Voluntary Versus State-Based Compliance Carbon Markets

The purpose of this document is to provide useful information about the voluntary and compliance carbon markets.

What is a Carbon Credit?

A carbon credit is a generic term for any tradable certificate or permit representing the right to emit one metric ton of carbon dioxide or the equivalent amount of a different greenhouse gas (tCO_2e) (Wikipedia, 2021). Agriculture can produce tradable carbon credits by increasing the amount of carbon stored in the soil or decreasing the amount of greenhouse gas (GHG) emissions attributed to the production of food, fiber, and energy products. In agriculture, important GHG include carbon dioxide (CO_2), nitrous oxide (N_2O), and methane (CH_4). Both on-farm (N_2O from soil) and embedded emissions (e.g., diesel and fertilizer manufacturing) should be counted. Sustainable farming practices may reduce net GHG emissions by building soil organic carbon stocks. Carbon storage in soil can generally be increased by many practices including:

- Planting cover crops,
- Returning the crop residues,
- Growing plants that produce a large amount of plant material (i.e., corn, grain sorghum, and perennial plants), and
- Minimizing soil disturbance.

Once the credits have been generated and verified, they can be sold to buyers through voluntary and compliance markets. Since changes in farming practices (e.g., cover crop) may require additional fuel and material input and thus higher upstream GHG emissions, carbon credits should be calculated using life-cycle analysis (LCA) tools to determine the net GHG reduction benefits (i.e., soil carbon increases less additional GHG emissions).

Selling Carbon Credits

When considering selling carbon credits to a voluntary or to a state-based compliance carbon program there are several important factors that should be considered. **First,** in a voluntary market, the rules (generally called "pathways") are created through a negotiation among the project developer or company, protocol developer, assessor and verifiers, and buyers. In contrast, state-based compliance market pathways are based on government legislation. **Second,** depending on carbon credit price, buyers can choose to participate, whereas in a state-based compliance market, the buyers may be legally obligated to purchase credits. The difference between the voluntary and compliance market purchasing requirements may be responsible for lower selling prices in the voluntary markets compared to compliance markets. For

example, many voluntary markets are paying between $10 to $20 per metric ton. In the California Low Carbon Fuels Standard, carbon credits are currently trading for $200 per metric ton. **Third**, for a seller to market credits, pathways must exist. These pathways are still being developed and involve discussion among the project developers, protocol developers, assessor and verifiers, and buyers.

Voluntary Markets

- The number of credits for trading are not fixed.
- Credit prices depend upon a contract between the buyer and the seller.
- Are managed by a coalition of companies that may be a company or a non-profit organization.
- Are often driven by corporate sustainability reporting (CSR), financial regulatory disclosure, or environmental, social, and governance (ESG) investing.
- Are complex in that each program has slightly different protocols developed by a number of protocol developers (most generally follow IPCC 2019 guidelines).
- Can include offsets and inset/emissions factors depending on the source or scope of the emissions (see Glossary document for definitions).
- Can be sold to a third-party entity.
- Are optional (not required by law) for the credit generator (i.e. farmer) or buyer (i.e. industry).
- May require adoption of new practices (additionality) or the purchase of a commercial product.
- Often vary in permanence requirements (10 to 100 years) for long-term soil carbon sequestration.
- Include pathways for payment or compensation for soil organic carbon storage, GHG emissions abatement, water quality improvement, and biodiversity enhancements.
- May provide pathways to obtain payments for storing carbon in soil.

Compliance Markets

- Are made in response to a government legislation.
- The number of credits for trading are fixed and are based on the regulatory requirements.
- Purchasing credits may not be optional for specific industries and manufacturers (buyers).
- Farmers choose whether to participate.
- Have been formed in 12 states and will be soon in other states as laws are passed.
- As of April 2021, options for providing payments in the California Lower Carbon Fuel Standard (LCFS) program for storing carbon in soil are under discussion.
    - Research is being conducted to determine an inexpensive and accurate pathway to measure/predict C storage.
- Each market selects or modifies an existing pathway (method) to fit their needs.
    - Example: The LCFS is an active market.
        - The goal of this program is to reduce the carbon intensity of petroleum-based fuels 20% by 2030 and 80% by 2050.

- Payments have been made to liquid fuel producers that help achieve these goals.
- Farm practices can further reduce GHG emissions. However, before farmers can receive payments, a pathway (method for measuring and validating the reduction) must be approved.
- Currently, the California (and Oregon) markets calculate carbon intensities using a modified form of the U.S. Department of Energy (DOE) GREET model.

Summary: Voluntary and compliance markets have similarities and differences. Similarities include that sellers can choose to participate and farmers may receive payments for participating. A difference is that in voluntary markets, buyers can choose to participate, whereas in compliance markets buyers may be required to participate. In addition, all markets have different pathways/protocols for determining offsets.

Role of the Federal Government

The U.S. Federal government influences renewable fuel production through the Renewable Fuel Standard. The RFS program is a national policy that requires a certain volume of renewable fuel to replace or reduce the quantity of petroleum-based transportation fuel, heating oil or jet fuel. The Renewable Fuel Standard, combined with other subsidies and mandates from both state and federal governments, has increased the amount of ethanol blended into the nation's fuel supply beyond what would occur in a free market. Under the law, the EPA sets annual quotas for conventional renewable fuel (usually corn-based ethanol), advanced ethanol alternatives made from non-edible material and biodiesel. These quotas are then translated into blending requirements for individual refiners. Companies that do not meet their blending mandates must buy Renewable Identification Numbers (RINs) to cover the difference, unless they are a small refinery that qualifies for a hardship waiver. In this program, the four fuel categories are biomass diesel, cellulosic biofuel, advanced biofuel, and total renewable fuelA full description of the RFS is beyond the scope of this fact sheet, and additional information is available at https://www.epa.gov/renewable-fuel-standard-program/fuel-pathways-under-renewable-fuel-standard.

At some time, the federal government may choose to regulate voluntary markets and the state-based compliance carbon trading programs. To date, there has been no federal movement on voluntary and state markets.

Question and Answers about Carbon Market

Disclaimer: Many answers to the voluntary carbon market questions are dependent upon the specific platform and their specific rules. This document is not intended to provide legal advice.

1. **Who is buying the credits?**
    - There are two broad carbon market types, voluntary and compliance markets.

- In voluntary markets, anyone who desires to reduce their carbon footprint can voluntarily purchase carbon credits.
    - Buying voluntary carbon credits is popular with high-emission industries such as manufacturing, technology, fuel, and food products.
    - Some examples of credit buyers include Cargill, Google, and Shell Energy.
    - Some corporations are voluntarily buying carbon credits to show their social responsibility, secure better financing rates, and to provide marketing opportunities.
- In compliance markets, such as the California or Oregon Low Carbon Fuels Standard (LCFS), fossil fuel makers are required by law to reduce the carbon intensity of their fuels. They do this by buying low carbon fuels to mix with their high carbon fuels or by buying carbon credits to offset this obligation.
    - The California LCFS compliance market was established by law in 2011 where the price of a metric ton of CO_2 (as of March 2021) is about $200.
    - Entities that are selling credits must have approved pathways (protocols/rules).

2. **Can I actually store carbon long term in soil?**
    - Yes, carbon can be stored in soils for a very long time if the carbon inputs in soils are equal-to or greater-than the carbon losses from soil respiration. Storing carbon in soil also improves soil productivity and resilience.
3. **How do I verify the amount of carbon in my soil?**
    - Soil sampling and subsequent analysis for soil organic matter (SOM) or soil organic/inorganic carbon is used to measure the amount of carbon in the soil.
    - Most commercial agricultural or soil labs will determine soil organic matter (SOM).
        - To roughly convert laboratory SOM results to soil organic carbon (SOC), multiply SOM by 0.58.
        - To convert SOC to the number of carbon credit(s), multiply SOC by 3.667 (The molecular weight of carbon dioxide (44 g/mol) divided by the molecular weight of carbon (12 g/mol)).
    - There are many different proposed pathways for estimating soil carbon change. Selected approaches to estimate C storage include:
        - At multiple locations, measure the changes in the amount of soil carbon stored in the soil. This involves sampling the same points multiple times.
        - Measure the amount of plant biomass returned to the soil annually. If this is greater than the maintenance requirement, C should be stored.

- Use a carbon model that considers climatic, soil benchmarks, and crop to estimate C storage.

4. **What do the different soil tests mean?**
    - Soil organic matter (SOM): measures all the organic materials in the soil and includes decomposing plant and animal tissues, and byproducts of microbial processes.
    - Soil organic carbon (SOC): is the of carbon content of the soil organic matter.
    - Permanganate-oxidizable carbon (POXC): Also known as active carbon, is highly sensitive to changes in management such as increasing or decreasing tillage or crop rotation diversity.
    - Soil inorganic carbon (SIC): is soil carbon stored in the form of carbonates and bi-carbonates of cations (Ca^{+2}, Mg^{+2}, K^{+1}, Na^{+1}).
    - Dissolved organic carbon (DOC): Is organic carbon dissolved in the soil water. It is organic carbon that can be rapidly mineralized.
    - Haney test for soil health: The Haney Test alone cannot be used to create carbon credits; it estimates the nutrient availability for soil microbes.
        - This test measures soil respiration (Solvita CO_2 burst test), water-soluble organic carbon, and organic nitrogen and their ratio.
        - Haney soil test numbers should be used as a comparison over time to determine your progress toward improving soil health.
        - Other test results included in the Haney test are nitrate, ammonia, phosphorus, aluminum, iron, phosphorus, calcium, magnesium, and sodium.
    - CO_2-burst test (Solvita): measure of soil respiration from soil microbes that is an index of microbial activity in soil.
    - Microbial biomass carbon: Carbon present in microbial organisms such as the bacterial cell, fungal hyphae, nematodes body, etc.
    - Labile carbon: forms of organic matter that decompose within a growing season or less than a year (green manures or leaf litter).
    - Non-labile carbon: complex organic compounds, such as lignin, that take several years to decompose.
    - Stable humus: organic matter which has reached a point of relative stability where the break down is very slow. This carbon might remain in the soil for centuries.
5. **How quickly and accurately can we detect changes in soil carbon?**
    - It can take at least four to five years to detect changes in soil organic carbon resulting from management changes. The ability to detect changes depends on interactions between management, climate, and soil.
6. **What depths do we need to measure for accurate soil carbon estimates?**

- Most standard fertilizer recommendations determine the soil organic matter of the surface soil. These values provide a reference for easy comparisons. To assess the amount of carbon that was sequestered, samples should be collected from the entire rooting zone.
- The soil root zone (generally up to 3ft) will be most impacted by management. This depth should be benchmarked (measured before a change in management) and monitored for SOC changes after management changes are implemented.

7. **What are the practices that will increase soil carbon the most/fastest?**
    - Management practices that increase the amount of carbon (manure or biomass) returned to the soil when combined with reducing soil disturbance have the greatest effect on increasing soil carbon storage. Examples include use of no-till, strip-till, and planting cover crops.
    - To find a combination of practices that works for your fields, it is helpful to visit with local agronomists or extension agents.
8. **How does weather (drought, flooding, etc.) affect carbon storage or loss?**
    - Soil carbon is lost through the microbiological degradation of plant materials that are contained within the soil and from soil loss during wind and water erosion events.
    - Climate factors that reduce the amount of biomass returned to the soil following harvest or changes the microbial activity can increase or decrease carbon loss.
    - If adverse conditions prevent planting a crop, soil carbon can be lost.
    - Extreme climatic events such as enhanced warming, drought, and heavy rainfall can change how much C is stored in soil.
9. **How does tillage affect soil carbon storage or loss?**
    - Soil carbon is protected when the soil is aggregated (binds together in small clumps) and is physically stable. Tillage breaks soil aggregates which makes the carbon stored in soil more susceptible to microbial decomposition and erosion.
10. **Do soils become saturated with carbon?**
    - A soil can reach a point where biomass additions are equal to the amount that is lost. At this point, soil carbon will stop increasing. However, this point can change with changes in temperature and moisture as well as increases or decreases in the amount of plant biomass added to the soil.
        - It may be possible to increase soil organic matter beyond the "saturation" point by planting cover crops, reducing tillage intensity, or planting crops that produce more plant biomass.

11. What are the different carbon markets?

- There are two broad carbon markets: compliance and voluntary. Compliance markets were the result of government regulations, whereas voluntary markets were developed by industry and non-profits.
- Multiple forms of compliance and voluntary markets currently exist. Most soil carbon credits are presently being traded through voluntary markets.
- For more information, see the supplemental document on voluntary versus compliance markets.

12. Who are the companies working in voluntary carbon markets?

- There are many opportunities for farmers to sell C credits through the voluntary markets. Each market has a slightly different pathway for estimating and selling credits. As of March 2021, some examples include:
    - Aspiring Universe
    - Bayer Carbon Initiative
    - CIBO Impact
    - ClimCo
    - Ecosystem Services Market Consortium (ESMC)
    - Evolution Markets
    - Farmers Business Network
    - Gradable
    - Indigo Carbon
    - Locus Agricultural Solutions
    - Nori
    - Nutrien
    - Soil and Water Outcomes Fund
    - TerraCarbon
    - TruCarbon (Land'O'Lakes + Truterra)
    - Verra
    - Western Sustainability Exchange
- See fact sheet for additional information.

13. Do I need a broker company?

- No, you do not necessarily need a broker company to sell carbon credits. Brokers can be independent traders or investors, tied to corporations or platforms, and/or specialty service providers.
- Some platforms enable farmers to directly sell their credits while others purchase credits from farmers for resale.

- Aggregation and brokering companies can reduce the amount of time you need to dedicate for selling carbon credits. The broker also assumes a portion of the sale risks.
    - However, most will either charge fees, take a portion of the proceeds for their services, or purchase credits at a flat rate for resale.
- You must consider how much time you are willing to commit to the sale of the credits, your risk comfort level, and your knowledge of the markets.

14. Can I sell carbon credits directly myself?

- As markets become more mature, the answer to this question can change. When you make your marketing decisions, consider your:
    - Knowledge, preferred level of involvement, risk comfort, available time, and willingness to monitor and verify the credits,
- There are currently platforms within the voluntary carbon market which allow farmers to directly register and sell their credits.
- It is too soon to tell if these self-service markets give producers a market advantage.

15. Who gets the payment/owns the credit on rented land?

- This is a gray area for voluntary carbon markets because the markets can change with time.
    - It is a good idea to seek out legal advice for your specific situation prior to entering carbon credit contracts.
    - For some carbon platforms, the credit follows the field (landowner), not the farmer. For other carbon platforms, this could be different.
- The ownership of credits is recorded in registries which are checked during the verification process to prevent two parties from obtaining duplicate credits on the same ground.
- Emission reductions (avoidance of carbon dioxide, nitrous oxide and methane emissions and the use of fossil fuels) and tillage and crop production practices (which generate offsets) are management choices and are the responsibility of the operator.
- Specifying the division of carbon credit responsibilities and ownership in rental agreements will help avoid conflicts.

16. What happens if I lose or can't show that I have increased carbon?

- The carbon credit contract will specify the steps that will be taken and/or consequences if credits do not pass verification.
- If the farmer cannot fulfill contractual obligations, many companies will pause or withhold payment until the obligations are met.
- If you have concerns that you may be unable to meet contract requirements, please seek appropriate legal counsel to explore your options.

17. **Is the program measuring and rewarding changes in soil carbon? Or rewarding adoption of conservation practices?**
    - Currently, most programs only award credits for soil carbon sequestration offsets and/or greenhouse gas emission reductions.
        - Some platforms, such as the Ecosystem Service Market Consortium, are working to develop protocols that encompass improvements in soil, air, and water quality.
    - Rewards for adopting specific management practices are being considered by some marketplaces. This approach is being considered to reduce quantification costs.
    - At this stage, the future of the market for ecosystem services is uncertain.
18. **Will farmers who have already been working to increase carbon in their soils be able to benefit from these programs?**
    - In the voluntary markets, payments are most often provided for adopting new practices (additionality, see glossary for definition). However, some companies allow farmers to receive payments if the new practices were only recently adopted.
    - Some markets have safeguards that reject applicants who intentionally degrade soil resources.
19. **Are greenhouse gas emissions and carbon footprints of the farm operation going to be considered in the programs? Is the program based on net storage rather than just carbon levels?**
    - Most programs measure the entire carbon footprint of the food or feedstock that is being produced, so this would account for all GHG (CO_2, N_2O, CH_4) emissions of the farm (land preparation through harvesting) and convert that value into carbon dioxide equivalent.
    - Carbon credit is a generic term for any tradable certificate or permit representing the right to emit one metric ton of carbon dioxide or the equivalent amount of a different greenhouse gas (tCO_2e). Carbon credits can be generated by following an approved pathway that quantifies and validates reductions in CO_2 emissions (CO_2 equivalent of GHGs). For example, switching from conventional tillage to no-tillage.
    - Carbon credits are a term which is misleading and confusing.
    - Other terms that can be used are CO_2 equivalent, soil organic carbon offsets, or greenhouse gas emission reductions. The SOC is converted to number of carbon credit(s), by multiplying SOC by 3.667.
    - Many life cycle analysis models convert greenhouse gases to CO_2 equivalent (CO_{2eq}).
20. **How large of a payment should I expect?**
    - Compliance markets are not approved for carbon storage in soil through crop production, and therefore payments will only be through the volunteer markets.

- In the volunteer markets, markets are variable and have been ranging from $4 to $40/acre. However, most range from $10 to $20 per acre.
    - As of March of 2021, carbon was worth roughly $200 per metric ton in the California LCFS compliance market. However, for a farmer to receive payments, there must be an existing pathway (i.e. an ethanol plant that meets LCFS requirements that a producer could sell to).
        - Discussions (April 2021) are being held with California LCFS to create pathways where farmers can receive payments for C storage in soil.
        - Within the California LCFS, pathways do exist for the payment of biofuel that meets LCFS criteria.
- The credit produced depends upon management practice.
    - Low or no till, cover crops, or conversion of row crop land to perennial grasses lead to a different quantity of carbon sequestration depending upon the environmental variables, soil, and previous land use.
- The payments are a function of many factors including,
    - The practices adopted
    - Expected greenhouse reductions
    - Verified reductions.

Glossary: Terms Often Used in Compliance and Volunteer Soil Carbon Markets

Additionality: This term is a belief or principle which can mean something different in each carbon market, so context is needed. It sometimes means that carbon credits can only be made if practices go beyond what is currently being done on the farm. Some markets require 'additional' activities or changes in farming which would not be possible without the sale of carbon credits. For example, if a farmer been using no-tillage for many years, then they will not earn credits for using no-tillage. In this context, credits could only be earned by doing something in addition to no-tillage. In other markets, additionality means producers are required to continue to reduce their emissions or continue to increase their soil carbon storage even if they are a low carbon producer. Not all markets require additionality. For example, the California Air Resource Board (CARB) compliance market does not use additionality.

Baseline: The amount of soil carbon on your farm at a point in time. A baseline would be that your soil has 20 tons of carbon per acre and that you apply 150 lbs N/(acre × year). Based on these values the

amount of carbon stored in the soil or decreases in the amount of N applied to the can be calculated. Baseline is a term that is often linked with past emissions and future goals or mandates.

Benchmark: Very similar to a baseline. It is a standard or a point of reference that can be used to verify changes in soil carbon. Benchmarks are commonly used in policies, such as Lower Carbon Fuel Standards to set an emission standard (rules for pollutant releases) for specific fuels or methods of making fuels. For example, if a fuel producer goes above their carbon benchmark, then they must purchase carbon credits (including emission reductions or offsets), but if they go below their benchmark, they can sell carbon credits as emission reductions to others.

Bulk density: A measure of how heavy and tightly packed the soil is. This is calculated by taking a known volume (size) of soil, drying the soil, and dividing the weight of the dry soil by its volume. Uncompacted (light, loose) soils with high organic matter content will have a low bulk density. Compacted (tight, hard, heavy) soils will have a high bulk density. Bulk density is required to quantify how much carbon is in the soil.

Business-as-usual: A set (unchanging) process or normal practices and activities. These normal practices can be for an individual farm or a region with similar traits. For example, planting corn every year in eastern South Dakota normally means fall tillage followed by disking in the spring and planting when soil temps go above 55 °F. The common practices for an area can be used to figure out the typical carbon footprint of an area and these averages are sometimes used in deciding carbon credit rules.

Calibration: The process of comparing measured values with known levels or standards. A process used to adjust models and/or tools to make them match real-world systems and results. When a model or tool has been calibrated, it can be used to estimate carbon storage.

CARB (California Air Resources Board): The "clean air agency" in the state government of California. This is a group of people appointed by the Governor of California and approved by the State Senate to set the rules for meeting California's climate change policies.

Carbon broker: A person or company that serves as a middleman between carbon credit (offset and emission reduction) sources and buyers. Each offset or emission reduction source can provide carbon credits. Brokers can help collect the number of carbon credits needed to attract corporate or other big buyers who can pay higher prices.

Carbon credit: A carbon credit is a generic term for any tradable certificate or permit representing the right to emit one metric ton of carbon dioxide or the equivalent amount of a different greenhouse gas (tCO_2e). It is also used to describe greenhouse gas emission reductions or offsets. There are three major

greenhouse gases that are related to farm operations that can generate carbon credits: carbon dioxide (CO_2), nitrous oxide (N_2O), and methane (CH_4). Each of these gases have a different effect on climate, so a common term called CO_2 equivalents ($CO_{2\,eq}$) is used to make all carbon credits equal. For example, 1 ton of methane is equal to about 25 tons carbon dioxide and 1 ton of nitrous oxide is about 300 tons of carbon dioxide.

CAP: Common Agricultural Policy in the European Union. Its main purpose is to provide a stable, sustainably produced supply of safe, low-cost food for people, while also ensuring a decent standard of living.

Cap: Defines the max amount allowed. As in a cap on emissions.

Cap-and-trade: A policy tool where the government places a limit or cap on the emissions from polluters. This cap can sometimes become tougher with time. Polluters can meet this cap by reducing their emissions, or by purchasing carbon credits. The carbon credit prices are set by market demand. The goal of this type of policy is to use high credit prices to push polluters into cutting emissions to save money. The U.S. Acid Rain program has successfully used cap-and-trade policy approaches to reduce acid rain.

Cap-and-invest: A policy tool where an annual governmental cap on emissions is set lower each year. Polluters must bid and pay for a limited number of emission allowances. The money paid by polluters is then invested to reduce emissions and do other things which benefit nature and/or people. The investment could be the creation of new parks and nature preserves or buying better, low-emission buses and low-cost bus rides to more places.

Carbon definitions:

1. **Soil organic matter (SOM):** measures all the organic materials in the soil such as rotting plant and animal tissues, and by-products of microbial processes.
2. **Soil organic carbon (SOC):** measures the amount of carbon content in soil organic matter.
3. **Permanganate-oxidizable carbon (POXC):** Also known as active carbon, this carbon is highly sensitive to changes such as increasing or decreasing tillage or crop rotation diversity. For more information see POXC.
4. **Soil inorganic carbon (SIC):** soil carbon stored in the form of carbonates and bicarbonates (like caliche or limestone). The most common form of carbonated in semi-arid and arid regions of the United States is calcium carbonate.
5. **Dissolved organic carbon (DOC):** this type of carbon is most often seen in water test results, not soil. It is carbon that is rapidly mineralized.

6. **Haney test for soil health:** measures water-soluble organic carbon, organic nitrogen, nitrate, ammonia, phosphate, aluminum, iron, calcium, magnesium, and sodium. Results are related to amount of soil nutrients that soil microbes can consume. For more information, see Haney Test for Soil Health.
7. **CO_2-burst test (Solvita):** measure of soil respiration from (breathing of) soil microbes that is an index of life in soil. For more information see Solvita.
8. **Microbial biomass carbon:** Carbon present in microscopic life (bacteria, fungi, nematodes) within the soil.
9. **Labile carbon:** Forms of organic matter that decompose or rot within a growing season or less than a year (green manures or leaf litter)
10. **Non-labile carbon:** Soil carbon locked in complex chemicals such as lignin (woody plant fibers in stems) that take several years to rot or decompose
11. **Stable humus:** organic matter which has reached a point of stability, where it will break down no further and might, if conditions do not change, remain in the soil for centuries.

Carbon dioxide (CO_2): A greenhouse gas which has a global warming potential (GWP) of one. Carbon dioxide is produced when plants, animals, microbes, and other living beings use oxygen to breathe (aerobic respiration). During this process, living beings convert food to energy and carbon dioxide. It is also made when fuels like coal, ethanol, or wood are burned. It is a common greenhouse gas which is both released to and taken from the air by farm activities.

Carbon dioxide equivalent ($CO_{2\,eq}$): A measure that converts greenhouse gases, based on their global warming potential (GWP) to an equivalent (comparable) amount of carbon dioxide. The impact that each gas has on our climate over the next one hundred years is called the global warming potential. The global warming potential of carbon dioxide is considered one, and other greenhouse gases are converted to equivalent amounts of carbon dioxide ($CO_{2\,eq}$) The conversion factors for methane and nitrous oxide are approximately 25 and 300, respectively. See carbon credit and EPA GHG Overview for more information.

Carbon footprint: This is a term that can have many meanings. How, when, and where it is used affects the meaning. The carbon footprint is the total amount of greenhouse gases that are made or produced by any given action. Many online tools such as TNC's Carbon Footprint Calculator can be used to assess personal carbon levels. In farming, the main greenhouse gases are carbon dioxide, nitrous oxide, and methane. Each of these gases have a different effect on the earth's climate, with nitrous oxide and methane having about 300 and 25 times more than the impact of carbon dioxide, respectively. As a result, a carbon footprint that only considers carbon dioxide can be markedly different than one that includes all greenhouse gases.

Carbon insetting: It is when a company can meet its carbon footprint reduction goals on its own without buying carbon credits.

Carbon intensity: This is a ratio of the gross or net emission of carbon dioxide and/or greenhouse gases per unit of energy made or used. In the U.S., this term often is used to compare biofuels as the net greenhouse gases emitted per British thermal unit (btu) of energy. However, it can also refer to carbon dioxide emissions only, which for some fuels, is much less than the total greenhouse gas emissions, or the term may not include soil carbon in the footprint.

Carbon market: This is a place where carbon credits are bought and sold. These markets can deal in more than soil carbon; most also trade credits created by reducing nitrous oxide, methane or other greenhouse gas emissions. There are two main types of carbon markets, voluntary and compliance.

Carbon offsetting: It when/where a company buys carbon credits to meet their carbon footprint goal.

Carbon sink: Has the ability to remove carbon dioxide for an indefinite period from the atmosphere.

Carbon source: Processes where carbon dioxide is released into the atmosphere.

CENTURY: The process-based model that is used to figure out greenhouse gas emissions and carbon storage due to crop, grassland, and forest growth. This model was built to estimate long-term nutrient changes in soil systems. The CENTURY model (and DAYCENT, the daily CENTURY) has been used by scientists for several decades and they useful in estimating soil carbon changes.

Certified emission reduction: A verified (checked) and measured decrease of one metric ton of carbon dioxide equivalent ($CO_{2\,eq}$) made following the rules of the Paris Accord and/or regional compliance markets such as found in California. This term is rarely used within the emerging voluntary carbon market within the United States.

Clean Development Mechanism (CDM): One of the Flexible Mechanisms defined in the Kyoto Protocol (IPCC, 2007) which generate Certified Emission Reduction units (CERs). An international program managed by the United Nations and established by the Kyoto Protocol to support sustainable development by certifying emission reductions in third-world countries and trading them to more developed countries.

COMET-Farm (CarbOn Management & Emissions Tool -Farm): A web-based tool that is maintained by the U.S. Department of Agriculture's Natural Resource Conservation Service (NRCS). This model is based on the which uses the DAYCENT model to estimate greenhouse gas emissions from crops. This tool can be used by farmers to estimate field-level greenhouse gas emissions and soil carbon.

Compliance market: A market formed in response to a government rule or regulation. A system for exchanging goods or services for money that people, businesses, or organizations must participate in to meet regulatory mandates. With respect to the carbon market, compliance markets have been established in many locations including, California and Oregon.

Corporate social responsibility: Large businesses are expected to follow U.S. standards and follow ethical practices, such as not using slave labor or dumping harmful chemicals into the streams and lakes. People want to know that the companies did not hurt nature or people when making the product they are buying and using. This collective (group) goal of doing business ethically and the right way is often called corporate social responsibility. Companies often purchase offsets voluntarily to appeal to buyers and to meet social responsibilities.

Credit/offset creation: A carbon credit, or offset, is a documented decrease in CO_2 or in other greenhouse gas (GHG) emissions that is traded from a CO_2-reducing source (ex: agricultural producer or clean fuel manufacturer) to a CO_2-emitting industry. The CO_2-emitting industry purchases credits to reduce their carbon footprint. Credits can be made by many different industries including manufacturing, shipping, energy production, and agriculture. For example, credits could be made by planting trees, developing an improved-efficiency engine, reducing the amount of nitrogen fertilizer applied to a field, or reducing tillage intensity. There are many ways to calculate credits and carbon footprints.

DAYCENT - A daily timestep version of the CENTURY model. This is a process-based model used to assess carbon, nitrogen, and water cycling in ecosystems.

Denitrification: This is a biological process where nitrate (fertilizer) is converted to nitrogen (N_2) gas and released to the air. This process is not fully efficient, and a portion can also be lost to the air as nitrogen oxide (NO) and nitrous oxide (N_2O).

DNDC (DeNitrification-DeComposition Model): A process-based model that estimates the greenhouse gas emissions and soil carbon due to crop, grassland, and forest growth. This model was developed to estimate soil nutrient changes. The DNDC model has been used by scientists for several decades and has proven useful worldwide in modeling soil nitrogen changes and nitrous oxide emissions.

Equilibrium: When the carbon inputs (what goes in) are equal to the carbon outputs (what goes out). The carbon inputs at the equilibrium value are the maintenance requirement (smallest amount of new carbon that needs to be added to keep current level of soil carbon). Returning more carbon to the soil than maintenance requirement should increase the amount of carbon stored in the soil.

Emission reduction: This is a type of carbon credit made when greenhouse gas emissions decrease. Emission reduction and credit creators are often linked to a specific suite of registries, verifiers, brokers, markets, and purchasers. Prominent registries include: Climate Action Reserve, Verra, the American Carbon Registry, The Climate Registry, and Gold Standard. The California Air Resources Board currently has 65 companies as accredited verifiers. Carbon credit registries are a clearinghouse for companies that are creating credits. Carbon credits require a viable pathway to show how credits are generated, verified, and sold.

Environmental, social, and governance (ESG) investments: Companies spend money and make changes voluntarily to reduce their impact on the environment. The company's activities generally go beyond what is required by law. As part of ESG investments, many companies purchase voluntary carbon credits.

EU ETS: This is the European Union's Emissions Trading System for greenhouse gases. The countries within the European Union have set required emission reductions and created a carbon market. Compliance with these mandates has created a premium international market for low carbon feedstock, biofuels, and bioproducts.

Fluorinated gases (F-gases): Man-made gases that have a very large global warming potential (up to 22,800x that of CO_2) and that can stay in the air for a very long time (thousands of years). There are four types: hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF_6) and nitrogen trifluoride (NF_3). Fluorinated gases are less commonly emitted by farm operations but are used in the electric grid, making electronics, and cooling systems like air conditioners and refrigerators.

Global warming potential: The impact each greenhouse gas will have on our climate over the next one hundred years is called the global warming potential. It is based on the climate forcing and level of the gas in the air.

Gold Standard: The Voluntary Gold Standard (GS VER), a standard for use within the voluntary carbon market, was launched in May 2006. This program was created after discussing standards with a diverse group of independent experts

Greenhouse gas: Any gas that retains heat within the atmosphere (air). There are 25 gases that the IPCC has found to cause climate problems. The most mentioned gases are water vapor (H_2O), carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4), sulfur hexafluoride (SF_6), ozone (O_3), and chlorofluorocarbon (CFCs). Chlorofluorocarbons are a group of many gases used in aerosol cans, refrigerators, and making many things, such as computer chips. The climate forcing, or ability to influence climate, of these gases varies and changes as more of these gases are emitted.

GREET® (Greenhouse gases, Regulated Emissions, and Energy use in Technologies model): A life cycle analysis model used to calculate carbon footprints**.** GREET® is a suite of life-cycle analysis (LCA) models developed at US-DOE- Argonne National Laboratory. This model has been adopted by many U.S. policymakers and is used in both California's and Oregon's carbon markets. GREET can be used to calculate life cycle energy consumption, fossil fuel energy used, greenhouse gas emissions, air pollution emissions, and water consumption of renewable and non-renewable fuels.

Insetting: Carbon insetting is a proactive approach to reducing greenhouse gas emissions that occurs within a company and supply chain.

IPCC: This is the International Panel on Climate Change. This global group of scientists work together to identify sources and sinks of greenhouse gases and to model how our world will be changed by these emissions in the future. This group publishes data and forecasts based on consensus (meaning, they all must agree, which is hard to do with several hundred scientists). Their findings are updated every few years as more is learned about climate change.

Kyoto Protocol: This is an international treaty adopted in 1997 which set the core rules and principles for carbon markets. This agreement created rules for developed and developing countries while setting voluntary country-specific targets for emission reductions.

Legume: A group of plants which take nitrogen from the air to add to their plant structure. Legumes belong to the **family Fabaceae (or Legumi**n**osa**e**),** or **the fruit or seed of such a plant.** When used as a dry grain, the seed is also called a pulse. Legumes are grown for people and livestock to eat. Well-known legumes include alfalfa, clover, beans, peas, soybeans, and peanuts. Legumes are notable that most of them have symbiotic nitrogen-fixing bacteria in structures called root nodules, and they play a key role in crop nitrogen dynamics.

Life cycle analysis (LCA): Life cycle analyses (LCAs) are used to gauge carbon intensities (CI) for ag products such as biofuels and high-end foods. The supply, demand, and use of ag products and trade-offs related with farm systems have direct and indirect effects on local, national, and global systems. Plants capture carbon from the air. With proper care, nature can transfer this carbon into soils. Many farm practices can reduce or avoid emissions. Farms and fields can be managed to make emission reduction credits or offsets, such as soil carbon credits, which can be sold. LCAs can be used to help make choices, reduce climate change, and build a lasting and robust economy.

Farm systems can vary lots within a farm or a given year. LCAs take a snapshot of these changes. Crop and animal yields do not always meet farm goals. As a result, we need to focus on long-term gains rather than short-term impacts. For example, changing crop residue into soil can take ten years of more. While

nitrogen losses due to poorly timed fertilizer use can occur within hours or days. Actions which support long-term, positive rural economy (such as using biofuels to produce crops) and farm system benefits (such as soil health and water quality) are needed to protect the future of our farms and ranches.

Lower Carbon Fuel Standard (LCFS): A type of policy which sets greenhouse gas emission standards for fuel makers. Many LCFS's are made to set up compliance-based carbon markets and incentivize lower carbon fuels. Low Carbon Fuel Standard (LCFS) compliance market in California was set up in 2011. Within this market the carbon price varies and in March 2021 it was about $200 per metric ton. In compliance markets, the price reflects the true cost of reducing carbon footprints. Currently, compliance carbon cap and trade markets have been created by California and Oregon (Clean Fuels Standard).

Mandate: A required action, activity, order, or target. This is a term commonly used when talking about laws or policies where compliance is required.

Mandatory: It is required.

Maintenance requirement: The amount of organic carbon required to keep the soil organic matter at the current level. The maintenance requirements for soil carbon vary with climate, soil type, and farm practices.

For example, if the surface 6 inches contains 2 million lbs of soil, the soil contains 3.5% organic matter, and 20% of biomass carbon is retained in the soil following degradation, then the maintenance requirement likely is,

$$\frac{2,000,000\ lbs}{acre\ \times 6\ inches} \times \frac{0.035\ lbs\ SOM}{1\ lbs\ soil} \times \frac{0.58\ lbs\ C}{l\ lbs\ SOM} \times \frac{0.02\ lbs\ lost}{1\ lbs\ C} = \frac{812\ lbs\ C\ lost}{acre\ \times 6\ inches}$$

$$\frac{812\ lbs\ C}{acre \times 6\ inches} \times \frac{1\ lbs\ biomass\ C\ added}{0.20\ lbs\ C\ returned} \times \frac{1\ lbs\ biomass}{0.42\ lbs\ biomass\ C} = \frac{9667\ lbs\ biomass}{acre\ \times 6\ inches}$$

The amount of residue varies across locations and crop varieties. This math assumes that only 20% of the added biomass goes into soil organic carbon. This biomass (9667 lbs biomass/acre) is the non-harvested surface residue (leaves, stems) plus roots that must be kept in fields to keep the soil organic matter at 3.5%. For corn, a 200 bushel/acre crop returns about 9500 lbs biomass per acre. If the root to shoot ratio (roots produced/{shoots + grain}) is 0.55, then for this example, the corn roots return over 5000 lbs biomass/acre to soil.

Methane (CH_4): A greenhouse gas that can be **converted to CO_2 eq by multiplying CH_4 by 25. The** amount of methane in the air has increased by about 150% since 1750. The primary ag sources of methane are from dairy and livestock.

Nitrification: The biological process where ammonium (NH_4) is oxidized into nitrate (NO_3). During this process, nitrous oxide, a greenhouse gas is produced.

Nitrous oxide (N_2O): Nitrous oxide is also known as laughing gas or nitrous, and it is produced during denitrification and nitrification. The amount of nitrous oxide in the air reached 333 parts per billion (ppb) in 2020 and is growing every year by about 1 ppb. Nitrous oxide has a global warming potential of around 300 times that of carbon dioxide. Nitrous oxide emission happens in short bursts, mostly just after fertilizer is applied to field. The relationship between N rate, climatic conditions, and how much is emitted as nitrous oxide is actively being researched.

Offsetting: The act of buying external carbon credits. It is not always possible for a company to meet their carbon goals. When a company is unable to do so, they can meet their targets by buying tradable carbon credits (emission reductions, offsets) from someone else. Carbon credits can be made when a system or resource (such as soil) serves as a 'sink' to remove and store harmful emissions. These sinks can be used to offset or counteract sources of emissions

Paris Agreement: This is an international treaty which took effect in 2016 to reduce global greenhouse gas emissions. The UNFCCC manages compliance with this legally binding treaty to address global climate change issues.

Permanence: Lasting or staying forever without changing. Permanence is defined by carbon laws and policies, which has given it many meanings. In soil, the idea of permanence is a balance between carbon additions and losses. For example, if the field biomass is always more than the maintenance requirement, then soil carbon will always stay stored. But if less biomass is added than the maintenance requirement then storage is not permanent.

Protocol: A guidebook or set of instructions listing how carbon credits are created, checked, and handled. Protocols will also explain the methods of how carbon will be counted.

Registry: A company or organization that tracks carbon credits (emission reductions and offsets) to ensure that they are not sold to multiple buyers. Registries also track when and by whom these credits are used. When carbon credits are used, they are 'retired' from the system.

Regulation: A rule or directive made and maintained by an authority.

Repeatability: The ability to follow modeling or testing methods that were used before and get the same results. With respect to carbon credits, this property is the same as replicability or reproducibility.

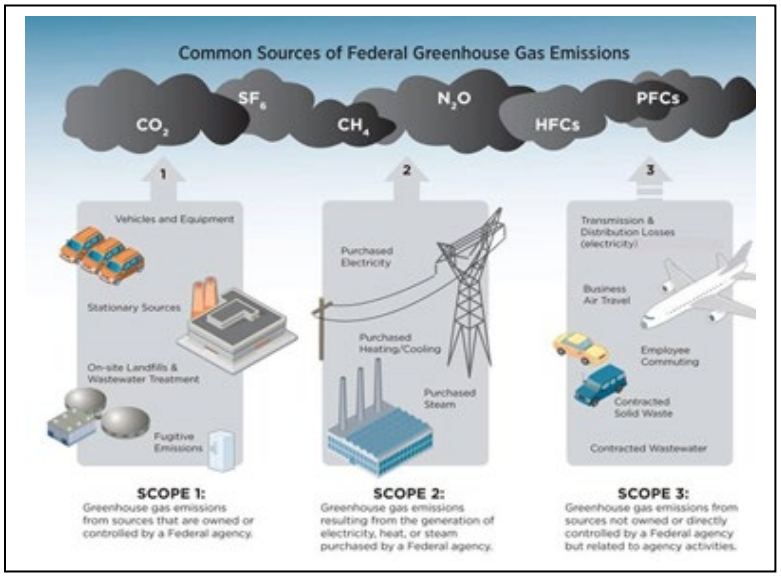
Reproducibility: The findings can be repeated.

Replicability: Doing an experiment again or more than once using the same methods.

Saturation: The point when no more of something can be absorbed. Saturation occurs when a system reaches a chemical or physical limit where no more can be accepted into the system. With soil carbon, some scientists believe that there is a point where no more carbon can be added to the soil. This point could be called the cap. This is a point of debate and some scientists do not believe this to be true.

Scope 1 GHG emissions: are direct emissions from sources that are owned or controlled by the EPA. Scope 1 includes on-site fossil fuel burning and fleet fuel use.

Scope 2 GHG emissions: are indirect emissions from sources that are owned or controlled by the EPA. Scope 2 includes emissions that result from making electricity, heat, or steam bought from a utility provider.



Scope 3 GHG emissions: are from sources not owned or directly controlled by EPA. Scope 3 emissions include employee travel and commuting. Scope 3 also includes emissions associated with contracted solid waste disposal and wastewater treatment. Some Scope 3 emissions can also result from transportation and distribution (T&D) losses associated with purchased electricity.

Sequester: The process of isolating and retaining something. When farmers 'sequester' soil carbon, they are using practices that pull carbon dioxide from the air and store it in stable forms in the soil.

Sink: A practice, process, or system which removes pollutants such as greenhouse gases. The most discussed sink for greenhouse gases is soil organic carbon. When plants remove carbon dioxide from the air and store in the soil, the process is called soil carbon sequestration.

Soil carbon sequestration: Soil carbon sequestration is a process of removing carbon dioxide (CO_2) from the air and storing it in the soil by adding soil organic matter. See also sequestration and carbon maintenance.

Soil health: Soil health, also referred to as soil quality, is the continued ability of soil to function as a vital living ecosystem that sustains plants, animals, and humans.

Source: A practice, process, or system which emits greenhouse gases into the air.

Transparency: All of the steps in a process are open for inspection. A process or system which is completely explained and visible to others. In the carbon market, transparency is a positive trait where all information on where, when, how, and what processes occurred to create a carbon credit can be viewed and nothing is hidden. Clearly showing the origin of credits helps to build trust and helps to show that the credits are real.

UNFCCC: This is the United Nations Framework Convention on Climate Change. This international agency works to develop global agreements to help fix climate change-related issues.

Validation: The action of checking or proving the validity or accuracy of something. A measurement process used to ground truth or check that models and/or methods are accurate and properly represent real systems.

Verification: The process of establishing the truth, accuracy, or validity of something. A process of checking that all information, methods, and results are true. Carbon credits go through a verification process by an independent third-party before they are sold. For carbon markets, the process is often like tax audits - the depth of the audit varies from paperwork checks to a visit where results are checked. With carbon markets, verification is used to catch entities which falsely report or misrepresent facts.

Volatilization: The loss of a gas to the air. This term is often used when talking about ammonia (NH_3) or other N fertilizer losses to the air. Losses can be minimized by following the 4R approach, apply at the right time, right place, right source, and right rate.

Voluntary market: A market where the buyers and sellers do not have to participate in selling and buying carbon credits. A system for exchanging goods or services for money that people, businesses, or organizations can choose to join in or not participate.

Voluntary Carbon Market Companies

Program	Website	Minimum Acres/requirements	Payments	Farmer Requirement	Details
Bayer Crop Science	https://bayercarbon.com/	a. No minimum acres for enrollment	a. Practices implemented prior to Jan 1, 2012 do not qualify	a. Enroll acres into the Bayer CarbonProgram through Climate FieldView digital ag platform	a. Receive yearly payments for verified and validated practices
		b. Producer must be located in selected states	b. Historical payment possible for practices implemented after Jan 1, 2012	b. Payment for management practices not for GHG emissions reductions	b. Not required to purchase Bayer products
		c. Fields cannot be enrolled in additional programs that generate credits	c. Will pay $3/a for reduced tillage and $6/acre for cover crops	c. Fields must remain in program for 10 years minus payments for historical practices plus in additional years where practices must be maintained	
Locus Agricultural Solutions; CarbonNOW	https://locusag.com/carbonnow/		a. One ton of C sequestered is equivalent to one carbon credit.	a. Join CarbonNow	a. Growers are issued carbon credit(s) to sell in an approved market place of their choice
			b. CarbonNOW will help the farmer identify an appropriate market place	b. In conjunction with using probiotic technology (Rhizolizer Duo), use or start using no-or low-tillage management, cover crops, reduced fertilizer, integrate livestock, and/or retain roots post-harvest.	
			c. Credits have been sold at $15/carbon credit	c. Score the fields using free software	
				d. Walk through data collection, documentation, soil sampling, and verification process	

Program	Website	Minimum Acres/requirements	Payments	Farmer Requirement	Details
CIBO	https://www.cibotechnologies.com/	a. No minimum size	a. Verification is done using remote sensing and computer vision	a. Sign contract	a. Launched in 2020
		b. Buyers buy direct from farmers	b. Once practices are verified, they are registered, and placed on CIBO impact market	b. Raise corn or soybeans	
		c. Carbon credit is equal to one tonne of carbon dioxide	c. No soil sampling, receive payments for activities you are already doing	c. Use regenerative practice	
		d. does not require multiyear contract		d. Provide shapefile and field boundaries	
				e. After crop emerges, practices are validated, credits are generated and placed on the market.	
ESMC; Ecosystem Services Market Consortium	https://ecosystemservicesmarket.org/	a. No minimum acres	a. Payment based on the measured beneficial outcomes of activities.	a. Producers must register in the system and enter required information for asset or credit generation, and certify information entered is accurate to the best of their knowledge.	a. ESMC is a non-profit organization

Program	Website	Minimum Acres/requirements	Payments	Farmer Requirement	Details
	See https://ecosystemservicesmarket.org/frequently-asked-questions for frequently asked questions	b. Croplands and rangelands qualify. Current acres include portions of the Corn and Soy Belt, Southern and Northern Great Plains, Great Lakes, Pacific Northwest and California	b. Paid for the amount of sequesters soil carbon, reduced GHG emissions, pounds of phosphorus and nitrogen, and tons of sediment prevented from being released into the watershed; and annual water savings from reduced irrigation withdrawals from natural water bodies (based on ESMC analysis).	b. Producers must show ownership of the assets that will sold into the market.	b. Pilot programs are taking place now with intention of market program launch in 2022.
		c. Producers are not required to implement a specific set of practices.	c. There is no contractual volume for producers and the standard contracting length is 5 years	c. The act of implementing conservation practices may have associated costs. Producers may be responsible for practice implementation costs and potential program expenses (such as soil carbon testing).	c. There is no enrollment fee or requirement to purchase agricultural products.
		d. Farmers implement conservation practices specific to their production system and geography	e. Producers' outcomes are calculated annually over the course of a 5-year crediting period (which may be renewed for three additional 5-year contracts for a total of 20 years maximum participation).		e. Scope 1 carbon greenhouse gas contracts are 10-year minimum.
		e. ESMC recognizes common practices referenced in NRCS Conservation Practice Standards. However. non-NRCS recognized practices may also be used, provided the outcomes justify their use.			

Program	Website	Minimum Acres/requirements	Payments	Farmer Requirement	Details
Farmer Business Network; Gradable	https://www.gradable.com/	a. Practices can be approved up to two years prior to entering program	a. Payments are buyer and seller dependent and you can bank credits.	a. Enroll fields	a. Gradable covers cost of samples to set baseline
			b. Over 5 years, 60% issued to the farmer	b. Share practices	
			c. 25% withheld to cover avoidable and unavoidable carbon losses over 100 years	c. Submit field reports	
			d. 15% of credits will be retained by Gradable	d. Earn credits for no/reduced tillage, cover crops, reduce N and use diverse rotations	
			e. For practices adopted in 2019 and 2020, the fixed floor price is $20 per credit		
Indigo Ag: Terraton/Indigo Carbon	https://carbon.indigoag.net/login	a. Field crops excluding rice and perennials	a. Fields enrolled in 2021 are guaranteed a minimum of $10 for verified credits	a. Must contract at least one field	a. Prior to credits being issued, data and documentation are verified
	Ms. Paula Sokolska; psokolska@indigoag.com	b. Requires a change in management, however, recent changes may qualify	b. Must farm in an Indigo-approved state: Arkansas, Colorado, Georgia, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Minnesota, Mississippi, Missouri, Nebraska, North Carolina, North Dakota, Ohio, Oklahoma, South Carolina, South Dakota, Tennessee, and Texas	b. Acceptable practices include: Planting a cover crop, targeting N, reducing tillage, and diversifying crop rotation	b. Carbon credits are issued and tracked through registries
			c. Credits are issued each year	c. Must enroll fields, draw field boundaries in Indigo software, and provide 3 to 5 years of historical management records	c. Some land does not qualify; histosols, land recently removed from native vegetation, acres already enrolled in other carbon programs, etc. See website for full list.

Program	Website	Minimum Acres/requirements	Payments	Farmer Requirement	Details
			d After harvest each year, credit sales can occur after verification in the following year	d. Provide current field records	
Nori	https://nori.com/for-growers	a. Create an account through Nori	a. Use a model and field records to estimate C storage.	a. Must have authority to sell credit	a. Can sell C storage from up to 5 years prior to enrolling.
		b. Have adequate historical and current field records	b. Have contract for work and select verifier	b. 10 year contract	b. Uses the Soil Metric's platform as the model. This model is based on output from DayCENT and 35 other models
		c. Provide data 3 years prior to regenerative practice switch date that may have occurred prior to enrollment	c. Buyers can choose to purchase credits or not once in the Nori marketplace	c. Pay verification costs which occurs every 3 years	
		d. Has not been in CRP since 2000	d. score projects to assess uncertainty and conduct final audit	d. provide field records annually	
			e. Set floor price for Nori carbon credits	e. Projects can be invalidated if contract is not followed	
Nutrien	https://www.nutrien.com	a. No minimum for enrollment	a. $20/a based off $10-20 per metric ton of CO2 equivalent selling price	a. Supply data in Nutrien's "Agrible" sustainability platform	a. Credits generated using existing and developing protocols
			b. Carbon credits verified and made available for purchase by Nutrien and other buyers	b. Reward growers for adoption of sustainable practices	b. A mixture of agronomic modeling and soil sampling will be used on the farm
					c. Some components of program are still under development
					d. Conducting pilot programs in 2021 with large-scale implementation in 2022.

Program	Website	Minimum Acres/requirements	Payments	Farmer Requirement	Details
Soil and Water Outcome fund	https://www.theoutcomesfund.com/	a. No minimum	a. Payment range up to $40 calibrated to the environmental outcomes generated.	a. Eligibility requirements include: 1. Must be in eligible area, 2. Must be adding or expanding conservation practices, 3. Must be HEL and Wetland compliant	a. Contract Term: 1 year with annual review.
			b. 50% of payment at time of contract signing and 50% after yearly verification.	b. Create account, provide field boundaries, baseline operation information, and proposed change(s), tile drainage information, and then submit application.	
			c. Farmers are paid for CO2e (soil carbon sequestration and N20 reductions), nitrogen prevented from entering waterways, and phosphorus prevented from entering waterways	c. Review proposal.	
				d. Approve and sign contract.	
				e. Implement terms of contract	
TruCarbon, 2021	https://www.truterraag.com/Carbon	a. Minimum of 2.5 acres	a. Initial TruCarbon program credits sold to Microsoft. Payment terms and buyers of future TruCarbon programs are yet to be determined.	a. Best candidates have implemented reduced or no tillage, continuous soil cover, cover crops, perennial crops and/or extended rotations. Lookback period of five years for initial TruCarbon program. Future programs may feature different terms.	a. Carbon levels confirmed either through measurement (soil sampling) or modeling, as well as, interviews and other field-level data.
		b. 2021 project is unregistered; future projects will be registered		b. Payments based on data as entered in Truterra Insights Engine.	b. Verified data is evaluated against carbon market certification standards and buyer requests.

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