Cover Crop Growing after Irrigated Hay Barley, Treasure County

Hysham NRCS Field Office

Yellowstone Irrigation District Lateral Organic Matter Improvement Targeted Implementation Plan

Address Organic Matter Depletion on Yellowstone Irrigation District Lateral

FY21-FY23

USDA United States Department of Agriculture

OVERVIEW AND BACKGROUND

Irrigators on the Yellowstone Irrigation District (YID) lateral, local Treasure County stakeholders and NRCS are interested in increasing organic matter on irrigated cropland in Treasure County. These fields have high tillage and soil disturbance from the field operations they implement to maintain their flood irrigation systems. Over half of all irrigated cropland in Treasure County is flood irrigated and operators are ready to adopt improved irrigation technologies that require less tillage to maintain and provide new opportunities to increase organic matter. Multiple producers in the county have focused on improving soil quality and note how much easier it has been to improve soil quality after converting from flood to sprinkler irrigation if other conservation practices are also applied.

Irrigation efficiency and soil degradation were resource concerns brought up at the 2019 Treasure County Local Work Group (LWG) and those concerns were included in the Treasure County Long Range Plan (LRP). Producers with flood irrigation in the county prefer less residue on their fields for flood irrigation water to be applied evenly across a field. A benefit of converting surface flood irrigation systems to sprinkler systems is a decreased need for tillage, to such an extent that no-till may be an option for some producers. Producers will also have a more efficient way to apply nutrients through the sprinkler system and will have better success growing a cover crop after a cash crop as the cover crop is easier to establish under a pivot compared to flood irrigation.

Pivot irrigation is a tool to help improve organic matter on irrigated cropland and pasture. A few other tools to improve soil quality include reduced/no till, nutrient management, irrigation water management, integrated pest management, forage and biomass planting, conservation crop rotation and cover crop. When looking at conservation practices that promote soil health, increased benefits are found from using multiple practices in conjunction with one another. Many of the practices are intertwined; conservation crop rotation increases plant productivity and breaks pest lifecycle, while reduced/no till along with cover crops can add organic matter to the soil with increased plant residue. Using multiple practices can help further decrease rates of wind and water erosion compared to using only one practice. Along the Yellowstone valley in Treasure County there is an even mix of annual crop farmers growing barley, wheat, corn, and sugar beets as the main crops and forage producers growing alfalfa with 2-3 years of annual hay production before being planted back to alfalfa. Annual crop producers will have greater opportunity to improve organic matter due to much more tillage in those operations compared to forage rotation. However, forage producers will also see a benefit from improving their organic matter.

The project area includes acreage serviced by Yellowstone Irrigation District (YID) Lateral Canal and is approximately 2,000 ac of cropland. Of these cropland acres, 1,818 ac are eligible to participate in NRCS programs. Addressing organic matter depletion via direct soil quality improving practices is the primary objective.

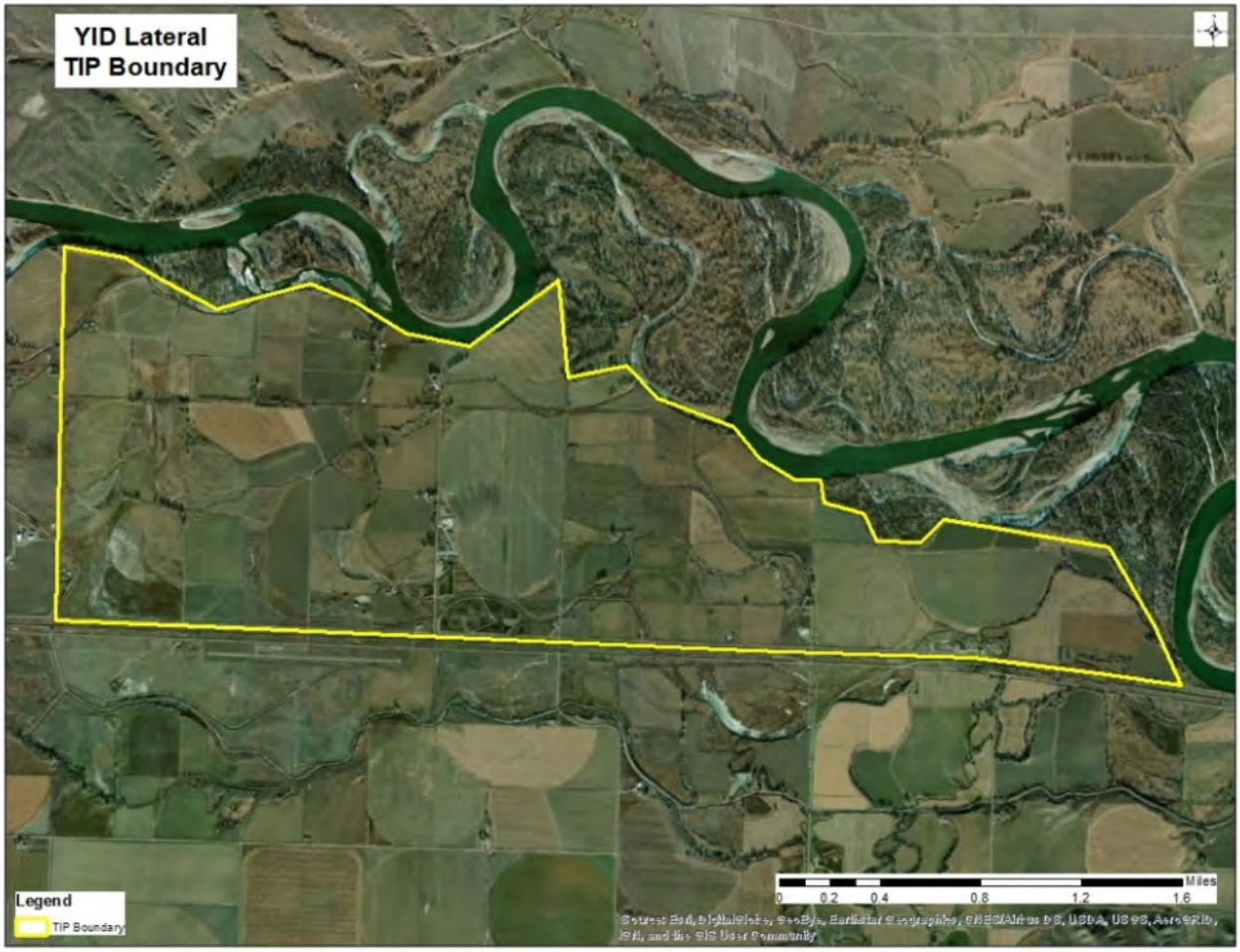

Figure 1. YID Lateral TIP Boundary

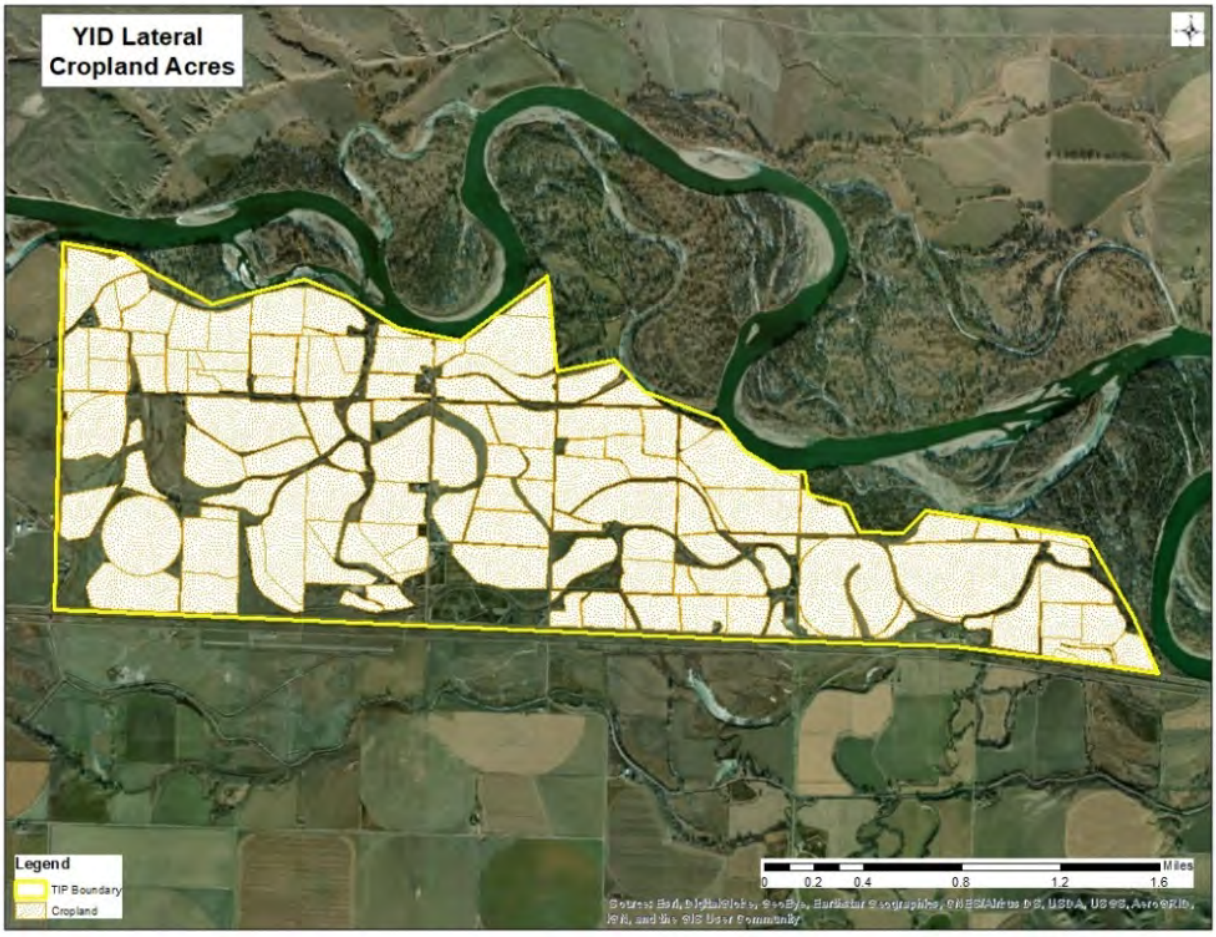

Figure 2: Cropland Acres in TIP Boundary, approximately 2,000 ac cropland (1,818 ac eligible to participate in NRCS Programs)

PROBLEM STATEMENT

Figure 3: Photo taken of wind erosion on irrigated crop field on March 2, 2020 in Treasure County

EROSION ISSUES

The effects of tillage have been on display in recent years through dust storms. A large windstorm hit the Billings area in March 2015, creating a giant dust storm that shut down the Interstate and resulted in one traffic fatality. The Billings Gazette ran a front-page article on the windstorm (Lutey, 2015) and took photos of the damage west of town. Farmers across multiple counties lost their newly-emerged barley crop due to blowing sediment and had to replant.

Figure 4:. March 2015 dust storm near Billings, MT. Photo credit: Larry Mayer, Billings Gazette

Furrow irrigation only adds to the erosion problem. Furrows create perfect drainage channels for water to wash away sediment and carry it directly to the river (Figure 3). Most of the irrigated soils in the Yellowstone Valley are silty clay loams. These soils have low infiltration rates and are particularly susceptible to runoff if irrigation water is over-applied or applied at rates that are greater than the intake rates of the soils. As an example, 2018 was a year with

greater than average precipitation. Spring rains made it difficult to get in the field and many conventional fields washed out due to flooding directly down the furrows. Even in a normal precipitation year, the irrigation induced erosion can be enough to exceed the T value of the soil without the addition of wind erosion. As a result, to mitigate soil erosion, reduced tillage should be coupled with sprinkler irrigation. Conversion from furrow to sprinkler irrigation removes the need for furrows and positive drainage. Thus, rows can be planted perpendicular to the natural slope of the field rather than parallel to the slope.

FOOD ISSUES

A farmer was just in the office explaining how he grows corn after corn after corn and he loads the seed up with pesticides/insecticides to allow it to grow in a non-functioning soil and follows it with multiple spray applications to keep weeds, disease, and pests under control in nonfunctioning soil. Also, an abundant amount of fertilizer is needed to grow the corn as soil alone is not providing the crop many nutrients in that system. Each year the corn is grown that way. Producer was asked what would happen if all the synthetic fertilizer, pesticides, insecticides were not available, and his response was simply "wouldn't have a crop". The current state of the soil is at the mercy of synthetics in order to grow crops, which is scary considering that is our nation's food supply.

ECONOMIC ISSUES

Addressing organic matter depletion is the primary objective of this TIP. Low commodity prices are driving producers along the YID Lateral to consider improving soil quality in order to become more financially sustainable and, in this case, increase net profit. Producers realize that their managements (low diversity crop rotations and intensive tillage operations) are depleting soil organic matter and relating that to their net profit. Treasure County soils can have 2-3% organic matter, but soil tests commonly show 1-2% organic matter.

Table 1: Value of Organic Matter (Dejong-Huges, 2020)

Nutrients in 1% OM		Value
Nitrogen	1,000 lbs. X $0.45/lb.	$450
Phosphorus	100 lbs. X $0.38/lb.	$38
Potassium	100 lbs. X $0.30/lb.	$30
Sulfur	100 lbs. X $0.42/lb.	$42
Carbon	10,000 lbs.	???
Value of 1%OM		$560

Assumptions:
2,000,000 lbs. soil in top 6". 1% Organic Matter = 20,000 lbs

The indicators of soil health illustrate how healthy soil is linked to economic success: soil organic matter, water holding capacity, earthworms and soil fauna, nutrient levels, and proper pH level all contribute to conditions that optimize crop production. Crop species rely on functioning soils to thrive.

Multiple factors limit soil quality improvement within the YID Lateral, but outdated irrigation water delivery systems that require extra tillage and can't deliver high vegetative yields are predominant. See Table 2 for local examples of crop rotations and how they affect soil quality indicators. The table shows Soil Conditioning Index (SCI) which indicates an increase or decrease in soil organic matter, and the greater the number indicates a stronger trend.

A healthy, functioning soil arises from plants, microbes, and soil inhabiting animals interacting together in order to create an environment that is sustainable for them. In managed systems, such as farmland, poor management choices interrupt these interactive functions or destroy them completely. We can restore soil health focusing on management that minimizes these interruptions, increases carbon, and stops soil degradation.

One of the most challenging aspects of managing soil health is the interactive nature of soil health characteristics. Producers should be aware of these complex relations and consider multiple conservation practices to improve soil health. For example, converting a flood irrigated field to pivot irrigation but maintaining low crop diversity will be difficult to increase organic matter. Implementing a crop rotation and nutrient management on a field where heavy tillage is required to maintain the irrigation system won't get us much further.

Table 2: Erosion, STIR, SCI Values on Different Crop Systems

	Rotation	County	Average Annual Wind Erosion (tons/acre)	STIR	SCI
Producer 1 After	Barley-wheat(cc)-barley(cc)-Alfalfa Hay No-Till - Pivot	Treasure	0	4.9	0.4
Producer 1 Before	Barley-wheat-barley-Alfalfa Hay Conventional - Flood	Treasure	10.7	27.6	-0.5
Producer 2 After	Wheat(cc)/Sugar Beet/ Barley(cc)/ Wheat/ Alf Seed Reduced Till - Pivot	Rosebud	1.1	34.2	0.5
Producer 2 Before	Wheat/Sugar Beet/ Barley/wheat/Alf Seed Conventional - Flood	Rosebud	29.9	86.6	-1.9
Producer 3 After	Corn/Soybean/Barley(cc)/ Corn/Soybean/Barley(cc)/ Alfalfa Hay Reduced Till - Flood	Rosebud	0.1	56.1	0.4
Producer 3 Before	Corn/Soybean/Corn/ Soybean/Corn/Soybean/ Alfalfa Hay Conventional - Flood	Rosebud	1.7	144	-0.1

Various benefits of soil health can be categorized into distinct groups. Ecological/environmental benefits contribute to the resiliency of the area without directly increasing agricultural yield, while agronomic benefits are those that manifest as net profit, through increased yields, decreased inputs, or combination thereof. Private benefits are those that are realized by a farmer, while external benefits are realized by others.

Table 3: Soil Health Benefit Categories (Stevens, 2015)

	Ecological/Environmental	**Agronomic**
Private	Erosion Control Local Biodiversity, Natural Beauty, Flood Control	Increased Yields Pest Control Reduced Fertilizer Expenditures Less Necessary Irrigation & Tillage Pass Farm onto Future Generations
External	Erosion Control Cleaner Water (Fewer Nitrates, Etc.) Flood Control Carbon Sequestration Local Biodiversity, Natural Beauty	Lower Risk for Pest Outbreaks Lower Risk for Disease Outbreaks Fewer Unwanted Nitrates from Runoff, Increased Wildlife

The primary resource concern for this Targeted Implementation Plan is Soil Quality Degradation-Organic Matter Depletion.

GOALS AND OBJECTIVES

This TIP's goal is to increase soil organic matter on cropland soils within the YID Lateral. This goal corresponds to the 2019 LWG priorities and the Hysham NRCS's LRP. The resource concern will be treated over three years. TIP outcomes are each field will have a positive SCI in the planned rotation and fields already with positive SCI will be moved to greater level. Reduced tillage with sugar beet rotations having STIR value of 80 or less and non-sugar beet rotations having STIR value of 40 or less. Increased crop diversity with at least 3 different crop types in planned rotation and for existing rotations with 3 crop types increase the planned rotation to 4 different crop types.

PROPOSED ALTERNATIVES AND ACTIONS

The following alternatives were considered:

ALTERNATIVE ONE – NO ACTION

Resource concerns will not be addressed, and crop fields will remain susceptible to continued soil quality degradation.

ALTERNATIVE TWO – STRUCTURE FOR WATER CONTROL (587), PUMPING PLANT (533), IRRIGATION PIPELINE (430), SPRINKLER SYSTEM (442)

Converting from flood irrigation to sprinkler irrigation would greatly improve irrigation efficiency of the YID lateral. However, just improving irrigation systems is only one tool to improve soil quality. If other practices aren't applied to cropland under the pivots, minimal soil quality benefit will be seen.

ALTERNATIVE THREE – STRUCTURE FOR WATER CONTROL (587), PUMPING PLANT (533), IRRIGATION PIPELINE (430), SPRINKLER SYSTEM (442), COVER CROP (340), FORAGE AND BIOMASS PLANTING (512), NO-TILL (329), REDUCED-TILL (345), NUTRIENT MANAGEMENT (590)

NRCS will offer conversion of flood irrigated fields to sprinkler irrigation along with management practices to allow producers the most options to improve soil quality. Preferred alternative.

PROPOSED SOLUTION

Alternative 3 is the chosen alternative. The chosen alternative is the most effective solution to reduce soil erosion and increase soil organic matter. Likewise, it will engage private landowners, leverage partners, and address identified resource concerns to achieve desirable results.

PARTNERSHIPS

- NRCS is the lead partner for this TIP. The local field office staff along with the Area Office engineering staff and agronomist will coordinate to make sure the project practices meet our requirements and will function to meet the applicant's needs.

- Treasure County Conservation District supports NRCS focused conservation efforts by sponsoring the LWG meetings and outreach. Financially the district offers a low interest loan program to implement conservation practices along with renting a no-till drill to producers.
- Farm Service Agency (FSA) offers low interest loans to producers to implement conservation practices.
- Montana Fish Wildlife & Parks offers wildlife habitat enhancement programs that cost share on pollinator plantings, cover crops, stubble height and idle cover that follows their state regulated program requirements. NRCS will promote Montana FWP programs and vice versa.
- Treasure County Commissioners support the project and will help with outreach.
- YID supports the project and will help with technical advice along with outreach and allow NRCS to attend board meetings to keep them up to date on status of the TIP
- Yellowstone River Conservation Districts Council will help with continued work with inventory on the YID and help YID with a Long Range Plan which could lead to the possibility of more TIP's along the YID
- Rosebud-Treasure MSU Extension supports the project and is available to help farmers with nitrate testing, collecting soil samples, and nutrient management recommendations in order to improve crop production and soil quality

IMPLEMENTATION

With the help of partners listed, NRCS will begin a targeted outreach campaign to generate interest in the program. Several producers have already expressed interest in a potential soil quality improvement TIP. YID Lateral Soil Quality TIP will be funded from FY 2021-2023, with all contracts ending by FY 2026. The first 2 years may include EQIP projects with pivots which will have higher cost. Last year of implementation is planned to only be soil quality improvement practices with no irrigation improvements (land continuing to be flood irrigated or land with pivots already installed).

Table 4: On Field Practices/Projected Cost

On Field Practices	Acres			
442 (Sprinkler System)	250	2021	2022	2023
340 (Cover Crop)	250	$200,000	$200,000	$150,000
512 (Forage and Biomass Planting)	100			
No-Till (329)	150			
Reduced-Till (345)	250			
Nutrient Management (590)	350			

Note: Some acres will overlap

The Hysham FO will design and certify all the vegetative practices installed as part of the TIP. Engineering practice design and certification will be handled by the Hysham FO with the assistance of Bozeman Area engineering staff on larger projects due to Job Approval Authority (JAA) levels.

PROGRESS EVALUATION AND ASSESSMENT

Inventories and photo monitoring will be completed before and after each treatment to document improvements. Monitoring and evaluation will be done by:

- Running individual Wind Erosion Prediction System (WEPS) models of both the benchmark and planned scenarios. WEPS document the changes in reduced erosion, improvements in soil organic matter, and decrease of the average Soil Tillage Intensity Rating (STIR) to insure we are making a positive impact on soil quality and relate it to goals outlined in goals and objective section of this TIP.
- Improvement in fertilization efficiency will be completed by working with producers each year to determine if fertilization is meeting crop production goals
- Once the TIP is completed, of the 1,818 eligible acres, 90% (1,632 ac) of the area serviced will have a positive SCI value with help from NRCS through Soil Quality TIP, Conservation Technical Assistance (CTA) through NRCS, or installing soil quality improvement practices on their own.

- Increased SCI is the short term goal of the TIP. However, true success of the TIP will not be able to be determined for many years through soil testing of organic matter after implementing soil quality improvement practices. WEPS models can predict SCI improvements, but soil tests are needed to verify the improvements. Because organic matter changes slowly (5-10 years), positive verification may be outside the scope of the TIP time limit. NRCS will follow up with producers after the conclusion of the TIP to check soil tests and monitor success through conservation technical assistance (CTA).
- Long term success of improving soil quality will benefit public and farmers as outlined in Table 1.

The TIP area is located approximately a mile from Hysham FO. The Hysham FO will take people on individual tours of the Soil Quality TIP and show practices installed. If producers would prefer, demonstrations and field tours will be held to continue education on soil quality improvement.

Models such as WEPS are important but producers will be more interested in seeing results through pictures and soil tests. Another goal of the TIP is to show producers around Treasure county and the entire area the benefits of healthy soil.

BEFORE

Figure 5:. Soil in TIP area. Poor irrigation, high tillage before planting, poor structure, marginal crop soil. Benefit from forage and biomass planting

Figure 6:. Field in TIP area. Spring grain field tilled up. Cover crop or reduced till would have been possibility.

Figure 7:. Field in TIP area. Spring grain under pivot harvested and residue removed. Cover crop would have been possibility.

Figure 8:. Soil in TIP area. Tillage layer present. Reduced/No Till would have been possibility.

Figure 9:. Irrigation drain water coming from fields in TIP area directly into Yellowstone River. Nutrient Management on those fields?

HOPEFULLY AFTER

Figure 10: Sugar Beets no-tilled into barley stubble in Treasure County

Figure 11: Sugar Beets no-tilled into barley stubble in Treasure County under pivot irrigation

Figure 12: Soil in Rosebud County under pivot implementing cover crop, forage and biomass planting and no-till. Good Structure, many aggregates, dark color, earthworms present

Pictures show the difference of healthy soil and obviously farmers in the area stand to benefit the most from this soil quality TIP. However, the goal is to tie these healthy soils into how it also benefits the public through cleaner water with less sediment runoff carrying nitrates and other nutrients and chemicals into Yellowstone River from which Hysham and many other towns get their drinking water. Healthier food without as much fertilizer, pesticides, insecticides, herbicides needed to grow crops to feed Americans. Improved flood control with soils being able to hold more water and less runoff. Improved wildlife habitat for private and public to enjoy. Increased carbon sequestration helping with climate change are just a few of benefits everyone will enjoy as more and more farmers focus on soils.

PRIORITY AND RANKING

LOCAL RANKING QUESTIONS (400 POINTS)

1. Will 3 or more soil improvement practices (no-till, reduced till, nutrient management, forage and biomass planting, cover crop) be planned?
2. Will the difference between the benchmark and planned SCI be 1 or greater?
3. Will the difference between the benchmark and the planned SCI be 0.5 or greater, but less than 1?
4. Will the difference between the benchmark and planned SCI be 0.25 or greater, but less than 0.5?
5. Will no-till or reduced till be contracted?
6. Will average annual erosion be under soil T value?

REFERENCES

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