Soil Amendments

Many wildlife habitat management activities involve planting and maintaining grasses, forbs (legumes* and wildflowers*), and annual grains*. For this reason, people involved in managing wildlife habitats should have a general knowledge of working with and improving soil conditions for the specific vegetation that they will be managing. It is true that plants grown to provide habitat don't necessarily have to produce as well as those grown for agricultural production in order to be beneficial to wildlife. In fact, in some situations, sparse stands of vegetation that might be considered a failure to a production farmer may actually be more desirable to wildlife as habitat than a maximum yield of the same crop. Likewise, native vegetation that is being managed for wildlife usually does not need additional soil additives because these wild type plants are more tolerant of a wide range of soil conditions. However, the addition of soil amendments such as lime, fertilizer, and organic matter can often make the difference between success and failure of other plantings. For instance, in acidic areas the addition of lime may be absolutely necessary for establishing certain legumes.

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Habitat HOW-TO'S

Soil Characteristics

In order to determine what, if any, soil amendments are needed for a particular crop on a given site, it is important to understand some basic concepts about soils. Some of the more important characteristics of soils are texture, structure, fertility, and pH.

Soil texture refers to the size of the soil particles. The smallest soil particles (less than .02mm) are clays. Clay is easily distinguished by its ability to stick together to form ribbons when wetted and squeezed between your fingers. Soils with high clay content (often referred to as heavy soils) tend to be very fertile but they are the most difficult soils to till because the small clay particles are easily compacted. Working clay ground when it is too wet will result in cloddy ground or a hard pan (discussed later in section on structure) that is impermeable to water and which has little or no air space between the soil particles. Medium sized soil particles (.02mm - .5mm) are referred to as silts. Silts are powdery when dry and are easily worked. The largest soil particles (.5mm – 2mm) are called sand. Sandy soils are very loose and easily worked

Figure 1. Assistance for applying soil amendments can be obtained from local cooperatives.

In some situations, sparse stands of vegetation that might be considered a failure to a production farmer may actually be more desirable to wildlife as habitat.

Figure 2. Broadcasting chemical fertilizers is an acceptable application technique.

Native vegetation usually does not need soil additives because these wild plants are more tolerant of a wide range of soil conditions.

but they are relatively infertile and have very little water holding capacity. Soils that contain nearly equal proportions of sand, silt, and clay particles are called loams. Loam soils are the most desirable because they are both fertile and easily tilled.

The important thing to remember about soil texture, when considering amendments, is that you cannot change the proportion of sand, silt, or clay within a particular soil under field conditions, but you can improve some of the poor qualities of certain soil textures by adding organic matter. For example, adding organic matter to clay soils will help reduce compaction, increase air space within the soil, increase water flow through the soil, and make the soil more tillable. Likewise, adding organic matter to sandy soils will increase fertility and water holding capacity.

Soil structure refers to the arrangement of soil particles. Soil particles can stick together forming soil aggregates of different shapes or structures such as flat (horizontal) plate-like layers, blocky chunks, or granular crumbs. Granular or crumb type soil structures are the most desirable because they contain lots of air space, allow water to move freely within the soil, and are easily tilled. Soils with platy or blocky structures are less permeable and harder to work. Poor soil structure can result from mismanagement such as when a clay soil is worked when it is too wet. As previously mentioned, this can result in a hard pan (an impermeable platy soil layer) or a cloddy (blocky) soil structure that is difficult to work. Soil structure can be improved by incorporating organic matter into the soil and by letting a particular field remain fallow or rest with a cover crop for one or more growing seasons. Over time, root penetration and seasonal freezing and thawing will help break up compacted soils.

Soil fertility refers to the amount of plant nutrients that are found in the soil and are in a form usable by plants. As previously mentioned, soils with a high clay content tend to be very fertile. This is because clay particles (called colloids) have the capacity to form chemical bonds with nutrients found in the soil. Organic matter in the soil can also form these bonds but silts and sands cannot. The three most important plant nutrients (sometimes called macro nutrients) found in the soil are nitrogen (N), phosphorus (P), and potassium (K). Micro nutrients or trace minerals, such as iron, boron, molybdenum, and manganese are needed by plants in very small quantities, but deficiencies or excesses of these minerals can be detrimental to certain plants.

Nitrogen is an essential element in chlorophyll, enzymes, amino acids, and proteins that are found within plants. Nitrogen promotes lush vegetative growth in plants, but too much nitrogen can reduce reproduction and lower disease resistance and hardiness of the plants. Nitrogen can exist in several different chemical forms, and is easily lost from the soil or made unavailable for plant use. This can occur when nitrogen is volatilized into gas that escapes into the atmosphere, or when nitrogen is immobilized by microbes in the soil. Leguminous plants are capable of fixing atmospheric nitrogen, making it available for use by the legumes and other plants.

Phosphorous helps plants produce energy and is a component of DNA. Phosphorous is necessary for photosynthesis, encourages flowering, and promotes root development and plant structure. Unlike nitrogen and potassium, phosphorous is not easily lost from the soil, but it can be tied up so that it is unavailable to plants. Some factors affecting phosphorous availability include soil pH and excessive amounts of trace minerals such as aluminum, iron, manganese, and calcium.

Plants need potassium for water and nutrient uptake, photosynthesis, stimulating seed production, tuber development, and for activating enzymes. Potassium is easily lost from soils due to leaching.

Soil pH is a relative measurement of hydrogen (H+) ions within the soil and is measured on a scale of 0 – 14. A pH level of 7.0 is considered neutral. Soils with a pH level below 7.0 are considered to be acidic (having a high concentration of H+ ions) and soils with a pH above 7.0 are considered basic or alkaline (having a low concentration of H+ ions). In humid regions like Kentucky, soils are most likely to be acidic and in dry regions they are more likely to be basic. However, soil pH levels can vary widely even from one field to another. Limestone based soils generally tend to be the least acidic or nearly neutral. This is because calcium from the limestone binds up (neutralizes) H+ ions in the soil. Most agricultural crops raised in Kentucky do best when soil pH levels are between 6.4 - 7.0. When pH levels are too low (acidic), nutrients can be tied up in the soil and made unavailable to plants. Acidic soils can also cause certain trace minerals to become toxic to plants.

Figure 3. Knowing the fertilizer analysis will help you determine the amount ot N, P, and K that should be applied. This bag of fertilizer, for example, contains 10% nitrogen, 10% phosphorous, and 10% potassium (10-10-10).

Soil Samples

The most effective way to determine the fertility and pH levels of a soil, as well as its need for fertilizer and lime, is to take a representative soil sample and have that sample tested. Your county agriculture extension agent can provide you with more information on taking soil samples and send your samples off for analysis. He or she can also give you specific fertilizer and lime recommendations for a particular crop based on the soil analysis results. Taking the soil sample basically involves using a soil probe or shovel to take 10 to 30 sub-samples of soil from the field being tested. In areas that are, or are going to be tilled, sub-samples should be taken 6-8 inches deep. In areas that are not going to be tilled the sub-samples should be taken 3-4 inches deep. Each sub-sample is basically a vertical slice of soil taken to the desired depth and approximately an inch square. Sub-samples should only be taken from areas that are representative of the whole field. Avoid areas like old fence rows or road beds. All of the sub-samples should be mixed thoroughly together in a bucket and then spread out on a large tray and allowed to air dry. Once the soil is dry, a small sample (about a pint) from all of the sub-samples should then be collected and put in a clean paper bag (special bags for this purpose are available from your county extension agent) and taken to your county extension agent for testing.

Soil texture cannot be changed but some of the poor qualities of certain soil textures (heavy clays and sandy soils) can be improved.

Organic Matter

Organic matter refers to the dead and decaying plant matter found in the soil. Organic matter is very biologically active, containing many microorganisms that are important for soil health. However, when soils are repeatedly worked or cropped the organic matter within the soil, and the microorganisms that it supports, are depleted. In such situations, organic matter must be continually replaced in order to keep the soil healthy. As previously mentioned, adding organic matter to a soil can have many benefits including improving soil structure, increasing water holding capacity and fertility of sandy soils, increasing air space and water movement in clay soils, and improving the tilth (workability) of the soil. Organic matter can be added at any time, but is generally applied in the spring and fall.

In humid regions like Kentucky, soils are most likely to be acidic.

One excellent source of organic matter is animal manure. If you have livestock, this source of organic matter will be readily available. One of the most effective ways of applying animal manure evenly over an area is through rotational grazing.* If you do not have livestock yourself, you may want to check with a neighbor who does. Many farmers often have large quantities of animal manure that they can't use and need to get rid of.

Animal manure is a very good source of plant nutrients. For instance, a ton of manure from dairy cattle contains about 11 lbs. of N (nitrogen), 9 lbs. of P (phosphorous), and 12 lbs. of K (potassium). A ton of poultry manure can contain as much as 45 lbs. of N, 40 lbs. of P, and 40 lbs. of K. However, it is important to note that nitrogen levels in the soil may initially go down after application of manure or other organic matter due to an increase in soil microbes tying up this nutrient. In a short time, though, the manure will eventually have the net effect of increasing the soil's nitrogen levels. Animal manure also helps replace trace minerals.

Figure 4. Applicator equipment for the "do-it-yourselfer" can be obtained through local cooperatives.

There are some disadvantages to applying animal manure though. Animal manure often contains seed from noxious weeds that can cause problems for new plantings. Applying lots of manure may also lower soil pH resulting in the need to apply more lime. General application rates of manure are usually between 9 – 18 tons per acre.

Another effective method of adding organic matter to a soil is by using a green manure crop. This is a cover crop, usually planted in the fall, which is capable of producing thick, lush, vegetation that can be incorporated into the soil by tilling the following spring. Annual grains*, such as winter wheat or rye are often used for this purpose, but legumes* are also an excellent choice due to their ability to fix nitrogen making it available for plant use. Winter peas, hairy vetch, and red clover are examples of legumes that make excellent green manure crops.

Crop residues such as corn or tobacco stalks can also be incorporated into the soil to increase organic matter, but you may want to use caution in spreading these in areas where the same crops will be grown. This is because they can sometimes spread diseases that are specific to that crop. Another source of organic matter is compost, although it may only be practical for small areas.

Chemical Fertilizers

Usually the easiest way to increase the levels of available plant nutrients (N, P, and K) within the soil is by applying chemical fertilizers. Chemical fertilizers should always be applied according to soil test recommendations. Applying too much fertilizer is not only a waste of money, but it can also be detrimental to your crops and result in environmental problems. Excess fertilizers can wash out of the soil and into a stream or other water body causing contamination. The old saying "if a little does a little good a lot ought to do a lot of good" is certainly not true when applying fertilizer.

Fertilizer and lime should always be applied based upon soil test results!

Chemical fertilizers can be purchased in many different forms and formulations. Granulated fertilizers, which are available in bags or in bulk form, are the most commonly used. Pre-mixed, bagged fertilizers have a guaranteed analysis expressed as the percentage of N, P, and K contained in the fertilizer. For instance, a fertilizer with an analysis of 5-10-15 contains 5% nitrogen, 10% phosphorous, and 15% potassium. This analysis allows you to determine how many pounds of a particular fertilizer it will take to give you a specified amount of a particular nutrient. For example, 100 pounds of ammonium nitrate fertilizer (analysis 34-0-0) contains 34 pounds of N. If your soil test results say that you need to apply 100 pounds of N per acre, you would have to apply 300 pounds of 34-0-0 fertilizer (or 102 pounds of N) per acre. The following formula can be used to make such calculations:

$$\text{Fertilizer Needs (lbs./acre)} = \frac{\text{Pounds N, P, or K needed /acre}}{\text{\% N, P, or K in the fertilizer}}$$

Where the % N, P, or K is expressed as a decimal

This can be complicated when you need to apply N, P, and K with pre-mixed bagged fertilizers. Bulk fertilizers on the other hand can be mixed to provide the exact proportions of N, P, and K called for in your soil test. Bulk fertilizers are also much easier to handle because they are delivered in a spreader that is used to apply them directly to the soil. This eliminates the need to handle large quantities of fertilizer by hand, as well as the need to own additional equipment for spreading the fertilizer. For these reasons, bulk fertilizers are more efficient for most circumstances. However, in small applications, such as ¼ acre food plots* in remote areas, bagged fertilizer may be more practical.

Timing of Application

In general, chemical fertilizers should be applied to the soil just prior to the peak growing time of the crop being managed. For most new plantings, fertilizer should be applied and incorporated into the soil at the time of, or just prior to planting. This will ensure the availability of adequate nutrients as soon as your seed germinates and the new plants begin to grow. One exception to this is that nitrogen generally should not be applied to native warm season grasses* at the time of planting because it will encourage the growth of weeds that compete with the new native grass seedlings. However, if Plateau herbicide was used to prepare the area for the establishment of the warm season grasses, you can apply fertilizer 4 – 6 weeks after planting, when the new grasses have sprouted and grown several inches. If Plateau was not used you should withhold nitrogen from the fertilizer the first year and top-dress it onto your warm season grasses the second spring. Existing stands of cool season grasses* and legumes* should be fertilized in early spring just as they begin to green up. Nutrients applied too early or late can be lost from the soil or taken up by weeds that are competing with the desired crop.

Lime should be applied several months ahead of time.

Lime

Lime is added to soils primarily to raise the pH to desired levels. The addition of lime also adds calcium and magnesium, both of which are necessary plant nutrients, to the soil and facilitates nitrogen fixation. As with chemical fertilizers, lime should be applied based upon soil test results. The amount of lime necessary will depend upon the current soil pH level and the soil's buffering capacity. Buffering capacity is a measure of the soil's resistance to pH changes. Soils with high clay content tend to have higher buffering capacities and therefore may require more lime to raise pH to the desired level.

The most widely used form of lime is crushed limestone, sometimes referred to as agricultural lime. The quality of agricultural limestone can vary greatly and is influenced by two factors. The first factor is the percentage of calcium carbonate in the lime expressed as the Calcium Carbonate Equivalent (CCE). The second factor is the fineness (sometimes referred to as the fineness factor, FF) of the lime. The more finely ground the limestone is, the more reactive it is making it more effective in raising soil pH. By Kentucky law, agricultural limestone must be ground fine enough so that 90% of it will pass through a 10 mesh screen (containing 10 holes/square inch) and at least 35% of it must pass through a 50 mesh screen (containing 50 holes/square inch). A measurement of lime quality, which considers both of these factors, is the Relative Neutralizing Value (RNV). This value estimates the percentage of the limestone that will dissolve within 3 – 4 years. The higher the RNV, the higher the quality of the limestone. RNV values for most agricultural limestone in Kentucky range from 50 – 80. Agricultural limestone is usually delivered to the field in a spreader truck and

NOTE: If a field is tilled in the fall, for incorporating lime or for any other reason, a cover crop should be planted on the field to prevent erosion and provide wildlife forage and cover through the winter.

SUMMARY OF OPTIONS:

Plants being managed:
- Native vegetation tolerant of most soil conditions
- Cool season grasses (lime and fertilize to soil test specifications)
- Annual grains with specific soil requirements

Soil Characteristics:
- Soil texture – sand, silt, clay, loam
- Soil structure – platy, blocky, granular, crumb
- Soil fertility – determine with soil test
- Soil pH – determine with soil test

Soil Amendments:
- Organic matter – animal manure, green manure, crop residue, compost
- Chemical fertilizers – bagged or bulk
- Lime – Agricultural limestone, hydrated lime, pelletized lime

*Related *Habitat How-To* references:

- Annual Grains
- Cool Season Grasses
- Cropland Management
- Food Plots
- Grazing and Haying
- Legumes
- Native Warm Season Grasses
- Natural Revegetation
- Wildflowers

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applied directly to the soil.

Hydrated lime and pelletized lime are also available in bags. These types of lime are much more reactive than crushed limestone. Hydrated lime is generally used at about 2/3 the rate necessary for agricultural limestone. However, although hydrated and pelletized lime work faster, they don't maintain the soil pH at desirable levels as long as agricultural limestone. Hydrated lime and pelletized lime are also much more expensive than agricultural limestone. Another disadvantage is that because it is bagged it requires a lot of heavy handling and you must have access to a lime spreader. In general, agricultural limestone is much more efficient than bagged lime, except in situations where you are liming small areas in hard to reach places.

Timing of Application

Fields should usually be limed at least 6 months prior to your expected planting date or the beginning of the growing season for the crop that you are managing. Therefore, if you are preparing ground for spring planting you should lime in the fall. The best results are achieved when the lime is thoroughly mixed into the soil by tilling. Otherwise you will raise the pH of the first inch or two of soil, but lower down in the root zone the soil can still be acidic. One method for mixing the lime in is to apply half the lime prior to tilling the field and then apply the other half to the surface after tilling.

As you can see, there are many factors to be considered in determining what, if any, soil amendments are necessary for reaching your habitat management goals. However, with a little knowledge of the soils that you are working with, the plants that you will be growing, and soil test results, the decision should be easier. Your Private Lands Wildlife Biologist and your County Agriculture Extension Agent can also give you more specific guidance.

Planning for My Property