the capability to conserve or consume more water when compared to a conventional non-VRI center pivot.

With regard to energy consumed by the pumping plant and sprinkler system, designers of VRI Zone prescriptions should strive to maintain a constant flow and pressure, i.e. as one portion of system is shutting down, another portion of equal water volume is turning on, limiting the change in pressure and pump requirements. VRI Speed would always maintain the same flow rate, varying speed of system to vary application depth rather than the system flow rate.

In the case where VRI Zones cannot achieve a uniform flow, a variable frequency drive must be installed. This can occur as either a change in the drive motor (electric), or as throttle control (internal combustion engine). The purpose of this is to maintain the life expectancy of the pumping plant and sprinkler system and that the pumping plant and sprinkler system can perform as expected.

The greatest potential of VRI is to maximize the vegetative soil potential across the entire field. Where application depth based on limiting soil type generally lead to under watering or drying out of certain soils, reducing crop yields. Varying application depth allows producers to maximize soil potential by varying depth or application, and fertilizer applications by soil and site conditions under a sprinkler system.

A word of caution, VRI if misused, can lead to leaching of chemicals. In the case of sandy soils with high infiltration rates, over application of water can drive fertilizer below crop rooting depth and into the ground water. To minimize this potential it is recommended that smaller depths of water be applied over several passes to achieve the same target application volume.

VRI is not for every field. Fields with homogenous soil types do not lend themselves well to VRI based on economics of increased crop production versus system costs. Producers should take into account that while some gains can be made with VRI, they will not always justify the initial input costs or maintenance of VRI. There is no general rule or standard as to when VRI would be of benefit with regards to varying soils or costs.

Recommendation for eligibility:
Eligibility requirements are set by the NRCS Programs division and ranking criteria through local work groups. The following are recommendations for those staffs to consider when developing policy. These recommendations are based on considerations for water quantity, quality and energy conversation.

Recommendation:

1) Require that any VRI system provide an increase of irrigation efficiency of at least 1% by reducing number of acres irrigated.

Example:
A typical 1300 foot center pivot has 121.9 acres under its base area. An increase in distribution efficiency of 1% based on area equals 1.2 acres of non-crop area that would not be irrigated. This area could be drainage ditch that bi-sects the crop field, wetland, pond, farm road or other non-cropped area.

In areas of the state under water allocations, a 1% increase would equal approximately an additional 0.1 inches of application depth available for crop use.

2) Require that the weighted average variation of soil water holding capacity not increase more than 30% compared to the limiting soil type at 50% depletion. For consideration the soil must be at least or exceed 10% of the area of interest.

Example;
Based on the center pivot from #1, soil data from Web Soil Survey results in the following:

Soil Name	Acres	%, AOI	50% AWC at root depth
Zook-SiCL	67.6	56%	3.1 - limiting
Gibbon – SiL	29.0	24%	4.7
Moody – SiCL	12.1	10%	5.75
Grigston - SiL	12.1	10%	6.1
Total	120.7	100%	
Weighted Average	$\frac{\sum(Acres * 50\%\ AWC)}{\sum Acres}$		4.0
Total % Increase	$\frac{[Weighted\ Average\ AWC - Limiting\ AWC]}{Limiting\ AWC}$ x100		29%

This increase in weighted AWC represents a potential 30 % increase in water consumption. This increase is attributed to being able to fully apply irrigation water to crops based on their soil needs, rather than the limiting case.
Note: the irrigation efficiency of the system did not change.

3) If no VFD is installed, then require that no end gun be installed on the sprinkler system for the life of the practice, 15 years.

A system that has both an end gun and VRI will create too much flow and pressure variation for a pumping system to remain un-effected.

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