MISSISSIPPI STATE UNIVERSITY™ EXTENSION

Comparing Conventional and Regenerative Approaches to Wildlife Food Plots

Wildlife food plots are used by hunters and land managers to attract wildlife for viewing or harvest and to improve nutrition for focal wildlife species. Food plots have traditionally been managed with "conventional" techniques borrowed from production agriculture that rely heavily on synthetic inputs. In recent decades, no-till techniques have gained popularity because they can reduce equipment requirements, tractor time, erosion potential, and synthetic inputs, while improving soil moisture retention and plant establishment rates.

Interest in "regenerative" techniques, with a focus on improving soil health, is growing. Regardless of where on the spectrum between conventional and regenerative management a food plot falls, the tools and techniques required to implement each management system will have cascading impacts on soil fertility, soil health, food plot productivity, cost-effectiveness, wildlife attraction, and overall wildlife benefit.

Soil fertility is the soil's ability to cycle and supply nutrients to support plant growth. Soil fertility exists on a continuum, where nutrient availability ranges from limited to abundant and freely available to plants. Different crops require varying levels of soil fertility for optimal growth, so producers spend considerable time and money on soil amendments to match the nutrient profile in the soil with the nutrient requirements of the crop. Plants grown in soils with optimal fertility typically produce more biomass and have better seed and fruit development, grazing tolerance, and weed suppression. Herbicide efficacy also improves with soil and plant fertility.

Soil health encompasses the physical, chemical, and biological components of soil, whereas soil fertility primarily relates to soil chemistry. Soil physical attributes relate to soil particle size and arrangement. Soil particles can be small (clay), medium (silt), or large (sand), and arrangement of particles to one another influences water infiltration, plant rooting depth, and microbial activity. Soil chemistry includes the macronutrient (nitrogen, phosphorus, potassium, etc.) and micronutrient (boron, copper, manganese, etc.) content of the soil, as well as the soil's capacity to release nutrients for plant growth. Soil biology includes bacteria, fungi, protozoa, and other microbes that reside on and around soil aggregates. Microbes perform various and complex roles for soil and plants by cycling nutrients, building organic matter, helping plants access otherwise inaccessible nutrients, suppressing diseases and pests, and promoting plant drought tolerance.

There are several techniques to improve soil fertility and health, achieve greater forage production, and increase attractiveness to wildlife. The conventional approach relies heavily on synthetic inputs, including soil amendments and herbicides, to promote maximum plant growth and suppress weeds. Conventional management often includes tillage to create a fine seedbed and an ideal rooting environment. Conventional food plots typically include low-diversity seed blends to maximize forage production and limit competition among planted species. The regenerative approach focuses on soil health and often excludes synthetic inputs and tillage, relying on high-diversity seed blends and robust populations of soil microbes to cycle nutrients and sustain food plot performance.

There is no one-size-fits-all approach to food plot management, so decisions on how to plant and manage food plots should be driven by objectives, opportunity, resources, and limitations. Here, we compare the tools, techniques, and considerations for establishing and managing conventional and regenerative wildlife food plots.

The Conventional Approach: Maximizing Yield through Synthetic Inputs

Limiting Competition with Herbicides

Herbicides suppress or kill undesirable plants. Excessive weed coverage in food plots reduces yield and may limit wildlife use, but some weeds can enhance attractiveness to wildlife by improving structure and/or foraging options. The decision to use an herbicide should be based on the objectives for a specific food plot, weed species present, coverage of weeds, and potential long-term negative effects of using the herbicide, such as residual soil activity preventing growth of future plantings.

There are three primary types of herbicides used in food plots: broad spectrum, broad-spectrum selective, and selective. **Broad-spectrum herbicides**, such as glyphosate, are designed to control all plants in all plant groups. Broad-spectrum herbicides often are used in burndown herbicide applications where the goal is to kill all plants before establishing a food plot. **Broad-spectrum selective herbicides** only control certain species of plants within multiple plant groups. Imazethapyr is a common broad-spectrum selective herbicide that controls some grasses, some forbs, and some sedges, but not every species of grass, forb, or sedge. For example, imazethapyr may be used in a perennial clover food plot to control weeds such as crabgrass, morningglory, and yellow nutsedge without killing the clover. **Selective herbicides** only control certain plant groups. Clethodim is a common selective herbicide used to control grasses in forb food plots. A selective herbicide application of clethodim could be used to control annual grasses in a clover plot, or an application of the forb-selective herbicide 2,4-D could be used to control forb weeds in a cereal grain plot.

An herbicide's label dictates method of application; foliar, preemergence, and pre-plant incorporated are among the most common. **Foliar herbicides,** such as glyphosate, must be applied to actively growing leaves to be effective. **Preemergence herbicides** are sprayed on the soil's surface before the weed emerges from the seed and incorporated into the soil profile via rainfall; they kill the weed seedling as it germinates. A preemergence application of imazethapyr is an excellent option to control incoming weeds when establishing a soybean food plot, though imazethapyr also can be applied pre-plant incorporated or postemergence on the foliage of weeds, depending on weed species. **Preplant incorporated herbicides** are applied on the soil's surface but are less mobile than preemergence herbicides, so they must be incorporated into the soil profile via tillage. Trifluralin is a common preplant incorporated herbicide when establishing sunflower food plots to control a variety of grass and broadleaf weeds.

Figure 1. This plot is receiving a selective foliar herbicide application to control incoming cool-season weeds before they establish and outcompete planted species. Controlling weeds soon after they germinate is ideal because younger weeds are more susceptible to herbicides and have not yet inhibited production of planted species.

Herbicides are useful for food plot managers, but their complexity and risks require a thorough understanding of the herbicide label, including weather conditions for successful application, required surfactants, and other factors. Risks associated with herbicide use include suppressed soil microbial populations, herbicide-resistant weeds, and human health concerns related to repeated exposure. Always read and follow herbicide labels.

Promoting Soil Fertility via Synthetic Soil Amendments

Importance of pH for Soil Fertility

Soil pH is a measure of the soil's acidity and can range from 1 (extremely acidic) to 14 (extremely basic). Most soils in the eastern United States have a pH ranging from 4.5 to 8.5. Different food plot species perform best within different pH ranges, but most perform well in soil with a neutral pH (6.5–7.5). Adjusting pH within the optimal range for a given food plot species is critical because certain soil nutrients are less available when pH is too high or too low. For example, phosphorus is most available between pH 6.5 and 7.5, whereas calcium is most available when pH is greater than 6.5. If soil pH is not within the optimum range for a given food plot species, applications of soil amendments such as nitrogen, phosphorus, potassium, and calcium will be significantly less effective at promoting plant growth.

Soil pH can be amended several ways, but lime applications are the most common. There are two primary types of lime: agricultural lime (ag lime) and pelletized lime. Ag lime is finely ground and more difficult to apply than pelletized lime without a spreader truck or buggy. It is a common misconception that pelletized lime reacts faster in soil than ag lime and that less is required to adjust pH. The neutralizing value of the two products is similar. Pelletized lime is more expensive than ag lime, but its ease of application is a significant benefit, especially in food plots that are difficult to access with a spreader truck or lime buggy.

The calcium carbonate equivalent (CCE) is a measure of a liming product's ability to neutralize soil relative to pure calcium carbonate. If a soil test calls for 2 tons of lime per acre and the liming product you plan to use has a CCE of 0.90, then 2.22 tons of the liming product are required per acre to adjust the pH to the desired level (2 tons / 0.90 = 2.22 tons).

The first step to establishing a successful conventional food plot is a soil test. The soil test will provide you with current soil conditions and soil amendment recommendations for the species you intend to plant. Soil tests are the cheapest and most effective way to ensure your food plot receives the correct type and amount of soil amendments.

Primary Soil Nutrients

There are 14 plant-essential nutrients provided by the soil that can be broken down into primary, secondary, and micronutrients. Most food plot practitioners achieve excellent yields by focusing on the soil's capacity to supply the primary and secondary nutrients. Micronutrients rarely limit food plot production. The primary nutrients are nitrogen, phosphorus, and potassium.

Nitrogen

Nitrogen (N) is a critical component of amino acids, proteins, and all plant life in general. All plants require N, but legumes can obtain N from a symbiotic relationship with microbes living on plant roots that can convert atmospheric N into plant-available forms. Clovers, soybeans, and American jointvetch are popular legumes used in food plots. However, there are more than 150 species of non-leguminous plants that form symbiotic relationships with microbes to acquire N.

Inoculating legume seed with the proper bacteria enables this symbiotic relationship and reduces or eliminates the need for additional N application. Earth's atmosphere is 78 percent N, which equates to more than 30,000 tons of N above every acre of land. Atmospheric N is extremely stable and unusable by plants, but these symbiotic bacteria can convert atmospheric N into plant-usable forms, and the bacteria obtain energy through carbohydrates from the plant in return. N application is usually necessary to maximize forage production of non-legume food plot species such as cereal grains, brassicas, and sunflowers.

Figure 2. The small, white nodules covering the roots of this crimson clover plant house the bacteria that acquire and transform atmospheric N into a form of N the plant can use. These microbes do not naturally occur in most soils, so legume seed should be inoculated with the proper strain of bacteria to ensure this symbiotic relationship can occur.

N is highly mobile in the soil and may be converted to forms that can be lost from the soil profile in a variety of ways. Timing and type of N application is critical. A plant's need for N fluctuates through time and stage of growth, but the best way to ensure a plant has the required N at the right time is to make multiple applications at key stages in a plant's life cycle. Nitrogen is used to maximize shoot, root, and seed development, so it's best to apply when plants are actively growing. However, many food plot practitioners don't have time to make multiple applications, so most people make a single N application at the time of planting.

There are numerous sources of synthetic N, but the most common include urea (46-0-0), ammonium nitrate (33/34-0-0), and ammonium sulfate (21-0-0-24S). See Table 1 for an explanation of how to interpret the numbers in a fertilizer analysis. Urea is the product most often used for food plot applications because it's easy to find and is typically less expensive than other N forms. Urea must be incorporated via tillage or applied the day before rainfall; otherwise, it is likely to be lost via volatilization into gaseous forms of N. If applied via no-till, volatilization is minimized by applying when air temperature is less than 50°F for an extended period or when there is at least 0.5 inches of rain in the forecast within a day of application. Incorporating urea with tillage is the best way to mitigate volatilization.

Ammonium nitrate is a great alternative to urea but may be more difficult to find. There is little risk of volatilization with ammonium nitrate, which makes it a more efficient N source in no-till food plots, when rain is not in the forecast, and when temperatures are higher than 50°F. However, the nitrate component of this fertilizer is prone to leaching out of the soil, which can be a problem in high-rainfall environments or sandy soils.

Ammonium sulfate is an expensive alternative to urea and ammonium nitrate, but it can be used when soil tests call for N and sulfur. Each of these N fertilizers contributes to soil acidification (reduces pH) as it breaks down and converts to plant-usable forms, but ammonium sulfate is the most acidifying N source. Most soils in the eastern U.S. have a pH ranging from acid (less than 6.5) to neutral (6.5–7.5), but some, such as those in the Black Prairie soil region, are basic (higher than 7.5). In basic soils, plant growth may benefit from application of an acidifying N source, such as ammonium sulfate, especially when a soil test calls for N and sulfur. No N source is best in all scenarios, so food plot practitioners should choose the N source that best addresses the needs and limitations in each situation.

Figure 3. This fertilizer application was mixed with the exact amounts of urea, triple superphosphate, and muriate of potash to ensure fertilizer rates matched soil test recommendations.

It is impossible to accurately amend soil without a soil test. Soil tests are a cheap way to ensure you are applying the correct fertilizers in appropriate quantities and not overapplying and wasting money on fertilizer or underapplying and restricting your food plot from reaching its potential for forage production.

When using the conventional approach, we typically recommend applying high-analysis fertilizers, such as urea (46-0-0), triple superphosphate (0-46-0), and muriate of potash (0-0-60) in custom mixes to ensure applications meet soil test recommendations, rather than applying a pre-mixed fertilizer, such as 13-13-13. It is difficult to apply the correct amount of one nutrient without over- or underapplying others when using pre-blended fertilizers.

Phosphorus

Phosphorus (P) is a critical component of plant energy, animal tissue growth (such as antlers, other bones, and feathers), and milk production during lactation. P also helps plants flower, ripen, and produce seed. Unlike N, P is immobile in the soil. Volatilization is not a concern with P, and leaching is uncommon, but the chemical characteristics of naturally occurring P often make it difficult for plants to obtain from the soil profile without the aid of soil microbes.

The most common synthetic P sources are triple superphosphate (0-46-0), mono-ammonium phosphate (11-52-0), and di-ammonium phosphate (18-46-0). These are high-analysis forms of P (meaning they contain more than 30 percent P by weight) and are effective P amendments in food plots. Triple superphosphate is commonly used because it is readily available at most farm and fertilizer stores. If your food plot requires N (non-legumes such as cereal grains, brassicas, sunflowers, etc.), mono- or di-ammonium phosphate are great options because they contain N and P.

Potassium

Potassium (K) is another primary plant nutrient essential for photosynthesis and nutrient movement within plants. K helps prevent lodging, which is common in cereal grains with weak stems and heavy seedheads or in strong winds. K improves root health and drought resistance by reducing water loss. Sufficient K levels also delay plant maturity (countering effects of P). K is moderately immobile in soil, but leaching still may be a concern in sandy soils with low cation exchange capacity and in high-rainfall environments.

One of the best K sources is muriate of potash (or simply potash, 0-0-60). Potash is readily soluble in water and generally the cheapest source of K. Potassium magnesium sulfate (also known as K-mag, 0-0-22-22S-11Mg) is another readily available source of K that may be used in food plots where sulfur and magnesium applications are needed. Unlike ammonium sulfate, the sulfur in K-mag does not contribute to soil acidity.

Cation exchange capacity (CEC) is the ability of the soil to hold cations (magnesium, calcium, potassium, etc.) by electrical attraction. CEC directly corresponds to soil fertility, where a soil with relatively greater CEC has greater nutrient-holding capacity. Soil type also influences CEC. Sandy soils generally have the lowest CEC (1–5), followed by loams (5–30), and clays (more than 30). Organic matter has an extremely high CEC (more than 200), which allows it to hold large quantities of nutrients.

Secondary Nutrients and Micronutrients

Soil tests also may call for secondary and/or micronutrients for some crops in certain soils. Secondary and micronutrients are not as limiting to plant growth as primary nutrients, but severe deficiencies can lead to visible symptoms and stunted growth. Alfalfa, for example, often requires an application of magnesium and/or boron to ensure healthy plants and maximum yield.

Plant secondary nutrients include calcium, magnesium, and sulfur. Calcium and magnesium deficiencies can be addressed during lime application if soil pH is low and requires neutralization. The two main types of lime, calcitic and dolomitic, are sources of calcium and calcium plus magnesium, respectively. If your soil does not require a lime application, magnesium can be amended with an application of magnesium sulfate (also known as Epsom salt, 0-0-0-10Mg-13S), and you may address calcium deficiencies with common products such as dicalcium phosphate (0-18.5-0-22Ca) or calcium nitrate (15.5-0-0-10Ca), which also provides N. Sulfur deficiencies may be addressed with ammonium sulfate, magnesium sulfate, or gypsum (0-0-0-23Ca-19S).

Micronutrient (iron, zinc, manganese, copper, chlorine, boron, and molybdenum) deficiencies are much less common than primary and secondary nutrient deficiencies. Micronutrients are immobile in the soil, so leaching is not a concern, and most will not limit plant growth if soil pH is near neutral (pH 6–7.5). If there is a micronutrient deficiency, an organic fertilizer (such as manure) usually corrects the imbalance. Manure often contains seeds from numerous problematic weeds, so be cautious when using it as a soil amendment. Foliar fertilizers (spray-on liquids) may be used to correct micronutrient deficiencies but not deficiencies associated with primary and most secondary nutrients because more of the nutrient is required than will stay in solution. However, since micronutrients are required in micro doses, these are easier to address with foliar sprays. There are a variety of foliar sources; contact your local Extension office for assistance.

Table 1. Readily available synthetic soil amendment products to correct common deficiencies in food plot soils. Make soil amendments based on soil test results for a specific food plot to minimize wasted fertilizer and money. Numbers in parentheses next to the product name represent the percentage of N, P, K, S, Ca, and Mg in each product. For example, K-mag (0-0-22-22S-11Mg) includes 0% N, 0% P, 22% K, 22% S, and 11% Mg by weight.

Product	Plant Primary Nutrients			Plant Secondary Nutrients			Acidifies or Basifies Soil pH
	Nitrogen	Phosphorus	Potassium	Magnesium	Calcium	Sulfur	
Urea (46-0-0)	yes						acidifies
Ammonium nitrate (33/34-0-0)	yes					yes	acidifies (when soil pH >7.0)
Ammonium sulfate (21-0-0-24S)	yes						acidifies (when soil pH >7.0)
Triple super phosphate (0-46-0)		yes					
Mono-ammonium phosphate (11-52-0)	yes	yes					
Di-ammonium phosphate (18-46-0)	yes	yes					
Dicalcium phosphate (0-18.5-0-22Ca		yes			yes		
Muriate of potash (0-0-60)			yes				
K-mag (0-0-22-22S-11Mg)			yes	yes		yes	
Epsom salt (0-0-0-13S-10Mg) (0-0-0-13S-10Mg)				yes		yes	
Calcium nitrate (15.5-0-0-10Ca)	yes				yes		
Dolomitic lime				yes	yes		basifies
Calcitic lime					yes		basifies

Food Plot Establishment via Tillage

Tillage is the process of using a rotovator, disk, plow, or other implement to disturb the soil and root systems of established plants, create a fine seedbed and an ideal rooting environment for incoming plants, and incorporate soil amendments. Tillage timing, depth, intensity, and frequency vary based on soil texture, moisture, and species being planted, but most conventional food plot practitioners till 2–3 weeks after a burndown herbicide application and after applying soil amendments. In this sequence, tillage will simultaneously break up thatch and large clods of soil while incorporating soil amendments to the proper depth.

The intensity of tillage required to create a fine seedbed varies with soil texture, soil moisture, and amount of thatch on the soil's surface. A finer seedbed is required when planting small seeds, such as brassicas, clovers, or American jointvetch, than for large seeds, such as cowpeas, soybeans, or cereal grains, because smaller seeds require better seed-to-soil contact. Cultipacking is most commonly used after planting to achieve proper seed-to-soil contact. However, in food plots with loose, fluffy soil, cultipacking is beneficial before and after planting small-seeded species to ensure seeds are not covered too deeply. Some concerns associated with tillage include loss of soil organic matter, reduced soil microbial activity, and poor soil structure, which leads to compaction and erosion.

Figure 4. Multiple disk passes may be required to break apart large clods of soil to achieve a fine seed bed in clay soils (A). Rototilling achieves a much finer seedbed than disking in clay soils (B). Soil clods break apart much easier in sand (C) and silt-dominated soils.

Figure 5. Cultipacking before planting, especially in fluffy soils, helps create a firm seedbed and prevents small-seeded species from being planted too deeply. After planting, cultipacking helps achieve ideal seed-to-soil contact to maximize germination rates.

Food Plot Establishment via No-till Techniques

No-till techniques can save managers time and money by reducing the number of tractor passes and implements required relative to conventional tillage. No-till top-sowing and no-till drilling are the most common methods of no-till planting. No-till top-sowing involves broadcasting seeds without tilling and often is followed by mowing existing thatch to provide some cover over the seeds and create a better environment for germination and seedling survival. No-till top-sowing is most effective with small-seeded species, but pay special attention to the amount of thatch covering small seeds. Small seeds lack the on-board energy required to emerge through a thick thatch layer.

No-till drilling requires a no-till drill that simultaneously slices open a furrow in the ground, places seeds, and closes the furrow. No-till drills allow planting into thick thatch layers to achieve excellent seed-to-soil contact and can be used to plant into actively growing food plots. No-till drills are expensive, but they are extremely versatile and can be used in tilled soils. No-till techniques help build soil organic matter, retain thatch for weed suppression, and hold soil moisture better than conventional tillage. However, no-till techniques can make incorporating soil amendments to the proper depth a challenge.

Figure 6. No-till drilling (A) and no-till top-sowing (B) reduce or eliminate the negative effects of tillage and can produce excellent food plots.

Maximizing Food Plot Performance with Species Selection

Many food plot practitioners neglect species selection as a tool to optimize food plot performance. Species selection is as foundational to food plot success as any of the tools or techniques discussed thus far. Food plot species vary tremendously in nutritional quality, structure, soil type they perform best in, nutrient requirements, drought tolerance, grazing resistance, forage preference timing, ability to suppress weeds, and susceptibility to diseases and pests.

For example, ladino and alsike clover perform best in moist soils, whereas alfalfa and chicory perform well on drier sites. If the goal for a food plot is to produce year-round forage for deer, crimson clover alone would be a poor choice. Rather, a blend of clovers such as crimson, berseem, arrowleaf, and red would better meet the objective because of their staggered maturity dates.

In scenarios where the objective is to provide food for deer during fall and winter and food and cover for turkeys in spring, balansa and cereal rye would be poor choices, especially if cereal rye is planted at a heavy rate. The balansa and cereal rye would provide good forage for deer during fall and winter, but they often become rank in spring and inhibit turkey movement. Crimson clover and awnless wheat would be better choices. Crimson clover and wheat produce tremendous forage for deer during fall and winter, and by mid-spring, crimson clover dies, allowing ease of movement for turkeys; awnless wheat provides excellent structure for turkeys and attractive seedheads for deer and turkeys.

These examples simply illustrate the complexity of species selection. There are excellent resources that cover this topic in depth, such as the book *Wildlife Food Plots and Early Successional Plants* by Craig Harper.

Adjusting the Conventional Approach to Reduce Inputs

Conventional and regenerative management exist on a continuum, and there are techniques to reduce inputs and potential negative effects of conventional practices:

- Dedicating acres to warm- or cool-season food plots can reduce tillage to once per year, rather than tilling the same acreage in spring before planting warm-season plots and again in fall before planting cool-season plots. This technique also prevents an "empty plate" by ensuring forage availability during transitional periods (having actively growing forages in warm-season plots while cool-season forages are establishing and vice versa).

- Rotating perennial food plots to annual species when weeds become too problematic allows you to use a single burndown herbicide application before establishing the annual plot, rather than multiple herbicide applications per year with limited efficacy in the perennial plot. There are few herbicides that do not harm perennial clovers but still control some of the most problematic weeds, so a burndown herbicide application to kill all plants may be the best option for long-term weed control. After 1 or 2 years of burndown herbicide applications and annual plantings, weeds should be better controlled, and the plot can be rotated back to perennials.

- Food plots can also be fallowed for one or more years between food plot plantings. Fallow food plots can provide outstanding structure for turkey broods and may produce plants with excellent forage value. When transitioning from a fallow field back to a food plot, simply apply a burndown herbicide 3 weeks before planting, then resume normal food plot management practices.

- Managers may find that a single preemergence herbicide application eliminates the need for multiple foliar applications throughout the growing season. Using a preemergence or pre-plant incorporated herbicide is an excellent way to deal with weeds before they become problematic. For example, a preemergence application of imazethapyr, S-metolachlor, and pendimethalin can control weeds in American jointvetch, soybean, and sunflower, respectively. Likewise, once a perennial clover plot is established, an application of imazethapyr can control incoming weeds preemergence. Without preemergence applications, some sites will require multiple herbicide applications throughout the growing season to deal with problematic weeds, especially in southern latitudes with long growing seasons and during years with ample rainfall where annual grass weeds are prevalent.

- No-till drilling and top-sowing are excellent options to alleviate problems associated with tillage, especially in food plots on steep slopes where erosion is a concern. No-till methods reduce soil erosion and compaction, loss of organic matter, tractor time, and wear-and-tear on equipment, and still produce productive food plots when implemented properly.

- Consider each of these options in the context of the primary objectives and limitations for each food plot. If the objective is strictly to maximize forage production, a low-input system in which tillage, herbicides, and fertilizers are entirely excluded may not be the best option. However, if optimizing forage production with reduced inputs is the objective, you can tailor your management to specific contexts by implementing the tools and techniques described above when appropriate.

Figure 7. This food plot was planted the previous fall and left fallow during summer. Common ragweed, buttercup, and daisy fleabane are now occupying the plot and are providing good forage for deer and excellent brooding cover for turkeys.

Figure 8. This cool-season food plot was producing high-quality forage from planting (September) through spring (A) and well into the following summer (B) because the planted species matched the site and had staggered maturity dates. Choosing clovers with staggered maturity dates alleviates competition between planted species and extends the forage production period beyond what a single-species planting would provide.

Figure 9. Preemergence herbicides are an excellent tool to combat problematic weeds before they germinate. Some food plot species, such as American jointvetch, allow use of preemergence herbicides at the time of planting (A), whereas others, such as perennial clovers, must be sprayed after planted species have established (B).

The Regenerative Approach: Promoting Food Plot Quality via Soil Health

The popularity of regenerative management has increased among agricultural producers in recent years and is now spreading among food plot practitioners. The regenerative approach focuses on producing healthy plants through healthy soil while reducing synthetic inputs. A soil's chemical (mineral content, CEC, etc.) and physical (particle size and arrangement) properties are important aspects of soil health and a regenerative program, but soil biology is the foundation. Healthy soil maintains diverse microbial communities that suppress plant diseases, effectively store and recycle plant nutrients, improve soil structure, and ultimately improve crop production.

Soil biology serves a prominent role in nutrient cycling and food plot performance. Arbuscular mycorrhizal fungi and associated bacteria are two groups of microbes that are extremely important. They are smaller than the finest plant roots and can access water and soil nutrients more effectively than plant roots. Fungi and bacteria form symbiotic relationships with plants and obtain carbohydrates (energy) produced by plants via photosynthesis in exchange for water and other nutrients. In addition to improving plant nutrient uptake, soil microbes are the foundation of soil organic matter. Plant and animal residues in the soil are broken down by soil microbes as part of microbial population growth, and the byproduct is organic matter. Living or recently dead plant and animal tissue is organic material, and organic matter is formed once organic material undergoes microbial decomposition.

When more plant and animal residues are retained in the soil, soil microbes increase, which in turn increases soil organic matter. Soil organic matter can hold exponentially more water and nutrients than soil without organic matter. Consider N, for example: Soils store approximately 2,000 pounds per acre of N to a 12-inch depth for every 1 percent of organic matter, though much is unavailable for plants to use. Soil microbes can tap into the soil organic matter's nutrient stores to meet their own nutritional needs and those of their leafy, aboveground counterparts when conditions permit. These complex relationships can take years to fully develop, so it is important to understand that improved soil health is not an overnight process.

Figure 10. This food plot was managed with regenerative practices to promote soil health and microbial activity. It contains 14 different species—a diversity of plants to cultivate and feed a diversity of soil microbes, which in turn help feed a diversity of plants.

Plant-microbe relationships vary by plant species, microbial species, soil type, season of year, region, site history, and current and historical management practices. Although there is no best management practice to maximize microbial performance in all scenarios, there are six key principles you can incorporate into a food plot program if your objectives include microbial performance, organic matter, and overall soil health:

1. **Minimize tillage.** Tillage can destroy microbe networks in the soil and reduce long-term soil health. Microbes help build soil aggregates, which are the large, crumby particles that give healthy soil a porous, dark, "chocolate cake" appearance. The space between aggregates provides channels for water to pass through and lots of surface area for microbes to live on. Frequent tillage destroys microbe networks and the aggregates they create, leading to compacted soils and poor water infiltration. Tillage also injects oxygen into the soil, leading to rapid growth of microbial populations, which, without other adequate food sources, forces microbes to consume and deplete soil organic matter. No-till systems retain microbe networks, soil aggregation, and plant residue on the soil surface, which gives microbes a food source and helps build organic matter.

   Soil microbial diversity increases with conservation tillage, particularly no-till systems, as opposed to deep tillage. Increased microbial diversity improves microbes' ability to effectively use soil carbon because different microbes can decompose different carbon compounds. Increased microbial diversity usually accompanies increased soil organic matter. Thus, moving toward a conservation tillage system not only reduces costs associated with deep tillage, but also can reduce the need for costly synthetic fertilizers by increasing organic matter retention.

2. **Minimize synthetic soil amendments.** Plants have little incentive to trade nutrients with soil microbes when their "big 3" nutrient needs (N, P, and K) are met through synthetic soil amendments. This lack of nutrient exchange can be detrimental for microbes and plants alike in some cases. When plants are supplied with synthetic fertilizers, they are no longer required to barter with soil microbes to meet their nutrient demands. Thus, microbes are unable to obtain resources from plants, and plants may not get an adequate supply of other nutrients they need that aren't provided through synthetic fertilizers. In healthy soil, microbes can supply plants with a complex array of nutrients on an as-needed basis. However, when plants are provided synthetic nutrients instead of trading with microbes, plant roots are forced to access nutrients on their own, and roots are less able to access nutrients than their smaller microbial counterparts. Not only can this lost symbiotic relationship lead to reduced soil organic matter and microbial populations, but it may also lead to plant diseases and pest outbreaks.
3. **Minimize pesticides.** Pesticides include herbicides, fungicides, and insecticides commonly used to control plant pests. Pesticides generally impact soil microbes negatively. For example, some research indicates glyphosate, a common herbicide used in agriculture and food plots, increases soil microbial respiration rates, especially when repeatedly applied. Although more respiration usually means more microbes, in soils sprayed with glyphosate, there are often increased populations of disease-causing microbes and simultaneous decreases of beneficial microbes that help plants suppress disease and exchange nutrients. A common conclusion of such studies is that glyphosate inhibits microbial diversity while promoting a few very specific, and sometimes pathogenic, groups of microbes. Most pesticides have not been evaluated for their impact on soil health, but it is possible that many produce negative effects.
4. **Plant diverse blends.** Different plant species interact with the soil profile and their neighboring plants in unique ways. For example, buckwheat is an excellent scavenger of P. Buckwheat roots produce mild acids that can "unlock" P from the soil, allowing uptake of P into the buckwheat plant. Once the buckwheat matures and dies, the P can be used by other plants because it is no longer chemically bound within the soil. Some brassicas, including rapeseed and turnips, as well as some radishes, can produce tap roots down to 6 feet deep, alleviating soil compaction and bringing nutrients from deep in the soil profile to the surface where they are accessible to other plants. Brassicas also may reduce soil-borne pathogens and root diseases for incoming crops when planted in rotation. Cereal rye suppresses pests and diseases by attracting beneficial insect predators, such as lady beetles, and is less affected by disease than other cereal grains. Cereal rye may suppress weeds through shading and allelopathy, a process where root secretions prevent establishment of competing plants. Species such as cowpeas and alfalfa attract many insects that provide outstanding bugging opportunities for turkeys. Some plants do not work as well in blends as others because of their competitive tendencies, so contact your local Extension office for more information or reference *Managing Cover Crops Profitably*, an excellent resource published by the Sustainable Agriculture Research and Education (SARE) program.

   Plant diversity also allows wildlife access to a buffet of options otherwise unavailable in monoculture food plots. When managed appropriately, monoculture plots can provide outstanding tonnage of some of the most important nutrients, but most wildlife species, including deer and turkeys, require a diverse diet. Planting diverse food plot blends is one strategy managers can use to provide a diversity of forages. However, species included in a blend should be favored by focal wildlife species or have a purpose related to soil health. Furthermore, habitat management practices, such as forest stand improvement and prescribed fire, should be used to increase plant diversity across a property and address needs of focal wildlife species at a larger scale, rather than focusing solely on food plots for forage diversity.

Figure 11. Regenerative seed blends often contain a diversity of species, including leguminous forbs, non-leguminous forbs, and grasses. Some species are included in the blend to feed wildlife, whereas others are primarily included for their soil health benefits.

5. **Keep living roots in the ground year-round**. Soil microbes have evolved in symbiotic relationships with plants and rely on plants for many of their nutrient needs. It is unnatural to see areas completely void of living roots for months out of the year like we do in some cropland systems from late fall through early spring. Soil microbes don't completely disappear when a field is fallow for months at a time, but their populations are not as robust going into the next growing season when compared to a soil with actively growing plants year-round.

   The presence of living roots year-round in food plots can be achieved in a variety of ways. One of the most common ways is through perennial plantings, such as clover or alfalfa. Although most perennials go through late summer and winter dormancy where they appear to be dead, their root systems are still alive and interacting with the soil. Some managers exclude perennials from regenerative mixes to avoid complications associated with managing diverse blends of annuals and perennials simultaneously. Instead, to achieve living roots year-round, they plant cool-season annuals directly into the standing biomass of the preceding warm-season blend of annuals, and then roller-crimp the standing warm-season plants or use another method of non-herbicide termination. The same process may be used to establish warm-season plots in standing cool-season biomass in the spring.

6. **Keep soil covered with thatch year-round**. Think of thatch as soil armor. This armor shields the soil's surface from harsh environmental conditions. For example, thatch shields the soil from direct sunlight during summer and insulates the soil during cold winter temperatures, thereby helping buffer soil temperature and soil microbes against environmental extremes. Regulated soil temperature benefits plant and microbial growth while limiting soil moisture loss via evaporation. Soil with no thatch often exceeds the ambient air temperature on sunny days and can easily reach 130°F or greater during summer. At this temperature, soil microbes die, and nearly all soil water is lost via transpiration rather than used for plant growth. Conversely, a soil covered with a layer of thatch remains much cooler even on the hottest summer days. This promotes microbes rather than killing them, and it also allows plants to use soil moisture more efficiently for growth.

   Thatch slowly decomposes and acts as a slow-release fertilizer. However, a thatch layer that is too thick can reduce germination and establishment rates of planted species, and can limit mobility of small wildlife, such as bobwhite quail and turkey broods. Healthy soil will quickly decompose thatch on the soil surface and prevent a thick thatch layer from accumulating. The main way to build thatch is through no-till planting because tillage incorporates thatch and deteriorates organic matter.

   Roller crimping is a popular method to terminate a crop of annuals and create a thatch layer. However, roller crimping is more effective on some species than others, and termination relies greatly on timing relative to plant maturity. Cereal rye is often included in diverse blends, and crimping is usually done when cereal rye is in the dough stage of seedhead development and most susceptible to crimp termination. However, other species in the blend will vary in maturity timing, so termination rates will vary.

Figure 12. This food plot has been managed regeneratively for several planting seasons. The thatch layer from the previous year is decomposing on the soil surface (brown thatch underneath green vegetation). The greenery is the most recent plot's biomass, which we no-till drilled directly into. Note the pale-yellow cowpea seed placed in the furrow in the center of the picture. After planting, this plot was roller crimped to terminate some of the living vegetation to function as a weed suppression layer and slow-release fertilizer for the incoming food plot.

Figure 13. This regenerative cool-season plot was no-till drilled just before roller crimping. The roller crimper terminated a portion of the vegetation, creating a thatch layer at ground level to suppress weeds while the incoming warm-season planting establishes.

A Note on Context

The six principles of regenerative management included here have been proven effective in agricultural settings through several research studies. One of the consistent findings of such studies is that soil health and overall crop productivity improve when implementing all components rather than one or two in isolation. In fact, implementing some of these practices without the others could result in a less productive food plot than using none of them. For example, eliminating synthetic soil amendments without implementing the other practices to increase organic matter and nutrient cycling could lead to a sparse, sickly food plot quickly overtaken by weeds, especially in soil with poor natural fertility.

Opportunities and Challenges for Regenerative Food Plots

Weed Control

One of the primary difficulties in establishing a regenerative food plot is weed control. Some regenerative practitioners allow weeds to grow unchecked because of the potential negative effects of herbicide on soil health. Other regenerative practitioners use herbicides on an as-needed basis, choosing establishment success and forage production over potential detriments to soil health. Your approach should depend on your objectives. If the objectives of a food plot program prioritize soil health above forage production, then allowing weeds to colonize, regardless of their impact on forage production, may be the appropriate decision. However, if optimizing forage production with soil health improvement is the primary objective, then eradicating the most problematic weeds with an herbicide application and following the six principles of regenerative management when otherwise reasonable would be the best solution.

Perennial grasses are one of the greatest challenges to implementing regenerative food plots without herbicides. If not controlled before planting, perennial grasses, such as tall fescue and vaseygrass, often increase in coverage and smother planted species. These species cannot be controlled with a roller crimper. A burndown herbicide application before planting can provide excellent control of these grasses and promote future success of a regenerative food plot. Even when problematic perennials are controlled at the onset of a regenerative program, they nearly always reemerge in future years without follow-up herbicide applications. Again, current conditions and your objectives—reducing/eliminating herbicides or maximizing establishment and growth of planted species—will determine the best approach.

Figure 14. This regenerative food plot has never received an herbicide application. Coverage of warm-season perennial grasses was sparse the first year of food plot establishment, but vaseygrass and bahiagrass overtook the food plot within 2 years. Without an herbicide application, the grasses will continue to smother planted species. A roller crimper will not terminate grasses such as vaseygrass, bahiagrass, bermudagrass, johnsongrass, tall fescue, orchardgrass, or any other perennial plant. These grasses are among the most problematic weeds to deal with, especially when herbicides are not used.

Food Plot Size Relative to Deer Density

There is evidence from production agriculture that regenerative practices can improve or maintain yield while drastically cutting input costs. However, the objectives and scale of production agriculture and wildlife food plots are different. The objective of most agricultural plantings is to produce a grain or other crop and limit yield reductions caused by wildlife, and almost all fields planted for agricultural production are much larger than food plots. Conversely, a successful food plot is consistently grazed (“damaged”) by wildlife and represents a fraction of the acreage of an agricultural field.

Figure 15. This regenerative warm-season food plot germinated well (A), but because of high deer density, relatively low grazing tolerance of planted species, and small acreage planted, the plot was overtaken by weeds within 3 weeks (B).

One of the keys to establishing and sustaining a successful regenerative food plot is ensuring planted species outcompete and smother weeds. On small-acreage food plots, especially on sites with high deer densities and limited alternative forage availability, regenerative plantings often establish well only to be grazed beyond the point of recovery by deer, leaving lots of vacant growing space for weeds to colonize. This problem may be worse in the early years of establishing regenerative food plots. On sites with a high deer density, consider establishing regenerative food plots in larger fields (more than 5 acres) and including species in the seed blend with greater grazing tolerance. Larger fields allow regenerative plantings to better persist, smother weeds, and develop thatch to alleviate weed competition and promote establishment success for the following plantings.

Figure 16. This cool-season regenerative food plot germinated well (A) and persisted throughout the fall and winter because the site has a low deer density and the food plot is relatively large. By spring, it produced tremendous tonnage, which we drilled our warm-season seeds into (B), followed by roller crimping to create a thatch layer to suppress weeds.

Figure 17. This conventional food plot grew side-by-side with the regenerative plot shown in Figure 14. A preemergence herbicide application suppressed weed competition while the plot established (A), and the grazing-tolerant American jointvetch persisted through the growing season (B) despite a high deer density and small-acreage food plot.

Forage production is often not as limited in small-acreage conventional food plots as in regenerative plots. Herbicides may be used to control weeds and release planted species from competition in conventional food plots, and grazing tolerance of regenerative blends is often less than conventional blends. Ideal conventional food plots include species that establish quickly to outcompete weeds, withstand grazing pressure, and allow use of certain herbicides if weeds become a problem. Regenerative food plot blends, especially those with a dozen or more species, contain some species that are highly attractive to wildlife with poor grazing tolerance and others that are lower-preference forages. For example, cowpeas and soybeans are highly selected by deer right after they germinate, but if grazed below the first leaves, they often die, leaving vacant space for weeds to colonize.

Regenerative seed blends containing a large percentage of high-preference forages such as cowpea and soybean will be especially difficult to establish in small fields. Food plot size relative to deer density and grazing tolerance of planted species are important considerations with conventional food plots also, but the inclusion of less-preferred species in regenerative blends increases the grazing pressure that high-preference species receive since there are relatively fewer plants of the high-preference species than in a conventional food plot. Thus, available forage is reduced and effects of a small food plot on grazing pressure are compounded as weeds colonize growing spaces that previously held high-preference species.

Thatch Inhibits Turkey Broods and Bobwhite Quail

A thatch layer thick enough to successfully suppress weeds will often inhibit movement of turkey poults and bobwhite quail. Despite its benefits of regulating soil moisture and temperature, acting as a slow-release fertilizer, and suppressing weeds, thatch can be detrimental when ground-foraging birds are an objective of your food plot program. Incorporating thatch via tillage as part of fallow management creates bare ground for easier movement and promotes a canopy of forbs. Soil disturbance promotes naturally occurring forbs, such as ragweed, partridge pea, sumpweed, lambsquarters, and others. These forbs form a canopy that helps regulate soil temperature and moisture and provides outstanding cover and foraging opportunity for various wildlife species such as ground-foraging songbirds, bobwhite quail, and turkey broods. Fire may be used in place of tillage to reduce the thatch layer, create bare ground, and promote a canopy of high-quality forbs for forage and cover. When ground-foraging birds, such as turkeys and bobwhites, are an objective of a food plot program, whether regenerative or conventional, occasional fallow management can produce outstanding brooding cover for birds and forage for deer.

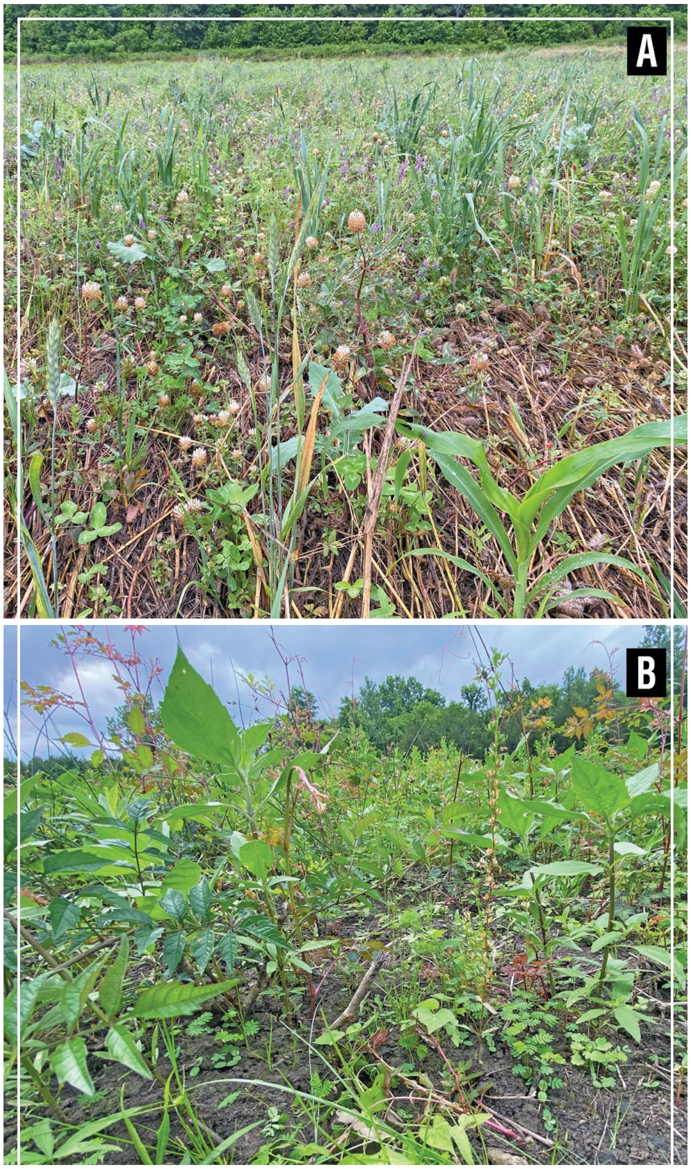

Figure 18. A thatch layer thick enough to suppress weeds can inhibit movement of turkey poults and bobwhite quail. This regenerative plot (A) has a thatch layer that would be difficult for turkey poults and quail to navigate. When turkeys or quail are an objective of your food plot program, occasionally rotating fields to fallow management through soil disturbance or prescribed fire reduces the thatch layer, creates bare ground, and promotes a canopy of naturally occurring forbs (B). This serves as excellent brooding cover for turkeys and can provide high-quality forage for deer.

When to Begin the Regenerative Process

The southern United States has long growing seasons, and most regions have very competitive warm-season weeds. It may be a good idea to start a regenerative food plot with a cool-season planting rather than a warm-season planting. If regenerative cool-season plantings are not overgrazed, they often produce tremendous tonnage during spring. After crimping, this growth can create a dense thatch layer to suppress weeds throughout the spring and summer months while the incoming warm-season plot establishes. Starting a regenerative food plot in spring often leads to excessive weed pressure because weed seeds are germinating at the same time as planted species. This order of operations may be less critical as latitude increases and growing season length shortens.

Plugging the Lowest Hole in the Bucket with Food Plots

Landscape context should be a consideration for any food plot practitioner. On sites where forage diversity is limited and other factors do not permit forest stand improvement or old-field management, food plots planted in diverse seed blends may help address the limitation. On sites where crude protein or phosphorus are the most limiting factor for wildlife management objectives, a low-diversity planting such as soybeans, cowpeas, or American jointvetch may better address the limitation by providing tremendous biomass of protein- and phosphorus-rich forage.

Summary

Conventional and regenerative approaches to wildlife food plots should be considered in the context of a manager's objectives. Each approach differentially influences soil fertility, soil health, food plot establishment success, options for weed control, and overall attraction to wildlife. Benefits of regenerative management have been realized in production agriculture, but we still know relatively little about how such practices translate to food plots where scale, species planted, and objectives are drastically different. At the time of this publication, Mississippi State University researchers are conducting a multi-state research project to determine how regenerative versus conventional food plot techniques impact soil, plants, insects, wildlife, and economics to shed light on many lingering questions and determine how management should change in various contexts.

An effective and efficient food plot program requires managers to set specific objectives for their food plots and use the tools most appropriate to achieve those objectives. One of the most common frustrations we observe stems from a failure to set clear objectives and/or to identify and implement the approaches best suited to meet those objectives. For example, if your objective is maximizing pounds of crude protein per acre in your food plots because you have identified crude protein availability as a limitation for your deer population, synthetic soil amendments and low-diversity blends of protein-rich forages are probably good choices. Conversely, if improved diversity and function of the soil microbiome in your food plots is your objective, then minimizing synthetic inputs and incorporating the other regenerative principles discussed here may be a better option. Do not fall into the trap of implementing a set of techniques just because it's the new fad among managers.

Appendix

Visual Symptoms of Common Nutrient Deficiencies in Food Plots

The best way to diagnose nutrient deficiencies in your food plot is with a plant tissue analysis because it is possible for a soil test to indicate sufficient nutrient levels while plants show deficiency symptoms. For example, a soil test may indicate sufficient levels of P even though plants are experiencing P deficiency because soil P is bound to aluminum, iron, or calcium phosphates and is not available to plants, especially in acid soils (pH <6). If you find yourself in such a situation, contact your local Extension office for specific recommendations. Below are a few examples of common nutrient deficiencies and how to identify them in your food plots.

Nitrogen

A nitrogen deficiency results in reduced protein content and yellowed leaves, starting in the older leaves and in the leaf center.

Figure 19. Nitrogen deficiency symptoms in wheat.

Phosphorus

A phosphorus deficiency results in poor root/seed development and purple coloration of older leaves.

Figure 20. Phosphorus deficiency symptoms in berseem clover (A) and wheat (B)

Potassium

A potassium deficiency results in leaves yellowing from the tip and edges, then to the center. A deficiency is first noticeable in older leaves.

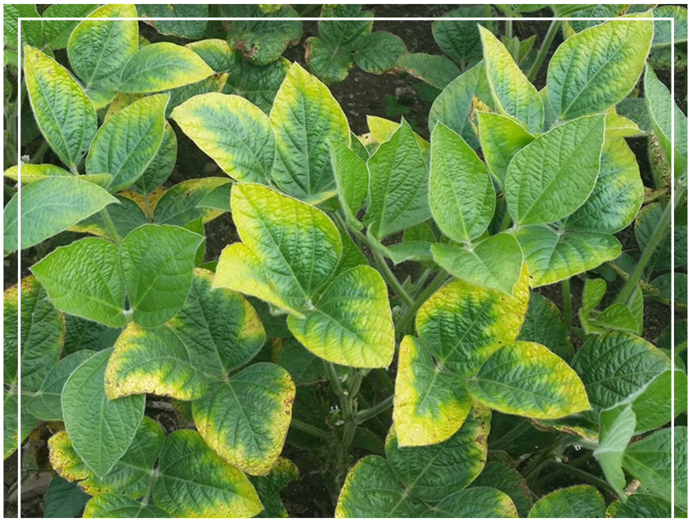

Figure 21. Potassium deficiency symptoms in soybean.

Calcium

A deficiency results in curled or otherwise misshapen leaves. Symptoms first appear in the youngest leaves, with brown spots along leaf margins and yellowish-brown veins. Calcium deficiencies are very uncommon in Mississippi.

Magnesium

A magnesium deficiency results in yellowing along leaf veins with areas of normal green coloration between veins. Symptoms are similar to those of a sulfur deficiency but are visible in the oldest leaves first. Magnesium deficiency is rare but may occur in well-drained soils with high rainfall.

Sulfur

A sulfur deficiency results in yellowing along leaf veins with areas of normal green coloration between veins. Symptoms are similar to those of a magnesium deficiency but are visible in the youngest leaves first.

Figure 22. Sulfur deficiency symptoms in corn.

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