Oklahoma Carbon Program

Methodology: Assessing No-Till Fields to Estimate GHG Storage and Other Ecosystem Service Benefits

v.2013

OKLAHOMA CONSERVATION COMMISSION

OKLAHOMA CARBON PROGRAM

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Direct questions or comments to:

Oklahoma Carbon Program
Oklahoma Conservation Commission
2800 N. Lincoln Boulevard, Suite 160
Oklahoma City, Oklahoma 73105 USA
Ph: 405.522.4739
Email: stacy.hansen@conservation.ok.gov

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1.0 About the Oklahoma Carbon Program

1.1 Authority

The Oklahoma Conservation Commission has statutory authority to verify and certify carbon sequestration in Oklahoma under Oklahoma Administrative Code Title 155 to implement 27A O.S. § 3-4-101 thru 3-4-105, which authorizes the Commission to establish and administer a carbon sequestration certification program. Permanent rules for the program went into effect July 1, 2009. The rules are authorized by the Oklahoma Carbon Sequestration Enhancement Act. Persons conducting verification of agricultural carbon offsets under the Oklahoma Carbon Program (OCP) shall use protocols written or approved by the Oklahoma Conservation Commission.

1.2 Description

The Oklahoma Carbon Program (OCP) is a voluntary program for the verification, certification, and registration of Oklahoma Carbon offsets and avoided emissions from agriculture, forestry, and geologic sequestration. OCP provides project verification to aggregators and buyers of carbon offsets. The purpose of the OCP is to improve soil, water, and air quality by encouraging Oklahomans to voluntarily implement practices that sequester greenhouse gases. The purpose of verification is to provide an independent third party review of project sites, data, and implementation methods to determine if a project has sequestered an expected amount of GHG.

1.3 Objectives

The OCP strives to provide the following to Oklahomans:

- Oversight of carbon market transactions in Oklahoma
- Information about carbon sequestration
- Quality verification and certification of Oklahoma carbon offsets
- Financial opportunities for Oklahoma farmers, ranchers, forestland managers, oil and gas and utility operators, who take action to sequester greenhouse gases
- Funding opportunities for Oklahoma Conservation Districts

2.0 About This Document

This methodology provides an opportunity for agriculture land managers to benefit from the greenhouse gas storage that results from no-till agriculture in Oklahoma. It was developed to train approved verifiers to collect management data used by OCP to quantify GHG sequestration and carbon offset benefits. The OCP uses the data to assess and quantify greenhouse gas storage potential, and other ecosystem service benefits of participating acres, as applicable. While full-scale verification (100% of acres in a project) is typically not financially feasible for a project, methods included here may be used at any scale as a stand-alone verification or for ground-truthing to confirm modeling results.

3.0 Applicability

This methodology is intended for use by trained professionals with significant experience and background in agriculture. It applies to fields designated as “cropland” by FSA that were converted from

conventional tillage to continuous no-tillage management on or after January 1, 2001, and are under carbon contract with an aggregator whose project meets eligibility criteria listed in Section 4.2.

4.0 Project Requirements

4.1 Aggregation

Aggregation, the pooling of acres owned and/or managed by separate landowners (entities) into a project with a defined geographic boundary, is an important component of carbon sequestration projects. "For agricultural offset projects to be effective, farm-level GHG emissions reductions need to be aggregated into larger, multi-landowner projects. Aggregation is one of – if not *the* most important – factor in the development of agricultural offset projects that are cost-effective and that will allow for the engagement of the agricultural sector in voluntary GHG mitigation efforts at a scale that matters (C-AGG 2013)."

[PLACEHOLDER for aggregation model language]

4.2 Project Eligibility Criteria

Table 1. Project Eligibility Criteria

Criteria	Definition	Requirement
Additionality	Additionality refers to a project or practice that, due to an incentive, adaptive management, or deviation from common practice, sequesters more GHG, or avoids more emissions of GHG, than would otherwise have occurred.	OCP requires projects and practices to meet the American Carbon Registry's Hybrid Additionality Test in which the project must: 1) exceed regulatory/legal requirements; 2) go beyond common practice; and 3) overcome one of three implementation barriers: institutional, financial or technical. Refer to the ACR Technical Standard 2009 v1.0.
Community and Environmental Impacts	The positive or negative impact to the community or environment where the project is located	OCP requires that, to qualify for certification, a project has not accidentally, intentionally, or through gross negligence violated the law as determined by a governmental entity having competent jurisdiction. The OCP also will not certify a carbon offset purported to be created by the intentional disturbance of soil followed by the subsequent replanting of crops or plants for the purpose of creating a carbon offset for monetary gain.
Duration	The length of time that the project or practice is under contract to sequester GHGs	OCP requires that agriculture projects have a minimum contract duration of five years.
Emissions	GHGs emitted from the project location during the project duration	OCP requires sectors under regulatory requirements by state or federal agencies to report GHG emissions to provide such information in the OCP application for verification. Sectors not subject to emissions reporting may voluntarily report emissions.

Criteria	Definition	Requirement
Frequency of Verification	The number of times verification occurs during the project period.	Frequency of verification depends on the length of the contract and the project budget. At minimum agricultural projects are monitored annually with site visits to 10% of the contracts and at least 10% of the acres, with self-certification done on 100% of contracts and 100% of acres.
Geographic Boundary	The above or below ground physical location of a project including the project's boundaries and all parcels or acres within the boundary that are individually sequestering carbon.	OCP requires project proponents to provide a detailed description of the geographic location and boundary of project activities. When multiple parcels are included, each parcel must be delineated and identified by county and legal location. Project aggregators shall provide maps, Geographic Information System shape files, layers, or other relevant information to delineate and identify the project location and boundary.
Information Management	The transmission, storage, and communication of information.	OCP requires project proponents to transmit information in the manner requested with a strong preference for electronic format when possible.
Location	Geographic area where project occurs.	Projects verified by the OCP must occur within the borders of Oklahoma. Projects that cross state lines will be considered for verification on a case-by-case basis, as the law allows.
Ownership	Legal entitlement to a carbon offset and its resulting benefits	OCP requires that offset contracts to be verified by the program clearly identify who has rights to the carbon offset. The OCP reserves the right to transfer a certificate to another person if the applicant/project proponent is found not to be legally entitled to the certificate.
Permanence	Permanence refers to the length of time the GHG is stored in soil, trees, or underground.	OCP requires soil carbon offset project proponents to ensure permanence during the carbon contract by having a plan to mitigate offset reversals by insurance and/or offset reserves.
Resource Management Plan	Description and explanation of the activities that have or will increase or maintain existing stored carbon.	OCP requires a resource management plan in a format approved by the OCP to be submitted with each application for verification, or submitted within an approved timeframe after the application.
Temporal Boundary	The timeframe that applies to the project.	Management resulting in increased carbon sequestration must have begun after January 1, 2001, and as per contract requirements.

5.0 Continuous No-Till Management Standard

The eligibility, management, and recordkeeping requirements together are referred to as the no-till management performance standard. The standard is a reference for no-till cropland managers, project proponents, and offset credit buyers seeking certification of carbon offsets through the Oklahoma

Carbon Program. It is based on the premise that tilled cropland is a source of GHG and leads to surface erosion, decreased organic matter, decreased water infiltration, and less wildlife habitat than tilled cropland, and that when biomass is managed there are broad ecosystem service benefits gained. To accommodate varying levels of management and project budgets, the management standard is divided into 5 tiers.

The management standard is a critical informational and motivational tool for producers, which clearly lays out levels of basic to advanced management. It can be used to reward producers who are in the early stages of a practice that has a GHG benefit, but at a lesser payment level than a producer who is doing more aggressive, progressive management. For example, stopping tillage has immediate, quantifiable, ecosystem benefits, but not as many benefits as stopping tillage, using cover crops, using precision application for fertilizer application, avoiding herbicide use, and establishing filter strips along a stream. The Ecosystem Services Progressive Management Crediting Matrix (Appendix B) lets carbon offset project proponents and credit buyers decide the price and level of management effort that they can afford, while still allowing producers to have an incentive, benefit, and clear goals for stepping up their management. The no-till performance standard below lists the level 1 eligibility and management requirements for participating fields.

5.1 Eligibility

To be considered for verification, lands must meet the definition of continuous no-till and be under carbon contract. Land must not otherwise be disqualified by the restrictions in section 5.2.

"Continuous No-Till," according to NRCS, is defined as managing the amount, orientation and distribution of crop and other plant residue on the soil surface year round while limiting soil-disturbing activities to only those necessary to place nutrients, condition residue, and plant crops (NRCS).

5.2 Restrictions

Tillage with full width tillage implements may not occur. This includes equipment such as chisels, cultivators, disks, harrows, plows, rotary hoes, sweeps, or any combination. Fields found to be out of compliance will not be certified for payment.

5.3 Requirements

Fields may not be tilled and must be managed with low soil disturbance instruments, such as no-till planter, no-till drill, strip-till implement, subsoil ripper with at least 24-inch shank spacing, anhydrous ammonia applicator, or low disturbance liquid manure injectors. Additional level 1 requirements must be observable during field verification as follows:

5.3.1 Biomass Management

- **Growing crop** is present in the field.
- **Residue** from previous crop is present and evenly distributed.
- **Anchored stalks** from previous crop are visible.
- **Cover crops** follow continuous cotton, soybeans, and legumes (i.e., beans, peas, lentils, etc.) in order to meet residue requirements.
- **Burning of residue/stubble** does not occur.

- **Partial grazing of winter wheat** is stopped by mid-March (livestock is removed).
- **Graze-out winter wheat** (beyond mid-March without harvesting for grain) occurs no more than once every three years and is followed immediately by a high residue warm season crop (sorghum, corn, etc.) or cover crop.
- **Hayed annual** crops are immediately followed by a high residue crop or cover crop. This requirement does not apply to perennial forages such as alfalfa.
- **Fallow acres** are idle for no more than 12 months. Failed plantings or prevented planting fields are considered fallow. Continuous wheat-fallow rotations with one crop in two years are not eligible.

6.0 Continuous No-Till Performance Standard - Rationale

Primary carbon sequestration occurs in fields managed with no-till due to the discontinuation of tillage, which slows the oxygenation of soil and the breakdown of organic matter. However, this protocol also assesses crop rotation, residue management, and the use of cover crops as an additional resource to assess and potentially credit secondary carbon sequestration.

The management restrictions and requirements in the no-till performance standard are based on NRCS management standards and a review of the scientific literature. We have prepared a rationale explaining the requirements pertaining to grazing, strip-till, haying, fallowing, biomass removal, and burning. Each section title states the premise on which the management requirement is based and is accompanied by an explanation.

6.1 No-Till is an Uncommon Practice in Oklahoma

The OCP considers no-till to be an uncommon practice in Oklahoma and therefore does verify no-till fields for carbon offset payments. According to the CTIC as cited in Vitale *et al.* 2011, no-till is an uncommon practice in Oklahoma, which ranks 35th out of 50 US states in conservation tillage use with 20.8 percent of cropped area under conservation tillage, and 32nd in no-till use with 10.1 percent of cropped area under no-till. In Oklahoma, winter wheat is the primary annual crop, accounting for nearly 80 percent of the acres seeded to annual crops (Vitale *et al*. 2011). The wheat monoculture appears to be a constraint to the adoption of no-till because of weed and insect pressure and a lack of an economically viable crop rotation system (Vitale *et al*. 2011).

6.2 Cover Crops Result in Higher Soil Carbon Sequestration

The use of cover crops has the potential to mitigate the deleterious effects of fallow periods, residue removal, or low-residue crop rotations (e.g., continuous cotton, soybeans, legumes, and sunflowers) as it relates to SOC sequestration. Numerous research studies across the U.S. with all types of cropping systems have shown the beneficial use of cover crops on soil properties.

Blanco-Canqui *et al.*, 2013, examined the effects of three cover crops; triticale, lentil and peas in a continuous wheat and a wheat-fallow rotation in southwest Kansas. They found after 5 years that the use of cover crops triticale and lentil significantly increased the SOC pool as compared with fallow and that triticale haying compared with no haying did not affect soil properties. This research also showed, though, that nine months after termination of the cover crops, that the cover crops had no effect on soil

properties, demonstrating that they must be continued in this semiarid climate to achieve long-term benefits.

In a 15-year study of a conservation and no-till winter wheat-grain sorghum crop rotation in south-central Kansas, Blanco-Canqui *et al*., 2011, found the use of hairy vetch as a winter cover crop or sun hemp or late-maturing soybeans as a summer cover crop resulted in higher SOC concentrations than the no cover crop rotations, especially in the 0-7.5 cm depth.

In no-till cotton-sorghum rotation plots in Georgia, Sainju *et al*. 2006, found that the inclusion of winter cover crops, vetch and rye, resulted in SOC sequestration as compared to winter weeds, which caused SOC depletion in the no-till plots. Similarly, Locke *et al*., 2012, found that the inclusion of rye or clover cover crops in cotton production near Stoneville, Mississippi, accumulated more soil C than no cover crops regardless of tillage.

In a literature review of 20 studies of cotton production systems in the southeastern U.S., Causarano *et al*., 2006, found that SOC sequestration with adoption of conservation tillage compared with conventional tillage was greater with than without a cover crop. They found that the data indicated that a cover crop in a conservation tillage system can essentially double the C sequestration benefit from that expected using conservation tillage alone.

6.3 Partial Grazing Does Not Significantly Impact GHG Sequestration

The OCP does not restrict partial grazing of winter wheat. It is assumed that if wheat is harvested then the grazing did not diminish yield to the point of impacting GHG sequestration. If yield was not affected by grazing, then it is assumed that the residue has not been reduced.

Any time residue is removed from an annual cropping system; there is less of an opportunity to sequester soil carbon. The ability to sequester soil carbon will be a function of the type (e.g. burning, haying, grazing), intensity, and frequency of residue removal. As reported by Hossain and cited by Vitale *et al*. 2007, nearly two-thirds of Oklahoma's producers are engaged in mixed crop-livestock systems. Much of this wheat is managed as dual purpose. Edwards et al. 2007 cited by Vitale *et al*. in 2011 explain that "Dual-purpose wheat is planted in the late summer, grazed in the fall and winter, and livestock are removed prior to the development of the first hollow stem to enable grain development and subsequent harvest in June."

Research in Oklahoma by Krenzer and Horn 1997 has shown that removing cattle from wheat pasture one to eight weeks prior to first hollow stem had no effect on grain yield. This was true regardless of the year or yield level. This is relevant to carbon sequestration because, depending on when livestock are removed, the amount of residue can be affected.

In Oklahoma, winter wheat is typically planted in mid-October and harvested in mid-June. "Edwards [Edwards *et al*. 2011] found that grazing usually decreases grain yield by 7% and early planting decreases grain yield by 7%." Early planting decreased grain yield because the wheat used more water in the fall. Because Oklahoma winters are generally dry, in March when the wheat comes out of dormancy, it tends to be more water stressed and therefore does not produce as much grain but could actually have grown more roots and aboveground biomass. Therefore, early planting would not decrease carbon input to the system, it just limits grain production. In some cases it could cause a greater input of carbon than wheat grain yields would indicate. This is true if the additional water stress is experienced after flowering, which decreases grain fill but doesn't decrease the production of straw. I suspect that over time the planting date would have a very small if any impact on carbon sequestration because it has more of an

impact on grain yield than on total biomass produced. This likely has little impact on carbon sequestration because of greater growth in the fall. These findings by Edwards likely don't significantly impact carbon sequestration as they are likely the result of alterations in the soil moisture after animals are removed more so than affecting carbon input into the system" (Warren 2013, pers. comm.).

6.4 Biomass Removal by Haying, Grazing Impacts GHG Sequestration

The OCP imposes an eligibility restriction on the use of "graze-out" wheat. When livestock are allowed to graze winter wheat beyond mid-March without the crop harvested for grain, this is called "graze-out." Because graze-out reduces the amount of residue that would be left in the field compared to harvest, OCP only certifies fields for carbon credit if graze out occurs only one in 3 years, and then only if it is immediately followed by a high residue, warm season crop (sorghum, corn, etc.) or cover crop. There is scant research on the effects of graze-out on carbon sequestration. The OCP restricts the practice on the assumption that it reduces carbon sequestration because it results in lower carbon inputs from residue and there is a lack of data to dispute this assumption.

The OCP requires residue removal from haying or baling to no more than once in 3 years and when residue removal occurs, it must be followed by a cover crop. Removing some or all crop residues from a field can have negative consequences for SOC sequestration for two reasons: (1) it reduces the amount of plant residue that can subsequently be transformed into SOC and (2) it can make the soil surface more vulnerable to water or wind erosion thereby depleting the soil of the most organic matter-rich portion of the soil profile.

In research conducted in western Kansas, Blanco-Canqui *et al*., 2009, found that in no-till winter wheat and plow till grain sorghum cropping systems, that residue removal at rates as low as 50% increased loss of sediment. They also found that no-till with 100% residue removal lost as much sediment as freshly tilled wheat plots with 0 or 25% removal and residue removal at 75 and 100% increased losses of SOC associated with sediment. They concluded erosion protection provided by no-till management was lost when residue removal exceeded 25%. In a study in eastern South Dakota of a no-till corn-soybean rotation, Osborne *et al*., 2011, found that increasing corn residue removal of 37%, 55% and 98% resulted in a significant decrease in soil organic matter (SOM). In a literature review of the effects of corn residue removal on soil productivity, Wilhelm *et al*., 2004, generally found negative effects on SOC with increasing residue removal.

6.5 Burning Negatively Impacts Carbon Sequestration

Burning has two negative effects related to carbon offsets in annual crop production systems: (1) it reduces the amount of plant residue that can subsequently be transformed into SOC (Hooker *et al*., 1981; Wuest *et al*., 2005; and Amuri *et al*., 2008) and (2) it produces CO_2 emissions from the combustion of the plant residue. It also negatively impacts soil health, especially if a soil is already of poor quality, which most cropland soils are. The soil surface devoid of grass succumbs to the pressure of raindrops, which pound the surface causing macropores made by worms to seal over. This increases erosion from runoff and decreases water absorption. Unhealthy, bare soil is also slower to regrow vegetation cover.

6.6 Fallowing Limits Carbon Sequestration

The OCP defines fallowing (laying idle) as a time period of more than 12 months in a growing season (e.g., October 1-September 30) without a growing crop. Based on a review of the literature, OCP has determined that continuous wheat-fallow systems are not eligible under the no-till protocol. Other cropping systems that do not use fallowing more frequently than once every 3 years, e.g. corn-wheat-fallow, are eligible, but are not eligible to receive carbon credits for the fallow year.

Cropping intensity and the amount of residue returned to the soil plays a key role in the amount of carbon (C) sequestration that occurs. Research has shown that greater cropping intensity, and limiting fallowing periods within the confines of what annual precipitation will allow to produce a viable crop, leads to greater carbon sequestration.

Researchers believe that summer fallow reduces C storage in several ways. First, frequent summer fallow usually reduces inputs of C into soils because there are no plant C inputs and second, it may enhance the rate of mineralization of soil organic carbon (SOC) to carbon dioxide CO_2 because it keeps the soil wetter and perhaps warmer for longer periods (Campbell *et al*., 2005).

Halvorson et al., 2002a, found that in eastern Colorado that a crop rotation of continuous corn under no-till (NT) management resulted in greater levels of SOC than a crop rotation of wheat-corn-fallow under NT management, which resulted in greater levels of SOC than a wheat-fallow rotation under NT management. In addition, this research also showed that a continuous wheat-fallow rotation under NT management did not result in any greater SOC than continuous wheat-fallow under reduced tillage or conventional tillage. Halvorson et al., 2002b found similar results for spring wheat cropping systems in North Dakota. The results of this study suggested that a continuous spring wheat-fallow system even under no-till may result in a loss of SOC.

Sherrod *et al*., 2003, showed that at three locations in eastern Colorado after 12 years of NT management, that those cropping systems that eliminate summer fallowing and integrate higher residue crops such as corn, grain sorghum or millet, maximize the amount of SOC sequestered. In research conducted near Bushland, Texas, Potter *et al*., 1998 also found that fallowing limits carbon accumulation and found that SOC content was not significantly different between tillage treatments in wheat-fallow and wheat-sorghum-fallow systems. Schomberg and Jones, 1999, in research conducted near Bushland, Texas found that a cropping system of continuous wheat under no-till management had higher SOC levels than a wheat-sorghum-fallow rotation under no-till management.

Historically, the cotton-winter wheat-fallow rotation is uncommon in Oklahoma, but it is becoming more likely for SW Oklahoma as drought conditions persist. In this rotation there are 11-12 months of fallow time instead of 15 months as would be found in a wheat fallow system. The fallow period in a cotton-wheat fallow system would also not generally be longer than 12 months (Warren 2013, pers. comm.) so this cropping system is eligible for certification.

6.7 Irrigated Cropland Sequesters GHG at a Higher Rate than Non-Irrigated

The OCP calculates carbon sequestration at a higher rate for irrigated cropland than for non-irrigated cropland, excluding the field corners not reached by the irrigation. NRCS classifies the corners as "dryland" which means they are considered non-irrigated (Mustain 2010, pers. comm.). The carbon sequestration rate in irrigation is higher under irrigation because higher yields equal higher amounts of residue delivered to the soil system, which should increase the potential carbon sequestration rate when the fields are converted to no-till (Warren 2010, pers. comm).

In a 10-year study of various no-till, irrigated, cropping systems (continuous corn, corn-winter wheat, corn-winter wheat-grain sorghum, and corn-winter wheat-grain sorghum-soybeans) near Tribune, Kansas, Halvorson and Schlegel found that these systems sequestered SOC at a rate ranging from 0.40 MT CO_2/ac/yr for the rotation with soybeans to a high of 1.0 MT CO_2/ac/yr for the continuous corn rotation, with an average across all cropping rotations of 0.80 MT CO_2/ac/yr for the 0-30 cm soil depth. This sequestration rate is substantially higher than the 0.2 to 0.4 MT CO_2/ac/yr rate used by OCP for

dryland no-till systems. Even with a 20% discount for conservativeness, this research would support a 0.60 MT CO_2/ac/yr crediting rate for irrigated no-till systems in Oklahoma.

Halvorson *et al*., 2003, found SOC sequestration rates of >1MT CO_2/ac/yr for no-till, irrigated continuous corn cropping systems near Ft. Collins, Colorado and near Dalhart, Texas at the 0-15 cm soil depth. They also found that under conventional tillage at the Ft. Collins site or with heavy grazing of the corn stalks at the Dalhart site, there was no appreciable SOC sequestration. Gillabel *et al*., 2007 found that various irrigated, conservation tillage cropping systems in southwest Nebraska stored up to 25% more SOC than similar dryland cropping systems. Most of this research attributed the additional SOC to the increased residue levels in the irrigated as compared to the dryland systems.

6.8 Strip-Till has a Positive Soil Condition Index

The OCP methodology includes assessment and crediting of strip till fields. Strip-till is a type of conservation tillage that tills only the strips where the crop will be planted. This inclusion is based on a review of NRCS's Soil Condition Index (SCI), which is a tool used by NRCS to determine if there is a soil health or soil quality concern caused by a cropping system. The SCI is based on three important conditions: (1) organic material grown or added to the soil, (2) field operations that alter organic material placement in the soil profile and that stimulate organic matter breakdown, and (3) erosion that removes and sorts surface soil organic matter (Franzluebbers *et al.* 2011). If the index rating equals a negative number, the cropping system is considered to be causing deteriorating soil health. If the index rating is positive, soil health is considered to not be a concern (Mustain 2009, pers. comm.).

An informal review of the SCI for this protocol included comparisons of the SCI for no-till and strip-till fields in three counties in west, central, and southeast Oklahoma. In all instances, the strip-till fields had worse indexes than the no-till fields by 0.1 to 0.25; however, the indexes were always positive, which indicates that there is not a soil health concern with strip-till (Mustain 2009, pers. comm.). A further review was done to determine if the location of tilled strips within strip-till fields would affect the SCI. The reviewers concluded that when no till or strip till is used with appropriate crop rotations, the SCI will more than likely be positive. This means there should be a positive trend in organic matter accumulation in the soil whether the same strip or new strips are tilled (Matlock 2009, pers. comm.).

The scientific literature provides little information to compare carbon sequestration in no-till and strip-till fields (Warren 2009, pers. comm.). There is a need to establish a baseline management condition so that a change in soil organic carbon (SOC) can be expected. If the baseline condition were to have a highly negative SCI score, then even a minimal conservation management technique would likely improve SOC sequestration. If, however, the baseline condition were at an acceptable level, then only more rigorous conservation measures could be expected to achieve SOC sequestration in the future. The successful calibration of SOC content on SCI scores will allow SCI to become a more quantitative tool in predicting SOC content for farmers wanting to adopt conservation practices (Franzluebbers *et al*. 2011).

7.0 Applications for Verification

Aggregators and land managers are provided with eligibility and application information. All applications for no-till verification are screened for eligibility.

7.1 Screening

The following application and supplemental information will be reviewed for completeness, clarity, and adherence to program requirements prior to contracts being considered for verification:

- Producer aggregator application
- Name, address, and phone number
- Number, size, and location of fields
- Legal location descriptions and aerial photographs
- Resource management plan with crop information
- Producer contract
- Proof of date converted from conventional tillage to no-till
- FSA current and historic Form 578 showing acres designated as "cropland"
- Aerial photo/map with fields delineated and acres shown

7.2 Field Information Sheet

Field location and status information is synthesized and organized into a spreadsheet provided to the field verifier. This allows the verifier to plan to optimize field time and facilitates overall GHG reduction reporting and project tracking.

Table 2: Example producer field information sheet

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	Last Name	First Name	County	Town	Legal	Applic Descr #	Total Acres Contracted	Acres No-Till	Acres Grass	Acres Range	FSA Cropland	Date Began Practice	Irrigated	NRCS Farm Plan	Grazing Plan	Farm Bill
2	Joe	Producer	Best	Sometown	E2NW4 24-22-22	1	68.2	0	9	0	Y	2004	N	Y	N	CRP
3	Joe	Producer	Best	Sometown	E2NW4 24-22-22		0	0	59.2	0	Y	2004	N	Y	N	
4	Joe	Producer	Best	Sometown	NE4 13-22-22	2	55.9	0	55.9	0	Y	2006	N	Y	N	
5	Joe	Producer	Best	Sometown	N2SE4 13-22-22	3	21.2	0	21.2	0	Y	???	N	Y	N	
6	Joe	Producer	Best	Sometown	S2NW4 22-22-22	4	64.4	0	64.4	0	Y	2006	N	Y	N	
7	Joe	Producer	Best	Sometown	SE4SW4 and SW4SI	8	49.3	0	49.3	0	Y	2006	N	Y	N	
8	Joe	Producer	Best	Sometown	SW4NE4 11-22-22	9	13.7	0	13.7	0	Y	2006	N	Y	N	

7.3 Selecting Fields for Verification

The OCP randomly selects at least 10% of eligible contracts for verification. If the total acres do not equal 10% of the project acres, additional sites are randomly selected to reach the 10%. After year one, the same process is followed with a random selection of previously visited sites added to the verification pool.

7.4 Contacting the Field Verifier

Once fields are selected for monitoring, the OCP contacts a verifier to request field verification services, provide instructions, and transmit the information in section 8.1.

8.0 Preparing for Field Visits

Field verifiers are tasked with performing a thorough review of the field information, and planning travel logistics before departing for field locations.

8.1 Gathering and Reviewing Information

Verifiers are provided the following information and contact the OCP with any questions:

- Producer's application
- Name, address, and phone number
- Number , size, and location of fields
- Legal location descriptions and aerial photographs/maps
- Resource management plan with crop information
- Producer information sheet

8.2 Contacting the Producer

Verifiers are responsible for contacting the land manager to set a date and time to conduct monitoring and to confirm field locations and best access. This is the time to ask if gates are locked, if the land is under hunting lease, and to determine if the land manager wants to be present during the field visit.

8.3 Planning Travel

Verifiers are required to plan travel routes in advance to optimize time spent driving and reduce fuel cost and GHG emissions from travel. Based on a review of the application and maps of field locations, the quickest, most efficient route is planned from the office to the fields.

9.0 Monitoring

Visual observations and data collection are referred to as monitoring. The Oklahoma Carbon Program monitors no-till fields to verify that a field or project is being managed in a way that sequesters an expected amount of greenhouse gas (GHG). Monitoring includes identifying the current and previous crop, width between rows, tillage, biomass removal, and irrigation status. This is done by walking a transect across the field and recording visual observations.

9.1 Timing

The optimum time to verify winter wheat fields is after planting when the planted crop has emerged, but is not so tall that it obscures residue, stalks, or the overall viewing of the field. The optimal time to verify **cool season crops** is from October 15 to November 30 and **warm season crops** from April 15 to June 30. These dates represent the ideal verification timing based on normal rainfall, planting time, and visibility after emergence. At its discretion, the OCP may vary the annual verification dates based on seasonal fluctuations in rainfall, planting time, or crop emergence. This timing does not allow for visual confirmation of graze-out during the current growing season. However, indications of graze-out are typically evident the next year by lack of residue and stalks in the field.

9.2 Frequency

Frequency of verification depends on the length of the contract and the project budget. At minimum agricultural projects are monitored annually with site visits to 10% of the contracts totaling at least 10% of the acres, with self-certification done on 100% of contracts and 100% of acres.

9.3 Field Forms

Field data collections begin with a working knowledge and understanding of the field forms to be used. There is one set of forms to fill out for each site. Basic information that should be on the forms includes

the land manager's name, the month, date, and year of data collection, field id number and legal description. The data form includes an attestation of truthfulness signed by the field verifier.

10.0 Methods

10.1 Continuous No-Till Field Data Collection

Equipment Needed

- Aerial photographs or NRCS maps
- Digital camera w/charged battery
- Field data forms
- Clipboard and pen
- GPS (optional)

10.1.1 Review the Map and Plan Field Transect Location

Look at the map to assess the size and shape of the field. Get an idea of what transect to walk to get the most complete overview of the field. If the field is relatively flat there may not be a need to walk the entire field.

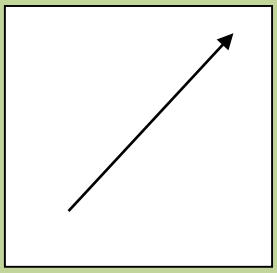
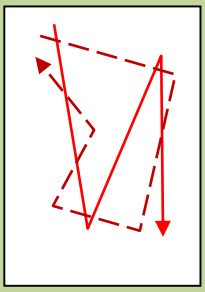
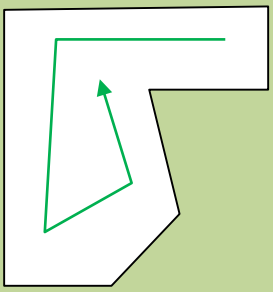
How to Walk a Transect		
Walk enough of the field to see all corners and gather enough data to get an accurate assessment of the field. If portions of the field are visually very different, record those acres on the field form and write notes to record your observations. The size and shape of the field will dictate how the field is walked to collect the data. The goal is to collect data that reflects the entire field. See examples below.		
Examples of transects based on field shape and size		
Example A. 20 acre field – Straight line: Pick a spot on the horizon to walk toward in a straight line.	**Example B.** 100 acre field – Zig-zag: Due to size, one line on the diagonal, as in example A, may not accurately capture the field. Try one of the two options shown below.	**Example C.** 200 acre field – Odd shaped field: may pose a challenge. Below is a suggested transect.
		

Figure 1: How to walk a transect

10.1.2 Confirm Field Acreage

Walk the field to determine if actual no-till acres equal the acres under contract. Begin observations away from the field boundary, 50 feet into the field: At this point begin walking the transect. Use visual comparison of field boundaries to NRCS maps or other aerial photos, and/or use GPS points taken and input to ARC-GIS or other aerial map program. Look for areas removed from cropping a (e.g. building new homesite, oil field activities) and note whether or not they are on the map. If not, subtract these acres from the acres you list under in the column "Acres in Field."

Note: When large, easily delineated and measureable areas exist that do not contain a newly planted crop or residue, or otherwise do not meet the practice standard, indicate the area on the map and field form.

Figure 2: Good residue and stubble, evidence of planting, but no green growing crop

10.1.3 Identify Tillage Type and Irrigation Status

Determine if the field is in continuous no-till or strip-till, or conventional tillage management, and whether or not it is irrigated.

- **Look at the soil surface** for loose crop residues remaining on the field after harvest. No-till fields build a surface mulch layer of partly decomposed crop residue on or near the soil surface. It may be more apparent between rows of crops.
- **Look across the field** to observe anchored crop stubble remaining (standing or angled) from the previous crop.
- **Look at the field and the map** to determine if a field is irrigated.
- **Note if the field appears to have been fallow** for one year or more. If so, determine the number of fallow acres and record the number on the field data form. If the field is fallow, there is no reason to continue verification.

10.1.4 Identify Irrigation Status

Center pivots do not reach the edges of the field, so if a 160 acre quarter section field is irrigated by center pivot, the edges (28 acres) are not included in the "Irrigated" acres column. Instead, record the number of irrigated acres as 132 acres.

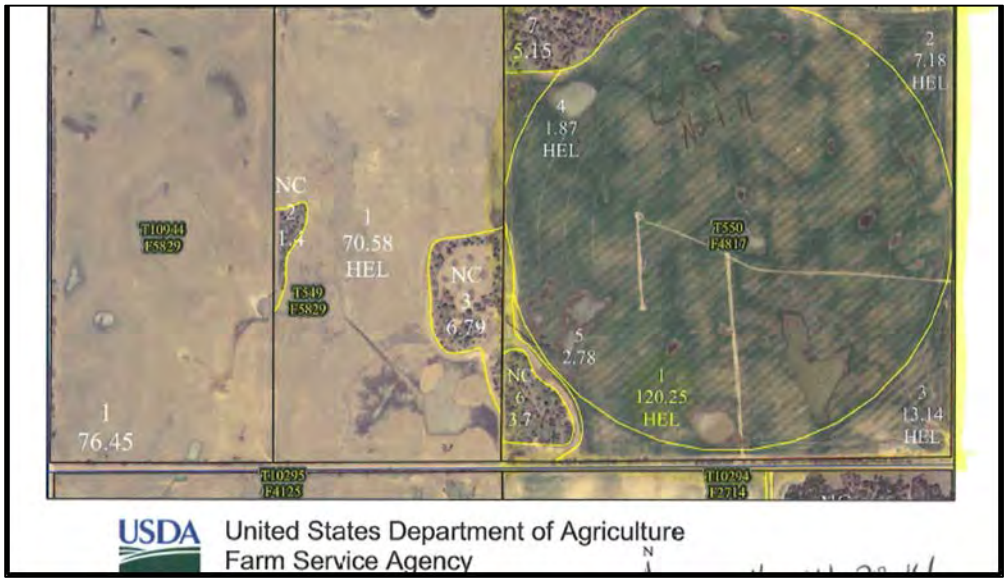


Figure 3: Aerial view map showing evidence of center pivot irrigation

10.1.5 Identify the Current Growing Crop and Residue from Previous Crop

Identify the new growing crop and the previous crop type by identifying the standing stalks and residue. Take pictures of each. If you are unable to identify the growing crop and/or residue, ask the producer or take a piece of the residue to an NRCS specialist for assistance.

Note: Crops must be planted annually, except when alfalfa is used in the crop rotation.
Fields that contain greater than a 50% stand of alfalfa count as no-till. If less than 50% with the remainder in grass, the field **are verified as seeded grassland.**

Figure 4: Close-up picture allowing for identification of crop and residue type by desk auditor

10.1.6 Take Pictures

Take at least three pictures in each field. Record the photo number from the camera onto the data form so that the correct pictures match up with the fields which fields as listed on the field form. Note that this is not the number of pictures taken, but the actual picture number 1,2,3, etc. showing on the camera.

- **Panoramic** taken looking down the rows providing an overview of field with no more than 1/3 of the picture showing sky.
- **Close up** that represents what the majority of the field looks like.
- **Close up at 45 degree angle** of the dominant cash crop or cover crop plants.
- **Areas of note** such as bare soil, tilled areas, evidence of burning, overgrazing, or haying.

Figure 5: Examples of correctly taken field photos

10.1.7 Determine if Residue and Stubble is Evenly Distributed across the Field

Loose crop residues remaining on the field after harvest should be uniformly distributed over the field. Examine the soil surface for any anchored crop stubble remaining (standing or angled) from the previous crop. Over time, no-till fields will build a surface mulch layer. A surface mulch layer is a layer of partly decomposed crop residue on or near the soil surface. It may be more apparent between rows of crops.

Figure 6: Fields with evenly distributed residue

Figure 7: Residue will be sparser in some fields, but still evenly distributed

10.1.8 Record Evidence of Full Width Tillage

Implements that require a leveling or smoothing after their use generally disturb the soil too much for an entire field to qualify as no-till. Determine the amount of acres under full width tillage and record the number on the field form. If less than one acre is disturbed, take a picture and write "<1" on the field form.

Figure 8: Green growing crop with residue of previous crop absent; both fields were tilled

Figure 9: Green growing crop with residue present

10.1.9 Determine if the residue or stalks have been removed by burning

Determine if the residue has been removed from all or some of the field by burning, determine the amount of acres burned and record the number on the verification form.

10.1.10 Determine the number of acres with residue removed by short-term grazing

Look for evidence of grazing livestock. If there is evidence of removal of plant residue by grazing during the current growing season, indicate on how many acres.

Note: If the field is or has been grazed, then grazing took place on 100% of the acres. An example of "short-term grazing" is when winter wheat is grazed until mid-march and then harvested in June.

10.1.11 Note if the previous crop was grazed-out

Determine whether the crop has been removed from all or some of the field by grazing instead of being harvested. Determine the amount of acres affected and record the number on the verification form.

Note: If the field is or has been grazed or grazed out, then grazing took place on 100% of the acres. "Grazed out" means that a crop has **not** been or will **not** be harvested by an implement, but instead has been used as forage for livestock with a majority of the plant being consumed by the animal, resulting in minimal or no residue remaining in the field. This is not the same as "short-term grazing," such as the grazing that occurs on winter wheat before cattle are pulled and the crop is harvested.

Figure 10: Winter wheat field in the process of being grazed out

Figure 11: Grazed out winter wheat with cow presence evident (left). Winter wheat of same age that will be harvested (right)

Fallow refers to a field that has not grown a crop within the previous 12-month growing season (October 1 to September 30).

Figure 12: No-till cropland with fallow evident due to presence of grazed annual grass cover

10.1.12 Measure the width of the rows

Measure the width of tilled rows and the width between planted rows if the field is no-till or strip tilled.

10.2 Field Form Completion

Calculate tally sheet totals and complete and sign the field form. Draw on the map the location of the transect walked across the field (Figure 15).

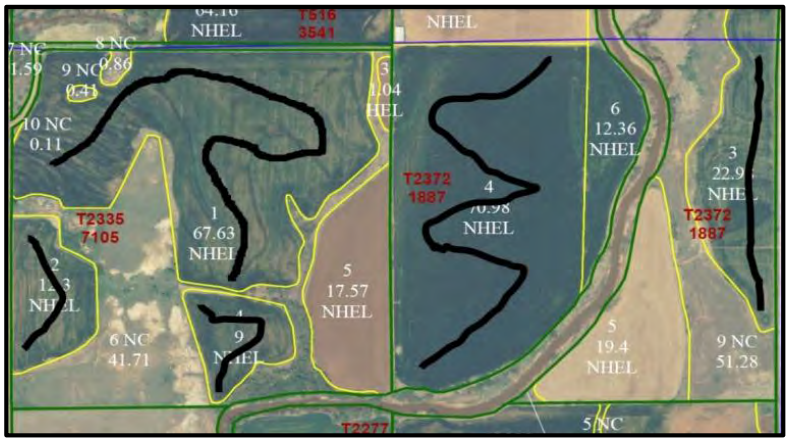


Figure 13: Example of field transects drawn on a map

11.0 Data Management

Adherence to this protocol, associated methodology and principles of accounting will ensure that project-based offsets represent emissions reductions and removals that are real, measurable, permanent, in excess of regulatory requirements and common practice, additional to business as usual, net of leakage, and verified by a competent third party.

11.1 Unit of Measure

Sequestration rates and GHG reductions are reported in metric tons, converting each metric ton to its carbon dioxide (CO2) equivalent (CO2e).

11.2 Conservativeness

Carbon sequestration rates used by the OCP are conservative default values based on soil carbon data and USDA modeling that provided regional averages of soil carbon sequestration rates over land areas with similar soils, climate, and water resources. As the dataset gathered from direct measurement of soil carbon samples in Oklahoma continues to grow, we routinely compare the sequestration rates with the default rates to make sure the rates we recommend to project proponents are based in science and a fair representation of soil dynamics in Oklahoma.

11.3 Uncertainty, Accuracy, and Precision

For agriculture practices, the OCP verification methodology meets the targeted 90% statistical confidence at +/- 10%. Calculations and estimates need to be as precise as possible to prevent material errors. It is important to identify errors during the verification process. Any of the common errors below could result in the project aggregator or verifier potentially over crediting GHG reductions: incorrectly defining project boundaries, transcription errors.

11.4 Reporting

Verification activities consist of a pre-verification application review, site visit of selected acres, and desk audit of field data documentation provided for those acres. Site visits are necessary to assess operations, confirm the project boundary, and assess management techniques.

11.5 Data Quality

The OCP has trained quality assurance officers in place to assess the performance of field verifiers and assure consistency of gathered data and reporting.

11.6 Confidentiality

The OCP requires verifiers to keep all matters of contracts and verification strictly confidential.

11.7 Baseline Estimation

OCP considers baseline emissions to be an estimate of the GHG emissions from sources within the project boundary that would have occurred in the absence of the project. Baseline carbon sequestration for tilled cropland is considered negative because tillage is a source of GHG emissions.

11.8 Quantifying Reversals

Verifier reports include photo documentation of management activities that positively and negatively affect GHG sequestration. Soil disturbance and other activities that violate eligibility requirements are considered a reversal and result in no credit given for the contract period.

11.9 Assessing Leakage

This protocol does not include a method to assess leakage at the field or project scale.

11.10 Quantifying Emission Reductions

The OCP uses GHG sequestration rates compiled for the Chicago Climate Exchange, which for conservativeness are discounted 20 percent from the average published rate for the region. The rates

do not assume that each enrolled acre sequesters that amount each year. The rate is "based on the average accumulation rates expected for large pools of farmland over multiple years based on the best available scientific information. The issuance rates are viewed as a discounted average that could be expected to occur for the entire pool of enrolled acreage over the …contract period" (CCX 2008). To-date, these rates have been deemed reasonable for use in Oklahoma by Oklahoma State University (OSU) researchers, as they are supported by small pools of historic and ongoing soil sampling data. OSU recommends the OCP not deviate from the regional values until there is sufficient data to recommend alternative rates (Warren. Email. 2010 Oct 14.).

Table 3: Sequestration rate of Oklahoma no-till fields

Sector	Practice	Sequestration Rate (metric tons CO2/acre/year)
Agriculture	No-till or Strip-till	0.2 – 0.6

Calculation: Price per ton x sequestration rate x acres = Payment to producer
Example: $3.50/metric ton CO2 x 0.4 metric tons/ac/yr x 300 acres = $420

Table 4: GHG Sources and sinks of no-till fields

Source/Sink	GHG	Include (I) or Exclude (E)	Quantification Method	Explanation
Soil	CO2	I	Regional default values	Actions that result in less sequestration than anticipated are documented and considered in GHG credit accounting.
	N2O	E	N/A	Not considered by this protocol at this time.
Equipment	CO2	E	N/A	Compared to emissions from managing marginal croplands, emissions are expected to decrease and are not accounted for.
	CH4	E	N/A	
	N2O	E	N/A	
Leakage	CO2	I	Subjective	Possible if grazing pressure is found to have shifted to and negatively impacted other fields.
Fertilizer Production and Application	CO2	E	N/A	Indirect emissions or reductions are not accounted for by this protocol.
	CH4	E		
	N2O	E		

11.11 Quantifying Project Emissions

The OCP includes in the no-till management standard requirements that reduce or avoid project emissions. The monitoring protocol does not include the quantification of project-based emissions.

12.0 Verification Audit

The field monitors and verifiers do not make the final decision about eligibility for carbon credit payments. Field verifiers are the eyes of the desk auditor. Providers of monitoring and field verification services for the OCP are tasked with using their knowledge, skills, and tools to accurately document with notes and photographs what they observe. Observations and data collection processes should be thoroughly documented on the forms provided so that a second verifier using these methods and

previous field forms would arrive at similar results. The data collected is expected to be accurate and complete to be used by the desk auditor to make a reasonable and valid decision about each field's eligibility for carbon credit payment.

[Place holder for step by step auditing process]

13.0 Reporting

[Place holder for reporting guidelines]

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Appendix A: Field Forms

No-Till / Strip-Till

Oklahoma Carbon Program
Field Verification Report

Producer Name: _____ **Aggregator Contract #** _____

The practices you are verifying are planting methods commonly referred to as no-till and strip till. The purpose of these practices is to manage the amount and distribution of crop residue on the soil surface year round while limiting soil-disturbing activities to only those necessary to place nutrients and plant crops.

Fields should be verified in late spring and late fall after crops have been planted, as follows:

Warm season crops - Spring: April 15 to June 30
Cool season crops - *Fall/Winter:* October 15 to Nov 30

**Dates represent ideal verification dates based on normal rainfall, planting time, and visibility after emergence. At its discretion, the OCP may vary the annual verification dates based on seasonal fluctuations in rainfall, planting time, and emergence.*

Section A: Location Information

Did you receive verbal permission from the producer to access land? Yes No
Did the producer accompany you during verification? Yes No

Field #	County	Legal Description (e.g. SW ¼ of NE ¼)

Section B: Photos

Photos should document field conditions and provide an accurate representation of the field. Include photos of crop residues as well as growing crops when present. **Avoid** taking photos in headlands, end rows and other overlap areas. Photos should also document questionable or contract compliance issues.

Take pictures of **each** field as follows:

A. Panoramic: Overview of field showing standing stalks and current growing crop.
B. Close up (taken at 5 to 10 feet): Ground surface, residue or lack of residue.
C. Close up (taken at 5 to 10 feet): Soil disturbance/tillage, evidence of burn, graze-out, areas where seeding was missed, or other noteworthy areas.

Section C: Things to Remember

- O Mark your transect on the map
- O Take photos of each field
- O Include notes, questions, explanations
- O Sign the signature/attestation page
- O Write clearly

Oklahoma Carbon Program
Field Verification Report

Producer name _____ **Verifier Name** _____ **Date** _____

Section D: Verifier Notes
Provide explanations of Section F below.

Field #	Date Visited	Notes

Section E: Verifier Signature / Attestation
The information in this report and accompanying photographs is true and accurate to the best of my knowledge and has not been intentionally misrepresented.

_____	_____	_____
Field Verifier Signature	Field Verifier Name (printed)	Date
_____	_____	_____
Internal Reviewer Signature	Internal Reviewer Name (printed)	Date

No-Till / Strip-Till

Oklahoma Carbon Program
Field Verification Report

Producer Name _____ **Verifier Name** _____ **Date** _____

Section F: Field Condition

Get out of the truck. All observations must be taken at least 50 feet inside the field boundary. Fill in every white box on this page.

How did you confirm the number of acres? *(Circle all that apply)* GPS Visual Map Other _____

Field #	2/ Tillage type (NT, ST, or Full)	1/ Acres in field	Irrigated (acres)	3/ Current growing crop (type)	3/ Previous Crop (type)	4/ Residue evenly distributed across field (acres)	5/ Evidence of full width tillage (acres)	6/ Residue or stubble burned (acres)	7/ Residue or stubble partially grazed (acres)	8/ Growing crop grazed out or hayed (acres)	9/ Fallow >1 year (acres)	10/ Width of planted row (inches)	10/ Width between planted rows (inches)	**Photo #**
												For strip till fields only		
														to
														to
														to
														to
														to
														to
														to
														to
Totals														

No-Till / Strip-Till

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INSTRUCTIONS

Get out of the truck. All observations must be taken at least 50 feet inside the field boundary:

1/ Locate field and confirm number of acres. Look at field to determine that location and number of acres are consistent with the map and contract. Visually compare field boundaries to map.	
2/ Determine whether field is no-till, strip-till, or conventional till, and note how many acres are irrigated.	
3/ Identify and record the current growing and the crop grown previous to the current crop. Look at residues to identify previous crop type(s). Continuously planted, low residue producing crops like cotton, soybeans, beans, and peas require a cover crop be planted each year in order to meet residue requirements for no-till.	
4/ Determine if residue and crop stubble is evenly distributed across the field. Loose crop residues remaining on the field after harvest should be uniformly distributed over the field. Examine the soil surface for any anchored crop stubble remaining (standing or angled) from the previous crop. Over time, no-till fields will build a surface mulch layer. A surface mulch layer is a layer of partly decomposed crop residue on or near the soil surface. It may be more apparent between rows of crops.	Record number of acres that contain evenly distributed residue.
5/ Record evidence of full width tillage (w/chisel plow, sweeps, cultivator, disk, moldboard plow, etc.) **Approved implements:** no-till planters; no-till drills and air seeders; strip-type fertilizer and low disturbance manure injectors and anhydrous applicators. **Unapproved implements:** All other implements are considered to be full-width or capable of full soil disturbance and therefore not compatible with this practice. Any full-width tillage should be recorded on the form, regardless of the depth of the tillage.	If yes, record the number of acres with tillage. If less than one acre, write "<1" on the field form.
6/ Is there evidence that crop residues or stubble has been burned?	If yes, record the number of acres burned.
7/ Is there evidence that crop residue or stalks was removed by haying or grazing?	If yes, record the number of acres.
8/ Is there evidence that the growing crop was grazed out and not harvested?	If yes, record the number of acres.
9/ Is there evidence that the field has been fallowed for 1 year or more?	If yes, record the number of acres.
10/ Record the width of the tilled, planted rows. *(Strip-till and Minimum-till fields only)*	
10/ Record the width *between* tilled, planted rows. *(Strip-till and Minimum-till fields only)*	

Appendix B: Progressive Management Crediting Matrix

Continuous No-Till Progressive Management Crediting Matrix

Mgmt Level	1	2	3	4	5
Soil Health & GHG Seq Mgmt	◦ Conversion of FSA "cropland" from conventional tillage to no tillage ◦ Growing crop present ◦ Residue present and evenly distributed ◦ Anchored stalks present ◦ Cover crops follow low residue crops ◦ Burning does not occur ◦ Grazing ends by 3/15 ◦ Fallow <12 months ◦ Hayed annual crops followed by high residue cover crop	◦ At least 50% of soil covered with residue ◦	◦ Plants deep-rooted cover crop ◦ Adds legume cover crop ◦	◦ Rotating high residue crops or ◦ Adds additional crop to rotation or ◦ Cover crop cocktail of at least 3 species ◦	◦ Use of continuous cover crops OR ◦ Cover crop cocktail 7 species or greater OR ◦ Add 2 additional crops to rotation
Nutrient Mgmt & Avoided Emissions	◦ Conversion of FSA "cropland" from conventional tillage to no tillage ◦	◦ Soil test annually ◦ Fertilizes according to soil test recommendations and ◦ Uses split N application, when applicable to crop ◦	◦ In-season N incorporation/injection or ◦ Slow release nutrients or ◦ Nitrogen inhibitors or ◦ Use of N-rich strips	◦ Applying fertilizer at variable rates through the use of electronic maps with a GPS receiver by using grid sampling or EC mapping	◦ Uses sensor based variable rate application techniques such as NDVI sensing to apply nitrogen fertilizer
Wildlife Mgmt	◦ Conversion of FSA "cropland" from conventional tillage to no tillage ◦	◦ Plants a cover crop and/or has implemented other contingencies or plantings specifically for improving wildlife habitat	◦ .Buffer strips exist around riparian areas ◦ Adds pollinator species to cover crop ◦	◦ Leaves un-harvested strip around perimeter of field ◦ Buffer strips exist along field edges that create corridors for wildlife movement ◦ Buffer strips all at least 30 m wide along drainages	◦ Using a stripper header for harvesting ◦ Buffer strips all at least 46 m wide along drainages ◦ Utilizes IPM for pest control
Water Quality Mgmt	◦ Conversion of FSA "cropland" from conventional tillage to no tillage	◦ If irrigated, an irrigation plan is adhered to ◦ Fertilizing according to soil test recommendations	◦ Riparian buffer is in place ◦ Filter strips established ◦ Applying split nitrogen applications ◦	◦ Livestock excluded from buffer ◦ Utilizing nitrogen injection ◦ Applying nitrogen rich strip	◦ Livestock excluded from stream ◦ Has field border ◦ GPS targeted pest spray ◦ IPM plan in place ◦ Using precision equipment to apply nitrogen