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The 5Rs of CARBON MANAGEMENT

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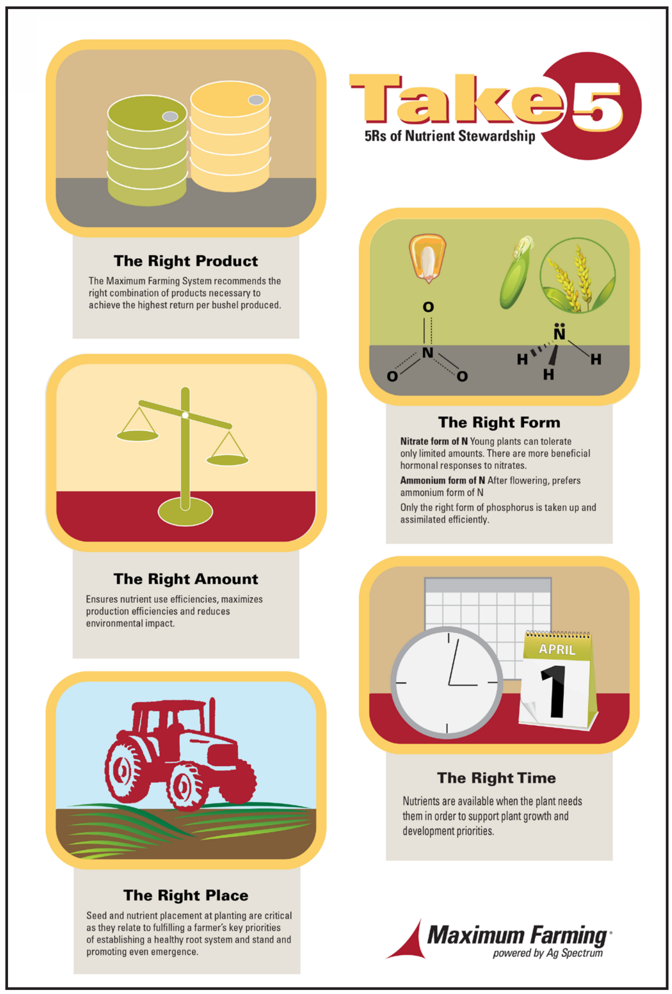
The Maximum Farming System emphasizes the 5Rs of nutrient management to optimally provide fertilizer support to achieve superior crop growth. One can also use the 5Rs to better support the natural processes that increase soil carbon to further improve soil health and crop productivity. To do so effectively, one needs to first understand the goals of carbon management.

Goals of Carbon Management in the Maximum Farming System are Multifold

When considering how to manage carbon on your farm, keep in mind the multiple goals a good steward is trying to achieve: optimize water availability, minimize topsoil erosion, reduce weed pressure, and increase biological activity. While there are multiple approaches to achieving these goals, whole System management that focuses on creating an optimal growing environment for planted crop roots will lead to the greatest improvements in soil health and crop productivity. Now let's look at how the 5Rs can be applied to manage the various sources of carbon on the farm.



5Rs of Crop Residue Management

Following harvest, crop residues provide the second largest contributor of carbon stocks. Sequestered in the plant while it is alive, this carbon gets returned to the soil right after harvest to promote nutrient cycling and support soil life. These residues are more difficult to consume because they are drier and less nutrient rich than living plant tissue. Less carbon is retained in the soil as residues decompose because more energy is required for their consumption and this is released as respiratory CO2. Nonetheless, the very large volume of residues makes this provision of carbon a visible and useful resource. Most notably, farmers can adjust the amount of soil covered by residues to reduce soil erosion and coarsely adjust soil temperature and moisture levels during spring planting windows. To achieve optimal use of the carbon in crop residues, farmers can apply the 5Rs to residue management to recycle mineral nutrients, sustain soil life over the winter, and improve soil conditions during the spring planting season.

RATE: Adjust to achieve 35-65% soil coverage by planting time to optimally manage soil temperature and moisture according to local conditions and need to reduce soil erosion potential.
TIME: Process residues at harvest, sizing to reach the target coverage necessary for optimal planting conditions.

PLACEMENT: Incorporate residues to accelerate decomposition and avoid piling (except in anticipation of removal for sale).
FORM: Size residues to meet spring target coverage, recognizing that legume residues decompose more rapidly than those of grass crops.
PRODUCT: Overlay soil amendments to accelerate decomposition and reduce C:N ratio of dry grass crop residues before spring planting.

5Rs of Cover Crops

While residues can provide substantial volumes of carbon, most of it is of low energetic quality. In contrast, growing plants can provide more accessible and readily converted energy to do the work of nutrient cycling even during the cooler months. By maintaining active plant growth year round, farmers increase soil biological activities that improve soil health and increase the profitability of cash cropping. Beyond that, certain species of cover crops provide specific value propositions related to increasing soil nitrogen, reducing weed pressure, disrupting compacted soil layers, providing seasonal forage and/or retaining topsoil.

RATE: Plant cover crops at lower seeding rates for easier chemical termination and at higher seeding rates for increased mulching.
TIME: Prioritize the requirements for reliable establishment and termination/harvest windows for your chosen cover crop when selecting maturity ratings of cash crops.
PLACEMENT: Adjust your herbicide program to avoid both cash crop and cover crop stress while addressing local weed issues.
FORM: Select a cover crop species based on its primary function and growth characteristics to maximize its value to your operation.
PRODUCT: Ensure cover crop seed is effectively weed- and disease-free.

5Rs of Crop Management

Cash crops represent the largest contributor to carbon stocks on the farm, up to 10,000 lbs. of fixed carbon per acre. The carbon they fix divides into building biomass, coping with stresses, and providing the energy. Crop genetics only partially determine what fraction of fixed carbon ends up in the marketed grain; soil health and farm management choices determine much of it as well. To achieve maximum yields, farmers can apply the 5Rs to crop management to reduce the frequency and severity of stresses experienced by their cash crops.

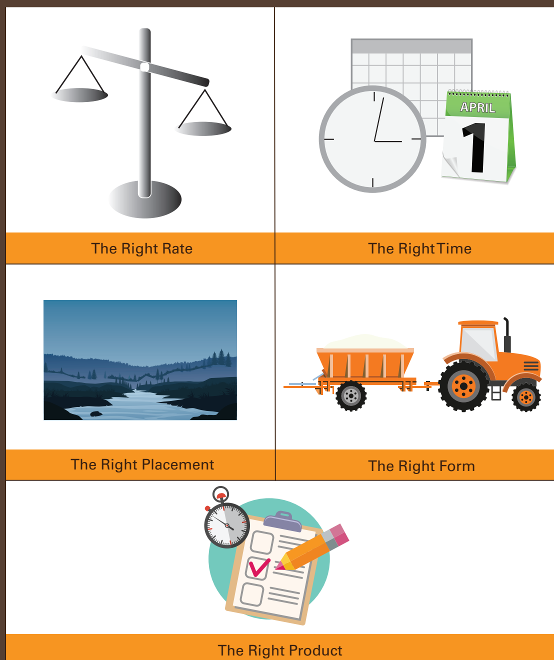
RATE: Plant the right seeding rate to balance yield potential.
TIME: Plant at the right time based on soil conditions and not by calendar date.
PLACEMENT: Plant at the right depth for your soil type and growing conditions.
FORM: Choose a crop that fits your environment and marketing plan.
PRODUCT: Choose the genetics package adapted for your cropping system.

5Rs of Manure & Compost

Where cover crops are operationally impractical, supplementing soil carbon stocks with raw or composted animal wastes can provide substantial benefits to soil health if properly applied. While often viewed primarily as a source of mineral nutrients, the real value of such amendments is in the carbon-based energy they provide along with those mineral nutrients to jump start soil biological activities. Because such materials are biologically-based and microbiologically active, their quality can be quite variable based on source, processing, and storage conditions. Therefore, applicators should test applied materials frequently (e.g. every 40 tons) and/or apply at conservative rates to ensure the applied amendments do not stress root growth or soil biology.

RATE: Restrict applications to prevent nutrient imbalances (e.g. add <30 lbs./A of P2O5) and limit disruptions due to high pH or salt content (e.g. excessive K, Na, or Cl).
TIME: Generally, apply in the fall and avoid applications from one month before planting until one month after emergence to prevent seedling stress.
PLACEMENT: Broadcast as evenly as possible and incorporate (or inject) at least two inches below the surface for best results.
FORM: Use what is locally available but be wary of "free" nutrient sources.
PRODUCT: Understand the chemistry and stability of the material you are applying to best estimate its value prior to purchase and test it post-delivery to verify its properties.

Soil Amendment Issues to Consider



RATE: Stick to approved farm and field nutrient management plans, especially where they are required by law.
TIME: Be aware of legal restrictions that limit timing of applications and avoid stressing plants (i.e. from planting through V6).
PLACEMENT: Be aware of legal restrictions that limit field placement, especially relative to runoff potential towards drainage ditches and surface waters.
FORM: Know the source and process used to handle the waste and avoid applying biosolids (i.e. sewage sludge) or other poorly characterized and chemically-treated materials.
PRODUCT: Recognize that test analyses are incomplete and nutrient values can vary by up to 3-fold between lots of delivered product when choosing how to use a material.

Carbon Cycle Balances Photosynthesis and Respiration

At the farm scale, planted crops and the management of soils are primary drivers of carbon cycles. Photosynthesis is the dominant means of depositing carbon into soils, so farm managers should focus on creating growing conditions that optimize soil health and crop productivity. Key to this is managing soil conditions in ways that maximize root growth. Doing this will ensure that soil carbon enrichment is maximized all year round. By providing high quality fixed carbon into the soil, plants fuel the activities of soil organisms whose activities make nutrients more available. Although much of that carbon is respired over time, there is a net accumulation of carbon to soils when they are properly managed.

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In addition to maximizing primary productivity of cash crops, minimizing tillage and planting cover crops are the two most significant ways farmers can assure that they are building soil carbon stocks on their farm. Tillage disrupts soil structure, providing more air and surface area for carbon digestion. This results in a higher rate of respiration and a net loss of carbon from soils over time if done extensively. Minimizing tillage (i.e. by practices that disrupt <25% of the soil surface on an annual basis) can conserve and even help build soil carbon, so do not worry about using it judiciously. Cover crops provide an equally important opportunity to improve soil functioning by adding carbon in the off season to keep soil processes fueled year round. Of course, to be economically viable, both tillage and cover cropping operations must provide improvements to soil health that lead to higher cash crop yields. By focusing on the benefits of carbon-building practices on cash crop yields, farmers will optimize soil carbon management.