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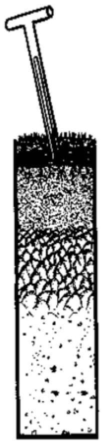


THE SOIL PROFILE

A newsletter providing information on issues relating to soils and plant nutrition in New Jersey

Volume 28 2023

Renewable Soil Fertility and Non-Commercial Nutrient Sources

Fertilizer prices have skyrocketed to record highs. Regardless of cost, soils and crops need nutrients. Fortunately, there are some alternatives to buying commercial fertilizers. Alternative nutrient sources are the topic for this issue of The Soil Profile newsletter. Regardless of source, the best way to assess the need for soil fertility inputs is a current soil test. Plant tissue analysis, observations of crop performance, and nutrient management plans (nutrient input minus harvest output) are also useful to monitor soil fertility status.

Conservation and Closure of Nutrient Cycles

Plant nutrients are chemical elements or fundamental units of nature. Because nutrients can potentially be recycled endlessly, they may be thought of as a renewable resource in perpetual motion. All that is required for a nutrient to function as a truly renewable resource is the application of agronomic knowledge and social ecology. This is known as the Rule of Return - substances harvested from the land must be recycled back to sustain soil fertility. It may also be thought of as a kind of "circular economy".

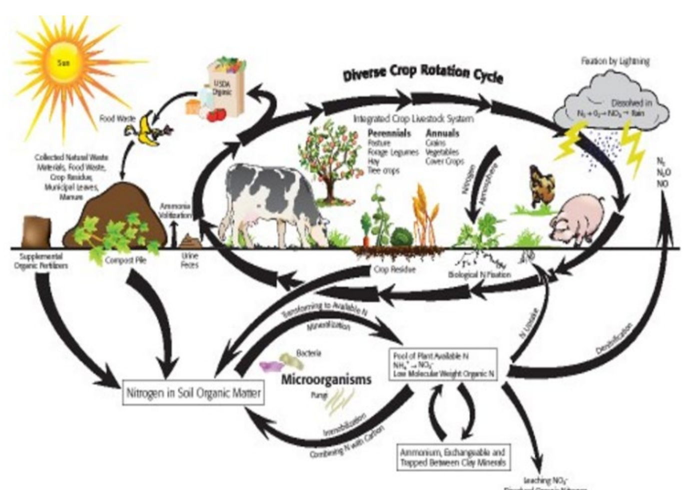
The wisdom behind the Rule of Return was historically understood as a cultural tradition in much of Asia. In a book published in 1911, Farmers of Forty Centuries or Permanent Agriculture in China, Korea, and Japan, American soil scientist F.H. King documented that the complete recycling of all types of natural waste materials was an effective means of sustaining soil fertility (Heckman 2013). The book is now regarded as a classic and was an inspiration to the organic farming movement.

Organic farmers practice the Rule of Return principle to close nutrient cycles and sustain soil fertility. In contrast, the commercial fertilizer industry "4R Nutrient Stewardship" program places minimal emphasis on closure of nutrient cycles and is silent on the Rule of Return stewardship principle.

When "waste" products derived from nature are recycled to restore and sustain soil fertility it does more than just recycle mineral plant nutrients. When materials are composted or directly land applied, they contribute to building soil organic matter content, feeding soil biology in ways that commercial chemical fertilizers do not.

Every plant nutrient undergoes a cycle that is unique to the chemistry and biology associated with that element. To the extent that farmers and gardeners understand nutrient cycles, they can apply that knowledge towards the capture and "domestication of nutrients" and minimize the need to purchase commercial fertilizers. This is especially true with N since the air above the land has an unlimited supply with a concentration level of 78% di-nitrogen gas (NN).

Managing the Nitrogen Cycle



The N cycle is complex because there are pathways that take this nutrient through both the soil, plants, animals, and the atmosphere.

This N is freely available to all farmers who are skilled at cultural practices for capturing this element from the atmosphere. Growing cover crops for biological N fixation or legumes as part of a crop rotation are reliable and cost-effective ways, to capture N and put it into the soil where it gets combined with organic matter and builds soil fertility.

The nitrogen cycle depicted above does not include an industrial fertilizer factory. Rather it is designed to emphasize the importance of legumes, crop rotation, livestock integration, conservation of waste materials, the rule of return, and composting. Manufacture of synthetic N fertilizer is expensive because it requires a large amount of energy. Solar energy and biological processes drive the N cycle in an idealized organic farming system.

Organic farming focuses on building and maintaining a higher level of soil organic matter which provides a reservoir for the slow release of N and other nutrients to crops. Diversified organic farming systems are designed to use crop rotation, perennial crops, legumes, livestock, waste recycling, and composting to build soil organic matter content and N fertility. The transformations within the N cycle are essentially the same as in natural ecosystems and conventional farming, but they are modified by organic cultural practices. The N in organic matter is slowly converted by microbial activity into forms useable by plants at rates that vary with soil temperature and moisture. Most of the N taken up by crops is in mineral form: ammonium or nitrate. However, plants can also utilize some N from organic compounds. The incorporation of plant residues low in N concentration can cause immobilization by which mineral forms of N are removed from the soil solution and used by microorganisms.

Well-managed organic farms can be self-sufficient in N by use of a combination of crop rotation, waste recycling, composting, integrated crop and livestock production, cover cropping, and cultural practices that minimize nutrient losses via erosion, leaching, and volatilization. National Organic Program standards do not allow use of industrially manufactured N fertilizers or sewage sludge.

Legume Nitrogen

Some examples of potential legume contributions of fixed N to soil fertility: Alfalfa 200 lb./acre, red clover 100 lb./acre, Sunn Hemp 140 lb./acre, hairy vetch 150 lb./acre.

Alfalfa in a crop rotation will almost always ensure that the next crop, often field corn, is well supplied with N and no supplemental N fertilizer will be needed.

Sunn hemp is a tropical legume that is becoming popular as a summer cover crop. It can supply substantial amounts of N to vegetable crops that follow it, but the N release pattern may not always match the needs of the crop. Hairy vetch is a winter cover crop that also can supply substantial N, but the amount varies depending on the growth stage when it is killed or if it was grown with winter rye as a cover crop mix.

Where legume cover cropping cannot ensure adequate N supply, soil organic matter may provide the necessary balance when good ecological soil fertility practices are being followed. Each 1% soil organic matter content may release on average about 40 lb./acre of available N. Thus, a soil with 3% organic matter content could potentially supply 120 lb./acre of N over the course of the growing season. But these are only rough estimates that can vary depending on weather conditions, especially soil temperature, and presence of decomposing crop residues.

Recycling natural waste materials via composting, applications of manure, and livestock integration into the farming system are all good cultural practices for supplying N as well as building soil organic matter content and supplying other valuable nutrients. However, in the case of non-composted manure use, organic vegetable growers must maintain a window of at least 120 days between time of application and harvest of vegetable crops.

Compost is great for building soil fertility and organic matter content, but it should not be used as the primary N source. There are some organic approved N sources for crop production, these materials are usually expensive and bulky. Also, the available N from these natural source products may not match the N uptake needs of the crop. Thus, these materials should not be relied upon as a primary N source for organic crop production. It is best to think in terms of developing an organic farming system plan where a combination of ecological and cultural practices buildup and maintain a soils capacity to supply N at rates that closely match crop demand.

Together, conventional, and organic growers are faced with the challenge of getting the supply of N to match crop demand. The crop uptake cycle for N is a function of the pattern of crop growth. Thus, when plants are small, N uptake rates are low, but as the growth rate increases, the N uptake demand also increases. Growers must carefully manage complex inputs to the N cycle and make timely adjustments for possible N deficits. Ideally, organic growers should build some insurance N fertility into the system to avoid the need to supplement with expensive N fertilizers. Also, they should recognize woody perennial crops as having a much different N uptake pattern from annual crops.

Soil Testing for Nitrogen Availability

The presidedress soil nitrate test (PSNT) is a useful tool to gage plant-available N contributions from manures, legumes, and organic matter. The PSNT test method calls for taking soil samples from 0 to 12-inch depth, during the growing season, when annual type crops are at an early vegetative growth stage.

This timing is still early enough to add supplemental N fertilizer if necessary. This soil test for N is useful for a wide range of vegetables that are grown as annuals. The PSNT is not suitable for perennials or tree crops.

The PSNT specifically measures nitrate-N concentrations in the surface foot of soil. Testing for ammonium-N in the soil generally does not improve the ability of the PSNT to make correct predictions. Besides nitrate and ammonium, there are other forms of N that may be taken up and utilized by plants. But just measuring nitrate provides an accurate index of N availability for predicting N sufficiency or the need for supplemental N fertilizer.

In most cases, the soil test will hopefully find that the soil N supply is adequate, and sufficiency should be the goal for building soil fertility of organic crop production. But when the PSNT identifies N deficient soils, supplemental N may be applied along beside the row using an organic approved N source. Hopefully, under good organic farming management, this will not happen often.

In other instances, the PSNT may find that the soil nitrate level is much higher than the sufficiency level of 25 ppm. Growers can also use this information to learn from experience, that they may sometimes be adding too much in the way of organic inputs to cause an excess N supply in soil.

In short, the PSNT is a useful diagnostic tool for organic growers to manage and adjust the N cycle to the needs of sustainable crop production. For further information visit Rutgers NJAES on the web for fact sheet on “Soil Nitrate Testing as a Guide to Nitrogen Management for Vegetable Crops”.

Nutrients from Horse Manure

New Jersey equine operations produce an abundance of manure from an estimated 43,000 horses. There is a great opportunity to build soil fertility using this non-commercial source of plant nutrients and organic matter. One horse can produce about 65 pounds of manure bedding mix per day. From the total population of horses in New Jersey, this equates to about 360 truckloads per day. To the extent that horses spend time in stalls or outside on pasture some fraction of this manure is not collected. Nevertheless, the volume is substantial on a statewide basis. Unfortunately, sometimes horse manure goes to landfills when it should be used to build and sustain soil fertility.

Beneficial use of manure and other natural waste materials requires information about its chemical composition. In the case of horse manure, its composition can vary based on numerous factors such as equine feeding practice, type of bedding material, feed composition and digestibility, horse stable hygiene or clean out practices, manure storage system, residence time on farm, and access to pasture.

New Jersey certified organic farmers often use horse manure as a material for building a compost pile. USDA organic standards for composting require the pile be established with an initial C/N ratio of between 25/1 and 40/1 (USDA AMS NOP, 2023). Thus, knowing the composition of starting materials is important.

To characterize the variability of horse manure, twenty truck loads collected from New Jersey equine operations were sampled over the period 2019 to 2022. The samples were sent to an agricultural laboratory for nutrient composition, moisture content, and carbon to nitrogen ratio.

In most cases, the carbon to nitrogen ratio of the horse manure was near 32, a balance suitable for making compost. Even when not composted and instead spread directly on fields, it usually supplies plant available N. Note in this photo of horse manure piles that the surrounding grasses are exhibiting much darker color and growth.

Forage and pastures are also very important for providing feed and exercise to equine. In terms of nutrient management planning, hay harvest uptakes and removes more P and K from soil than any other crop produced in New Jersey. A typical 4 tons/acre hay harvest removes about 40 lbs./acre P and 260 lbs./acre K. When this hay is fed to horses, approximately 80% of the ingested nutrients are discharged in the manure. The bedding material, usually wood shavings and sometimes straw, tends to dilute or change the mineral composition of horse manure. Nevertheless, hay fields are good choices for where to utilize the nutrients from horse manure.

Based on field trials with horse manure, farmers accepting and spreading this material may expect soil fertility P and K levels to increase and to also raise soil pH. Soil organic matter content is increased with surface applications of horse manure. Because of the presence of wood shavings, the soil organic residue from horse manures is relatively persistent. Where horse manure has been applied to pasturelands, the species composition may change. Typically, it will increase the population of clover in the forage mix. The yield of forage biomass may be increased every year over a period of several years following an application of horse manure.

Horse manure bedding mix nutrient composition expressed on a volume or per cubic yard bases.

Manure Characteristics	Min	Max	Average
Moisture (%)	69.74	73.04	71.92 ± 1.39
C/N Ratio	14.08	48.65	32.48 ± 11.28
	lbs./ yard		
C	41.33	104.97	58.68 ± 18.48
N	1.06	8.35	3.03 ± 2.18
NH4-N	0.08	0.52	0.25 ± 0.13
P	0.28	1.37	0.54 ± 0.26
K	0.77	5.12	2.11 ± 0.97
Ca	0.69	2.78	1.47 ± 0.61
Mg	0.29	1.47	0.59 ± 0.32
Na	0.06	0.27	0.14 ± 0.05
S	0.18	0.58	0.33 ± 0.12
	macronutirents lbs./ yard		
B	0.003	0.019	0.007 ± 0.004
Fe	0.412	3.036	1.43 ± 0.88
Mn	0.071	0.339	0.153 ± 0.086
Cu	0.006	0.032	0.014 ± 0.009
Zn	0.026	0.118	0.051 ± 0.031

Nutrients from Shade Tree Leaves

A major review, Community Shade Tree Leaves, Beneficial Uses for Agriculture was published in 2022 online in HortTechnology. A summary of the article is published below.

Research at Rutgers NJAES has identified many ways to use community collected shade tree leaves as a beneficial resource on local farms. Agricultural uses for shade tree leaves keep this material out of landfills and builds community relationships between urban centers and farmers. In the process nutrients are recycled to restore fertility and soil organic matter content and soil health is enhanced.

On average (dry matter basis) shade tree leaves contain as a percentage: 1.0% N 1.0, 0.1% P, 0.38% K, 0.1% S, 1.6% Ca, and 0.2% Mg. When applied in a 3-inch layer with a manure spreader, leaves would typically add about 200 lbs. N/acre that slowing become plant available over a period several years.

The New Jersey Department of Environmental Protection requires that land-applied shade tree leaves be incorporated into soil with tillage. This regulation should be reconsidered given that surface mulching with shade tree leaves can benefit many crops. Leaf mulch on the surface can provide excellent weed control without herbicides, enhance orchard tree establishment, prevent soil splash onto crops, and protect against soil erosion.

Because collected shade tree leaves typically have a C/N ratio of 50/1, they have the potential to cause N deficiency in crops in the first year after application. Having legumes in the crop rotation or planting a N-fixing crop after shade tree land application should mitigate concerns with N deficiency. However, research shows that even non-legumes such as corn can perform well in the first year after shade tree leaves were applied when given the usual recommended N fertilizer rate. Pumpkin also performs well with the usual recommended N fertilizer rate so long as the supplemental sidedress N application is applied early enough to prevent N deficiency. In general, there appears to be no need to increase the rate of N fertilizer when utilizing shade tree leaves in crop production. Shade tree leaves add substantial amounts of N to soil that slowly becomes available to crops in the second and third years after application. This slow-release N benefits subsequent crops in rotation and may reduce the need for supplement N fertilizer. Beyond crop production, shade tree leaves also may be used for livestock bedding. The urine and fecal soaked bedding material should have a more favorable C/N ratio for making compost or for land application as manure.

Wood Chips

Arbor service companies are currently busy taking down dead trees killed by the emerald ash borer. An abundance of wood chips can often be arranged to be delivered for free by truck load. Wood chips are a concentrated source of organic matter and can serve as a landscape mulch, used as bedding for livestock, or as a supplemental material for composting.

To determine the nutrient content, a truck load of wood chips was sampled in the late summer and another load in winter. The summer sample still contained leaves whereas the winter sample was just wood chips without leaves.

When leaves are present the carbon to nitrogen ratio (about 52/1) of wood chips is lower than with pure wood chips (about 100/1). Also, the concentrations of plant nutrients tend to be greater when leaves are mixed with the wood chips.

Nutrient concentrations in wood chips with and without leaves. Nutrients expressed on a percent dry basis.

Nutrient	Wood Chip with Leaves	Pure Wood Chips
Carbon to Nitrogen Ratio	52	100
	%	
Nitrogen	0.91	0.5
Phosphorus	0.09	0.02
Potassium	0.25	0.16
Calcium	1.25	0.23
Magnesium	0.08	0.03
Sulfur	0.05	0.01
Sodium	0.01	0.02
	ppm	
Boron	11	4
Iron	242	17
Manganese	238	4
Copper	7	7
Zinc	44	5

Discarded Christmas Trees

In early January, post-holiday Christmas Trees are readily accessible and perfect for recycling. Discarded Christmas Trees can also be used to block wind and shelter livestock such as goats as shown in the photo below.

The trees can also be shredded, made into mulch, or composted. The nutrients contained within the trees will contribute to building soil fertility. On average, a unit of 100 shredded Christmas Trees contain in lbs. 29 units of Nitrogen, 3 of Phosphorus, 8 of Potassium, 12 of Calcium, 2 of Magnesium, and 1 of Sulfur.

Lawn Grass Clippings

Leaving the clippings on the lawn recycles nutrients and can reduce the need for turfgrass fertilization by about half. In general, Rutgers Cooperative Extension recommends the so called "Cut it and leave it" approach to lawn care but in the spring with a surge of growth collection of clippings is sometimes appropriate.

Fresh grass clippings typically have a carbon to nitrogen ratio (about 20:1) that is favorable for composting when mixed with other materials, such as autumn shade tree leaves, which contain much less N. But grass clippings are most abundant in the spring and shade trees are available in the fall. And grass clippings cannot be stockpiled for long without exhibiting unpleasant odors.

The clippings, when spread in a 1 to 2-inch layer over the soil surface can serve as mulch to control weeds. Grass clippings decompose rapidly and will release useful amounts of N to vegetable crops during the first and second growing season after application. For example, the photo below shows sweet corn mulched with grass clippings.

Grass clippings can be spread to fields with a manure spreader and planted to a N demanding crop. Since most grass clippings are collected in spring, May through June, land amended with grass clipping could be used to grow a late summer vegetable that can utilize the N that is expected to become available. Cabbage, for example, has a high N requirement and could be planted in mid to late July.

Fresh grass clippings typically contain about 80% water. But if they have been stockpiled the moisture content may be closer to 50%. A cubic yard of grass clippings weighs about 430 lbs. at 50% moisture or 215 lbs. on a dry weight basis. Each cubic yard of grass clippings would contain in lbs. 6.5 of Nitrogen, 0.86 Phosphorus, 4 Potassium, 1.8 Calcium, 0.7 Magnesium, and 0.8 Sulfur.

A reasonable application rate may be about 50 cubic yards per acre, which would add about 325 lbs. N. Assuming about half of the N contained in the grass clippings becomes available during the growing season, this could supply an estimated 165 lbs. of N. This could supply much of the expected N needs of a cabbage crop. Nutrients from the applied grass clippings may be expected to provide some soil fertility benefit to subsequent crops for several years with may be monitored by soil testing.

Wood Ash as a Liming Material

Homes that burn wood for heat should value and utilize the ash residue as a liming material and as a source of calcium, magnesium, and potassium.

A sample of wood ash from my farmhouse woodstove was analyzed for concentration of minerals and total acid neutralizing power (calcium carbonate equivalent: CCE). The sample of ash was finely sieved to remove larger particles of char before analysis. It was found to contain 25% calcium, 2.2% magnesium, 9.4% potassium, and 0.4 % sodium. The neutralizing power or CCE was 80%. Note that results may vary depending on firewood tree species and many other factors.

For comparison, a high calcium commercial limestone may contain 33% calcium and 2% magnesium and have neutralizing power of 98% CCE. The cost of having a truck deliver and spread this limestone (from a quarry in Lancaster County, PA) would be about $73 per ton for a farm in Hunterdon County New Jersey.

To demonstrate how wood ash can change soil chemistry and fertility, the ash or agricultural limestone for comparison were each added to an acid sandy loam soil with an initial soil pH of 5.1. Six weeks after the soil was amended it was tested at the Rutgers Soil Test Lab for pH and fertility.

The soil test reported that pH increased from 5.1 to 6.5 for the ash treatment and to 6.3 for the limestone treatment. The ash was as effective as the limestone for raising the soil pH level. The soil test levels of calcium and magnesium were increased for both the ash and limestone treatments.

Potassium is well supplied to soil by applications of wood ash as demonstrated by an increase in soil test CEC saturation level from 4% to 7% K.

These findings demonstrate that wood ash is an effective liming material that is comparable with limestone for neutralizing soil acidity. It also can boost soil fertility levels for potassium, calcium, and magnesium.

Soil pH and fertility levels after adding limestone or wood ash.

Treatment	Soil pH	Calcium	Magnesium	Potassium
		% Saturation CEC		
None	5.1	29	8	4
Limestone	6.4	55	14	4
Wood Ash	6.6	55	10	7

A substantial amount of wood ash is available in some regions with wood burning power plants. Considering current prices for limestone and potassium fertilizers, wood ash should be regarded as a valuable soil amendment. Beneficial use of wood ash from commercial sources should begin with a lab analysis and a recent soil test. The ash should only be applied to acid soils and to crops that need liming. Also, be sure the source of ash does not include residues from burning trash or toxic substances such as treated or painted lumber containing heavy metals.

Egg Shells as a Liming Material

What becomes of the eggshells from food processors that consume a lot of eggs? Do the eggshells go into a dumpster and from there into a landfill? What a terrible loss to soil fertility. We should do more to teach and build relationships between food customers and farmers to put the Rule of Return into practice. Perhaps egg buyers can be inspired to recycle eggs shells to the farm where they originated.

Eggshells from a mix of white, brown, and blue chicken eggs were collected and analyzed for nutrient content and acid neutralizing ability (CCE). The moisture content was just 6%. Since the water content is almost negligible, I will report the nutrient content and acid neutralizing value on a dry matter basis. The concentration of calcium was 36.7%, magnesium 0.25%, sodium 0.11%, and nitrogen 0.60%. Iron was 24 ppm. Phosphorus, potassium, sulfur, and most micronutrients were below the laboratory detection limit. The lab analysis of eggshells shows that it is mostly composed of calcium carbonate which is very similar to a typical commercial grade calcite agricultural limestone. The small amount of nitrogen present likely comes from residues of egg protein.

Aside from the nutrient composition, the value of eggshells as a liming material is of special interest. The Calcium Carbonate Equivalent (CCE) was 46.5%. For reference, and as used in limestone labeling laws, pure calcium carbonate has a standard value for CCE of 100%. Findings suggest that eggshells would be slightly less than half as effective as high quality commercial agricultural limestone for neutralizing soil acidity. This means that the application rate for eggshells would need to be about twice the rate as compared to a recommended rate of limestone.

There are other soil fertility considerations. The concentration of magnesium in eggshells is very low. Thus, as a liming material, eggshells may be regarded as high calcium type of "limestone". If magnesium soil test levels are low, magnesium fertilizer would be needed since eggshells provide very little of this nutrient.

Eggshells do not have a particle fineness like high-quality pulverized commercial grade limestone. The coarseness of the material will slow its acid neutralizing activity. But with tillage to crush the eggshells and time and they should serve the normal expected function of a liming material.

Coffee Grounds

Coffee grounds were collected from a shop in Lambertville that brews fresh coffee. A sample of the spent coffee grounds was separated from the paper filters and sent to an agricultural lab for nutrient analysis. The lab reported that the moisture content was 59% and the organic content was about 40%. On a dry basis the material contained 2.24% N, 0.09% P, 0.65% K, and 0.13% S.

With a carbon to nitrogen ratio was 23, coffee grounds could be applied to compost piles or directly to soils as a source of N and organic matter. Based on that ratio, it should not be expected to cause N deficiency in crops where it is applied to soils.

If the coffee filters were included, because of the very high carbon to nitrogen ratio of paper, it would shift the composition to that of a material that may cause a temporary N deficiency in crops. Also, if spread on the soil surface, the coffee filters could litter the landscape. When coffee filters are in the mix, the material would be best incorporated into a compost pile.

Newspaper

Paper is sometimes used for mulching crops or as a bedding material for animals. A major constituent of paper is cellulose which adds organic matter to soil. However, because the nutrient content of paper is very low it contributes very little to soil fertility except for organic matter. The very high carbon to nitrogen ratio (175 to 1) of newspaper indicates that it will likely decrease the N availability from soil. A detailed chemical analysis of local newspapers was reported in The Soil Profile newsletter in Winter 1993.

Milk

Sometime milk is discarded for various reasons. It could be because it has passed the sell-by-date, or it could be from times when the milk from a dairy animal is not fit for market. Also, sometimes there is an excess of skim milk when the cream is separated to make butter or ice cream.

To determine the fertilizer value, a commercial brand of skim milk was purchased from a store and sent to an agricultural lab for nutrient analysis. The composition of skim milk is reported here as the amount of nutrient contained in 1000 gallons: 57.3 lb. N, 10.6 lb. P, 1.69 lb. K, 13.24 lb. Ca, 1.11 lb. Mg, 3.76 lb. Na, and 3.4 lb. S.

Milk is rich in protein which rapidly becomes available for plant uptake when added to soil. Studies conducted in my soil fertility program with Sudan grass as a crop to test the growth response to skim milk have demonstrated a potential doubling of biomass yield as compared to an unfertilized control.

For gardeners, a reasonable application rate may be about one cup of milk per tomato plant or for row crop garden vegetables about a half cup per square foot.

Sea Water

The salts in ocean water are rich in chloride and sodium but also contain beneficial amounts of sulfate, magnesium, calcium, potassium, and micronutrients. Sodium is classified as essential to some plant species, for example, corn and sugar beets. It is beneficial to many other crops when supplied in moderation since to a limited extent sodium can substitute for potassium nutrition.

Field trials we conducted at Rutgers NJAES suggest that applications of seas salts from ocean water may improve the flavor of tomatoes. Studies from Israel and Italy also indicate that modest applications of salt water can benefit tomato. Gardner's visiting the Jersey shore can collect sea water from the Atlantic Ocean in a jug and bring it home. Application of a third of a gallon of sea water, which contains about 45 grams of salt, is enough to treat one tomato plant. The seawater drench should be applied around the base of the plant two weeks after transplanting or early bloom. To prevent leaf burn, do not allow the seawater to touch the leaves. In our trials we did not observe any negative effects of the seawater treatment on tomato plant size or fruit production.

Asparagus may also benefit from applications of seawater. Salt helps protect asparagus from fusarium crown rot based on field trials conducted at the Connecticut Agricultural Experiment Station. Typically, rock salt is used and applied at about 500 pounds per acre after the asparagus harvest season. Brackish water or seawater can be used in place of rock salt.

Human Urine

Urine, something we produce every day, is perhaps the most renewable soil fertility resource. The average adult produces about 100 to 150 gallons of urine per year. The design of modern sanatory systems normally causes urine to be wasted as it is flushed away to sewage treatment plants.

Nutrients contained in 100 gallons of human urine would typically supply in pounds: 4.8 Nitrogen, 0.3 Phosphorus, 1.3 Potassium, 0.4 Sulfur, 1.2 Sodium, 0.02 Calcium, and 0.01 Magnesium. This is an average nutrient excretion as urine from one person over a year. Values, however, will vary depending on diet.

In 2021, I collected my urine and saved it in containers to experiment with its potential use as a fertilizer. After a first cutting of hay, I took some of the accumulated stored urine and spread it after diluting it with water on a field section to spell out the letters: NPK. The photo taken three weeks later shows the green up and growth response to the applied urine.

A typical fertilizer recommendation to produce grass pasture or hay for livestock feed is to broadcast 25 to 50 pounds of N after each pasture rotation or harvest. Thus, about 500 to 1000 gallons of urine applied per acre as a liquid fertilizer would be needed to satisfy that N recommendation. That application of urine will supply at the same time useful amounts of other nutrients.

Much of the N contained in urine is potentially volatile as ammonia which can go off into the atmosphere. Thus, to minimize ammonia volatilization and conserve the N for crop uptake, the urine should ideally be applied just before a rain shower is expected or irrigation can be used to move the N into the soil. A dilution of the urine with water will also help move it into the soil, reduce ammonia volatilization, and prevent salt injury to plants.

Urine as fertilizer should not be used for production of food crops directly consumed by people. Instead use it on grain and forage crops that have a high demand for N and are grown for livestock feed.

To learn more about using urine as a fertilizer, check out the works of the Rich Earth Institute: http://richearthinstitute.org/ in Brattleboro, VT. People in Battleboro volunteer to collect their urine in what may be called “Community Supported Soil Fertility”. It is a new twist on Community Supported Agriculture or CSA, wherein this case the objective is feeding the soil that feeds us.

The Rich Earth Institute has considerable experience collecting and turning human urine into fertilizer. Located in southern Vermont, the Institute conducts field trials with human urine. The Rich Earth Institute reports that grass hay yields from urine application are equivalent to that produced from commercial fertilizer.

Although human urine is not technically on the USDA-NOP prohibited list, it is generally not recommended for use in certified organic crop production. As always check with your certifier before land application of any fertilizer material discussed here in this newsletter before application to Certified Organic Farmland.

Food Waste and Miscellaneous Materials

Some materials, such as food waste, are not suitable for direct application to land and are better composted first. Many of the previously discussed materials such as wood chips, grass clippings, horse manure, and shade tree leaves can be blended with food waste to achieve the desired carbon to nitrogen ratio of about 30 to 1 to begin the composting process.

Once compost has matured it may be land applied as a soil fertility amendment. While compost can be a very beneficial soil fertility input, repeated heavy applications should be monitored based on soil testing. Nitrogen availability from compost is slowly available to crops over a period of several years. In the first year of a compost application typically only 10 to 20% of the applied N from the compost becomes available to crops in the first growing season.

When compost is applied, as the primary source of N for crops, it tends to supply excessive amounts of P and K. To give an example, if 50 tons (moist weight) were applied per acre a typical compost might add to the soil 500 lbs. N, 100 lbs. P, and 240 lbs. K per acre. Assuming a 15% availability factor for the applied compost N, about 75 lbs. N becomes available to crops in the first growing season. Such an application would tend to exceed the P and K needs of most crops. Consequently, when repeated applications of compost are made to supply N to crops, it often results in the buildup of excessive levels of P and K in the soil.

Thus, compost should not be used as the primary source of N for crop production. It is best to use compost in combination with crop rotations and cover crops that include N fixing legumes. Growers using compost should soil test to monitor for changes in levels of P and K over time.

An educational field day at the Rodale institute exhibited compost application rates of 10, 25, and 50 tons/acre:

Conservation of Nutrients

Another approach to maintaining soil fertility without purchasing inputs is to conserve the reserves of nutrients already in the soil. Keeping farmland covered or planted to cover crops prevents soil erosion and nutrient runoff. Also, winter cover crops such as cereal rye soak up residual nutrients after crop harvest. Cover cropping minimizes leaching of nutrients out of the soil profile.

Crop residues such as straw following wheat harvest for grain can be baled and taken off the field or it can be left on the soil as mulch and for the recycling of nutrients. When not harvested, each ton of wheat straw leaves 20 pounds of K on the field with a current value at about $15.

Manure Resource Website

The New Jersey Department of Agriculture and the New Jersey Compost Council are working towards developing a website to connect livestock farms with excess manure to composters seeking materials for composting. Farmers seeking alternatives to commercial fertilizer can check this website; expected to be online by March 2024.

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