



Nutrient Management Plan (590) for Organic Systems

Oregon Implementation Guide



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Figure 2. Six-foot-tall fava bean cover crop, Fong Farms, Woodland, California 2006.

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Figure 1. (On front cover) Lettuce at Diggin' Roots Farm, OR.
Photo: Shawn Linehan (<http://www.shawnlinehan.com/>)

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Nutrient Management Plan (590) for Organic Systems Implementation Guide

Purpose and Objectives

This document is an instruction guide for creating and implementing a nutrient management plan (NMP) on certified or transitioning organic lands.

An NMP for organically managed lands describes the amount, source, placement, form, and timing of the application of nutrients and soil amendments, generally by field, to meet crop nutrient needs while protecting water quality, improving soil health, and utilizing manure and other organically acceptable byproducts as nutrient sources.



*Figure 3. Cover crop mix of rye and phacilia on Sauvie Island, OR.
Photo: Ben Howell (Oregon Tilth)*

Developing an NMP entails:

- 1) Determining a crop's need for nitrogen, phosphorus, potassium, and other nutrients as appropriate
- 2) Crediting all significant sources of nutrients in the system such as the nitrogen contribution of cover crops, the mineralization of nitrogen based on input history (previous years' manure/ organic byproducts applications), and any nitrate that may be contained in irrigation water
- 3) Determining the target nutrient application rate (the difference between the crop need and the nutrient credits)
- 4) Evaluating likelihood of nutrients moving past the edge of a field or below the root zone (leaching and runoff)
- 5) Calculating the appropriate rate of manure/ organic product application based on this risk

Instructions

 **This icon indicates you should fill in data on the Implementation Requirement Worksheet in Appendix D, pages 26-30.**

 **In the *Field and Crop Information* section, list the crops in the order they are grown. Check the box for the current crop. Make additional copies of the form as needed.**

Relevant National Organic Program (NOP) Regulations

National Organic Program (NOP) regulations section 205.203 should be referenced when assessing nutrient management in organic systems. The entire NOP regulations, as well as lists of approved and prohibited materials and other information can be found at the NOP website: www.ams.usda.gov/AMSv1.0/nop

Section 205.203 Soil Fertility and Crop Nutrient Management Practice Standard

- (a) The producer must select and implement tillage and cultivation practices that maintain or improve the physical, chemical, and biological condition of soil and minimize soil erosion.
- (b) The producer must manage crop nutrients and soil fertility through rotations, cover crops, and the application of plant and animal materials.
- (c) The producer must manage plant and animal materials to maintain or improve soil organic matter content in a manner that does not contribute to contamination of crops, soil, or water by plant nutrients, pathogenic organisms, heavy metals, or residues of prohibited substances. Animal and plant materials include:
 - (1) Raw animal manure, which must be composted unless it is:
 - (i) Applied to land used for a crop not intended for human consumption;
 - (ii) Incorporated into the soil not less than 120 days prior to the harvest of a product whose edible portion has direct contact with the soil surface or soil particles; or
 - (iii) Incorporated into the soil not less than 90 days prior to the harvest of a product whose edible portion does not have direct contact with the soil surface or soil particles;
 - (2) Composted plant and animal materials produced through a process that:
 - (i) Established an initial C:N ratio of between 25:1 and 40:1; and
 - (ii) Maintained a temperature of between 131 °F and 170 °F for 3 days using an in-vessel or static aerated pile system; or
 - (iii) Maintained a temperature of between 131 °F and 170 °F for 15 days using a windrow composting system, during which period, the materials must be turned a minimum of five times.
 - (3) Uncomposted plant materials.
- (d) A producer may manage crop nutrients and soil fertility to maintain or improve soil organic matter content in a manner that does not contribute to contamination of crops, soil, or water by plant nutrients, pathogenic organisms, heavy metals, or residues of prohibited substances by applying:
 - (1) A crop nutrient or soil amendment included on the National List of synthetic substances allowed for use in organic crop production;
 - (2) A mined substance of low solubility;
 - (3) A mined substance of high solubility: Provided, That, the substance is used in compliance with the conditions established on the National List of non-synthetic materials prohibited for crop production;
 - (4) Ash obtained from the burning of a plant or animal material, except as prohibited in paragraph (e) of this section: Provided, That, the material burned has not been treated or combined with a prohibited substance or the ash is not included on the National List of nonsynthetic substances prohibited for use in organic crop production; and
 - (5) A plant or animal material that has been chemically altered by a manufacturing process: Provided, That, the material is included on the National List of synthetic substances allowed for use in organic crop production established in § 205.601.
- (e) The producer must not use:
 - (1) Any fertilizer or composted plant and animal material that contains a synthetic substance not included on the National List of synthetic substances allowed for use in organic crop production;
 - (2) Sewage sludge (biosolids) as defined in 40 CFR part 503; and
 - (3) Burning as a means of disposal for crop residues produced on the operation: Except, That, burning may be used to suppress the spread of disease or to stimulate seed germination.

Section 1.

Determining Crop Need for Nitrogen, Phosphorus, and Potassium

This section outlines the process and resources to be used to calculate the demand of a particular crop for N, P, K, and other nutrients. Sources of information about crop nutrient needs can be found in Appendix C, Section 1.

It is common for organic farms to grow many different crops on relatively small acreages and for soil texture to vary across the farm. In order to develop a practical nutrient management plan for small plot acreages, it may be helpful to work with the grower to develop groupings of crops that have similar growth habits and nutrient needs, and manage the grouping's nutrient needs as a single entity. Crop rotations are required in organic systems. Growers should have a crop rotation plan as part of their organic system plan.

Additional information to guide soil sampling strategies and crop rotations on diverse organic vegetable farms can be found in Appendix C, Section 1. Some possible groupings include:

- **Nitrogen Needs (Ideal):** Low/Medium/High N. See Table 1.
- **Plant Family:** For example, all solanaceous or all brassica crops
- **Timing:** Early season, mid-season, and late season plantings. Timing will impact nutrient availability from soil N mineralization. Early season crops will be unlikely to pull much from the soil and should be fertilized accordingly.
- **Crop Growth:** Short-season crops, long-season crops
- **Crop Type:** Grains, legumes, vegetables, fruits
- **Other:** Growers also take other considerations into account such as irrigation system layout, pest cycles, and soil type.

Table 1. Nitrogen requirement of vegetable crops based on seasonal nitrogen uptake

Low Total N Need <120 lb/acre	Medium Total N Need <120-200 lb/acre	High Total N Need >200 lb/acre
Baby greens	Carrot	Broccoli
Beans	Corn, Sweet	Cabbage
Cucumbers	Garlic	Cauliflower
Radish	Lettuce	Celery
Spinach	Melons	Potato
Squashes	Onion	
	Peppers	
	Tomatoes	
— Gaskell et al. 2006, <i>Soil Fertility Management for Organic Crops</i>		

Oregon grows a great variety of specialty crops. Oregon State University cooperative extension has horticulturists and agronomists who can point you in the right direction for informational resources about the nutrient needs of less commonly planted crops. Some specialty crops may require higher amounts of particular micronutrients, which if not present will limit quality and yields. Other crops may be more sensitive to excess micronutrients, such as citrus sensitivity to boron. If no University recommendations are available for a crop, an acceptable strategy is to balance N, P and K applied with N, P and K expected to be removed by the crop.

 **Enter crop nutrient requirements and yields under *Recommended Nutrients to Meet Yield*.**

Resources for Nutrient Requirements of Crops

NRCS Crop Nutrient Tool:

<http://plants.usda.gov/npk/main>

NRCS Agricultural Waste Management Field Handbook provides data on N, P and K content of a wide variety of crops.

<ftp://ftp.wcc.nrcs.usda.gov/wntsc/AWM/handbook/ch6.pdf>

Oregon State University Fertilizer/Nutrient Management Guidelines for Crops:

<http://extension.oregonstate.edu/catalog/details.php?sortnum=0134&name=Fertilizer+Guides&cat=Agriculture>

Section 2.

Developing Nutrient Credits

This section outlines some methods to calculate the nutrient contributions of:

- Soil Organic Matter (SOM) N mineralization
- Cover crops
- Organic amendments such as manure, compost, and some specialty fertilizers

The input history of a field is valuable, because many sources of organic N continue to mineralize over several years. As part of their organic recordkeeping requirements, organic farmers will have records of their soil fertility inputs, as well as yield data, and these can help to make a more comprehensive nutrient management plan. Transitioning farmers may have no records if they are early in their transition. Recent soil test information will provide information about what is present in the soil. Sources of information about organically acceptable fertilizers can be found in Appendix A, Tables 4, 5, and 6.

Soil Test Information and Resources

Soil test and leaf test results taken at different times of year provide valuable data for monitoring the performance of nutrient management plans. This is especially useful for refining N fertilizer rates. Pre-Side-dress Nitrate Tests (PSNTs) can ensure a grower that N levels are sufficient for the crop. PSNTs are generally done in the late spring and allow the grower to respond to early spring weather conditions that impact N mineralization. End-of-season soil nitrate tests can determine whether N fertilizer rates were higher than necessary. In most perennial crops, leaf tests are used to determine crop nutrient status. These naturally incorporate non-fertilizer nutrients taken up by the crop.

Mineralization from “native” SOM is generally not included in NRCS nutrient management plans because land-grant university recommendations for N fertilizer application rate assume typical soil N mineralization already (under conventional management). However under long-term management with consistently high organic-N inputs, soil N mineralization may supply a significant portion of crop N needs.

P and K should be managed by soil tests and attention to P and K removal through harvest of crop biomass. P and K fertilization decisions typically do not require consideration of target yield for the crop. Crops grown

in soil with high P and K concentrations usually do not respond to P and K fertilizers. When large amounts of crop biomass are removed at harvest (i.e., alfalfa, or corn silage) significant amounts of P and K are removed from the soil. Other crops such as raspberries or blackberries do not remove large amounts of P and K.

Soil test results can come in either text or graphical formats. Discuss with the producer which format is preferred. University nutrient management guides provide more accurate crop-specific sufficiency levels than general ranges. Refer to Oregon’s Conservation Practice Standard 590 for the required soil tests. A listing of accredited (NAPT-PAP certified labs) soil testing labs can be accessed at: www.naptprogram.org/pap/labs. Tests of plant tissue, water and organic materials must be conducted by labs that are certified by organizations noted in Oregon’s 590 practice standard.



Enter soil test results under the *Soil Test Information* section.

Nitrogen (N)

Nitrogen in organic systems is often tied up in organic matter, and not in a form that is immediately available to plants. Most organically acceptable sources of N have lower N concentrations than chemical fertilizers, and typically release less of their total N in the first cropping season. In contrast, PAN for chemical fertilizers such as urea, ammonium sulfate, and others, is 100%. That is, the N is available to the plant shortly after application as either nitrate (NO_3 —this is the form most plants take up N), or ammonium (NH_4^+). Possible sources of N for organic systems include compost, manures, cover crops, organic matter mineralization, organic approved fertilizers (fish meal, feather meal, etc.), and irrigation water.

In some locations, irrigation water can have significant levels of nitrates, so it’s a good idea to have the irrigation water tested. The nitrate contribution from irrigation water should be taken into account when developing nutrient budgets, but there are many variables to consider: uptake by plant, irrigation water going beyond root system, and nitrate variability in water during the season. Table 12 provides conversions to calculate parts per million to lbs/acre inch.

PAN Plant-Available Nitrogen —
Nutrient Source: Soil N Mineralization

This is the process whereby the stock of N that is “stored” in SOM decomposes to release plant-available nitrogen (PAN). Because organic farmers typically apply more organic matter than conventional farmers, PAN provided by soil N mineralization generally increases under organic management. The most recent organic inputs have the most influence on PAN release from soil organic matter. Most University nutrient management guides account for some background soil N mineralization, but not usually the high levels often found on established organic farms. The potential rate of soil N mineralization is a function of temperature, tillage, type of soil, and other factors. Any figures developed for PAN from soil N mineralization must be considered approximate.

While organic growers are required to record applications of materials, they might not have the nutrient analyses they need to do a calculation. Approximate numbers can be used in this situation.

How to Estimate Soil N Mineralization

1. Organic amendments (composts, manure, cover crops, fertilizers, etc.) applied to the soil will continue to provide PAN in subsequent years, but in ever-smaller quantities. Organic fertilizers such as blood meal, and feather meal, which are higher in N, will provide roughly 75% of their N in the first year and up to 50% of their N within a week of application (Gaskell, 2007). Assuming some materials have been applied, first calculate total N application per year. To determine the PAN for the current year, refer to Tables 7-9. The estimation rule for PAN available in years 1, 2, and 3 post-application are 8%, 5%, and 3% of total N applied, respectively. See Table 2, below. Although a soil with more organic matter contains more total N, SOM levels

are not a good indicator of PAN as soil temperature, moisture, and many other soil management factors are not considered. Laboratories that estimate PAN based on SOM typically do not have calibration data to support their estimates (Horneck, 2011).

2. If previous organic input history is not available, then credit 50 lbs N/acre if the field received substantial organic inputs (i.e. cover crops and manure or compost) for at least three consecutive years.

PAN Plant-Available Nitrogen —
Nutrient Source: Manures and Compost

To determine PAN from manure and compost products you must first analyze the nitrogen content. Table 7, Appendix A, based on Oregon State University’s Organic Fertilizer and Cover Crop Calculator (Andrews, et al.), identifies the PAN % or pounds after four weeks for manure, compost, and other organic amendments.

In order to obtain the full N benefits of manure, applications should be incorporated immediately. Significant amounts of ammonia-N can be lost within one to two days of application through volatilization (see Table 5 Appendix A). Significant amounts of N may also be lost if manure is applied too far in advance of the period of rapid N uptake by the crop, even if the manure is incorporated. For fall manure applications, up to half of the N may be lost by the time of greatest crop demand the following year (Magdoff, 2009).

Poultry litter is a popular organic amendment because of high N and P levels, but it may be high in arsenic, copper and zinc due to additives in their feed. Analysis of poultry litter should include Zn, Cu, and As to ensure that soil is not being contaminated.

Table 2. PAN Credits.	
PAN, Percent of Total N (general rule)	Years After Application
45% x total N lbs/acre	current year
8% x total N lbs/acre	1
5% x total N lbs/acre	2
3% x total N lbs/acre	3

Manure and Compost

Refer to page 4 for additional National Organic Program regulations related to the use of manure and compost on organic farms. It should also be noted that manure and compost inputs from non-organic sources are allowed as long as there is no risk of contamination.

PAN Plant-Available Nitrogen — Nutrient Source: Cover Crops

Cover crops and green manures provide both nitrogen and organic matter to the soil. The amount of N and organic matter provided will depend on the cover crop species, or mix, crop biomass, and growth stage when killed. These same factors will influence how rapidly the cover crop will decompose, and whether it will release, or immobilize PAN. Most PAN is released in four to six weeks after cover crop termination. For a comprehensive guide on this topic see 'Estimating Plant Available Nitrogen Release from Cover Crops, PNW 636'. In this publication we will review the shortcut method as outlined in that document.

PAN from any cover crop is minimal when the cover crop is very small. For solo cover crops, the best time to terminate the cover crop to maximize PAN depends on whether the cover crop is a legume or a non-legume.

- PAN from a robust stand of legumes (Figure 4) peaks at budding growth stage. PAN declines slowly as reproductive growth continues.
- PAN from cereal residues is positive early in the spring (through tillering, mid- to late March). As stem elongation proceeds (jointing), PAN from cereal residues declines. By the time the flag leaf (uppermost leaf) emerges (Feekes growth stage 8 or Zadoks 37), PAN from cereal crop residue is near zero. When cereal heads are visible, PAN from cereals is negative.

To maximize PAN, kill cereal cover crops early, but wait until bud stage to kill legumes. In cereal/legume mixtures, the best crop growth stage for maximum PAN benefit depends on the percentage of legume in the stand. Figure 4 illustrates how PAN changes over time in solo and mixed cover crop stands.

- When the cover crop is mostly legume, it behaves much the same as does a pure legume cover crop—the PAN from crop residue increases until cereal boot stage. (Feekes stage 10; Zadoks stage 45). After pure, or majority cereal stands reach jointing stage, PAN declines.
- When a cover crop has more cereal than legume (25 percent legume line in Figure 4), it follows a similar PAN curve as a solo cereal crop, but negative PAN is usually not seen until the cereal reaches boot stage (around mid-May).

Seeding legume/cereal mixes instead of a solo cereal crop allows greater flexibility in timing of cover crop

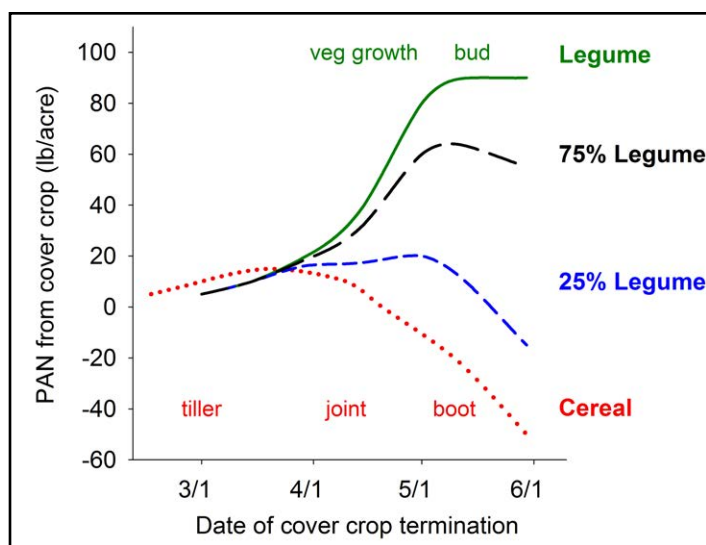


Figure 4. Effect of kill date on typical plant-available N (PAN) release from cereal, legume, or mixed stands. Based on compilation of field data from Willamette Valley cover crop trials. Figure from PNW 636, Estimating Plant-available Nitrogen Release from Cover Crops (Sullivan and Andrews, 2012), ©Oregon State University. Used by permission.

termination without consequences of negative PAN. Cover crop mixes also combine the N fixation benefits of legumes with weed suppression and soil benefits of cereals. The percent N in cereals varies with field history. Fields that have a history of manure/compost application and/or legumes in rotation often have higher percent N in cereal than do fields with a history of only N fertilizer application.

Biomass determination. The first step in estimating PAN from a cover crop is determining how much cover crop biomass is present. Visual estimates of cover crop biomass are not very accurate, especially for multi-species cover crop mixes. Cutting and weighing cover crop biomass is the preferred method to estimate PAN. Generally, cover crop roots are not included in this calculation. Harvest the above-ground cover crop with quadrats or a sickle bar mower (see Sullivan et al. 2012, Appendix C, Section 5 for additional sampling instructions). Any harvest method can be used that gives you a clean plant sample with a known harvest area.

To determine the PAN you'll need to estimate the percent dry matter (DM; Tables 3 and 9). You will need to either use a ballpark estimate of DM or oven dry the sample that has been collected. Mixed, vegetative cover crop DM will usually be between 12 and 18%. Very wet clover samples are usually 10 to 12 % DM. Cereals after head emergence are usually 20 to 25% DM.

Table 3. Estimated plant-available N (PAN) release from decomposition of crop residues in soil at 4 and 10 weeks

	Total N	C:N	4 wk	10 wk	4 wk	10 wk
	% N, dry wt		PAN, % of residue total N		lbs PAN/dry ton	
Cereals after head emergence	1	40	-40	<0	-8	<0
Cereals, tillering/jointing	2	20	5	20	2	8
50/50 Cereal/Legume Mix or Flowering Legumes	3	13	35	40	21	24
Legumes, vegetative	4	10	50	55	40	44

Adapted from OSU Extension publication EM9010-E (2010): Nutrient management guide for sweet corn (western Oregon). See "Biomass determination" on page 8 for a discussion of estimating the percent of dry matter.

Negative PAN values indicate immobilization of N by cover crop residue.

With a good stand and cover crop kill near bud or head emergence stage of plant development, the typical cover crop PAN credit is 50 lb N/acre for cereal legume mixtures, and up to 100 lb PAN/acre for legumes.

Shortcut method. Harvest and measure cover crop biomass and use typical values for cover crop DM and percent N (Table 3) to estimate PAN. See Table 9 for information and sample calculations about how to estimate cover crop contributions to PAN. More accurate estimations can be made with lab analysis (Sullivan & Andrews, 2012).

 Enter figures for PAN available from previous applications of manure, compost and cover crops under *Nutrient Sources* section. Alternatively, use the rates established in your state's Nutrient Management Planning tool.



Figure 5. Assessing the biomass of a cover crop.

Phosphorus (P)

In nature, most plants, except brassicas, receive much of their phosphorus through mycorrhizal interactions with the soil. This is particularly true in perennial systems. In organic systems, with regular cover crops, this interaction may be more prominent than in conventionally managed systems because organically managed soils can provide better conditions for mycorrhizal survival. If manures, or composted manures, have been regularly applied at rates to meet a crop's N needs, this may result in more P (and K) than the crop requires. After many years, this can result in over-accumulation of P and K, and any solution requires some combination of reduced applications and/or increased uptake and removal of these nutrients.

Potassium (K)

Potassium is available as a positive ion, or cation, and soils with a high cation exchange capacity (CEC) will generally have more capacity to store K. Most soils with high clay content, high organic matter levels (>3%), or both will

have high CEC. There are thousands of pounds per acre of potassium in an average, non-sandy soil, but most of that is unavailable to plants—usually only 1-2% is available. Repeated applications of manures can lead to over-abundance of K (as well as P) in the soil.

Secondary Macronutrients and Micronutrients

Micronutrients are important to plant health, and can be limiting factors for both yield and quality in some production systems, or, when present in excessive amounts, can reduce availability of other nutrients or have a negative impact on plant health. Soil tests should provide information on the levels of the secondary macronutrients Calcium (Ca), Sulfur (S), and Magnesium (Mg), as well as micronutrients, such as Manganese (Mn), Iron (Fe), Zinc (Zn), Copper (Cu), and Boron (B). Documented soil deficiency, either through soil or tissue tests, is required per NOP regulations prior to applying any synthetic micronutrients.

Section 3.

Determining Nutrient Application Rates

Determining nutrient application rates consists of taking your crop's nutrient needs and subtracting any credits from the system. If the credits are less than the crop's nutrient need, the grower will need to apply supplemental nutrients in order to achieve the desired yield. Not all of the N applied this year will be available to the crop in the first year. A balanced nutrient program will supply sufficient PAN, P_2O_5 , K_2O , and other nutrients while avoiding excesses. The example below demonstrates this approach.



Add up all the PAN nutrient credits from the previous applications of manure, compost, cover crops, as well as what can be expected from the irrigation water for this season's crop. This total should be subtracted from the total Nutrients Recommended for Yield.

Example

Assume that after all the nutrient credits are subtracted, the values for the Nutrients Recommended for Yield are:

80 lbs PAN, 40 lbs P_2O_5 , and 60 lbs K_2O per acre.

The manure analysis is 3% N, or 60 lbs total N per dry ton. According to Table 7, PAN Estimates for Uncomposted Manure, at 10 weeks PAN released is about 30% of the product, or 18 lbs PAN per dry ton. This material is 60% dry matter (therefore, 40% water), so to make consideration for this:

$18 \text{ lbs PAN} \times 0.60 = 10.8 \text{ lbs PAN per "as is" ton}$

$80 \text{ lbs PAN/acre} \div 10.8 \text{ lbs PAN/Ton} = 7.4 \text{ T/ac}$

This is the application rate that meets the crop's nitrogen need.

The manure also contains 20.6 lbs P_2O_5 /dry ton (reported on a dry basis this time) and 37.8 lbs K_2O /dry ton according to the analysis.

To calculate how much P_2O_5 the 7.4 T/acre manure application rate will provide:

Application rate: $7.4 \text{ T/ac} \times .6 \text{ (60\% dry matter)} \times 20.6 \text{ lbs } P_2O_5/\text{dry ton} = 91.5 \text{ lbs } P_2O_5/\text{ac}$

91.5 lbs P_2O_5 /ac is being applied with the 7.4 T/ac manure.

Note that this is over twice as much P_2O_5 as is required by the crop. What are some other fertilizer options that would supply sufficient N, but less P_2O_5 ?

To calculate how much K_2O the 7.4 T/acre manure application rate will provide:

Application rate: $7.4 \text{ T/ac} \times .6 \text{ (60\% dry matter)} \times 37.8 \text{ lbs } K_2O/\text{dry ton} = 168 \text{ lbs } K_2O/\text{ac}$

168 lbs K_2O /ac is being applied with the 7.4 T/ac manure. This is nearly three times as much K_2O /ac as is required.

What are some other fertilizer options that would supply sufficient N and P, but less K_2O /ac?

Refer to Tables 4-6 for additional organic fertilizer options.

Please note: Calculations here use lbs N/ton or PAN/ton because litter and compost are commonly delivered by the ton.



Enter planned NPK applications to the right of line 7 (Manure), line 8 (Compost), or line 9 (Specialty Fertilizers) in the appropriate nutrient column.

Timing and Application Method

The timing, application, and incorporation methods of nutrients is most important relative to conserving N and P. Manure applications can provide significant N to the soil if they are incorporated within 12 hours of application. If the manure is broadcast and left on the surface, between one half and two thirds of the available N can be lost to volatilization after one week (see Table 5, Appendix A). Even in reduced-till systems, application close to the time of planting will decrease the likelihood of loss by runoff or erosion. Manures are generally best applied just before soil tillage, but diligence is needed to ensure that National Organic Program harvest-interval regulations related to manure applications are followed.

N mineralized from manures during a rainy period may leach N into the water table or, if eroded, may carry into surface waters. Fall applications of manure on annual row crops do risk considerable N loss, even if incorporated in regions with significant winter/spring precipitation. The ammonium is converted to nitrate, and then is subject to leaching and denitrification before the N is available for next year's crop (Magdoff & Van Es, 2009). Denitrification is the microbial conversion of nitrates to nitrous oxides,

and mostly occurs in soils that become anaerobic due to high water tables, poor drainage, or surface sealing. But regardless of the mechanism of N loss, the loss of N to water or air should be minimized through applications of N appropriate to plant needs. The forms of N applied, as well as its time of application can influence the percentage N taken up by plants, and lost to leaching or the atmosphere. The goal of N management is to have minimal nitrate-N present in soil that could be leached through rainfall or irrigation or denitrified. This may allow for fall manure applications with low risk of N leaching due to winter rains. Manures mixed with large amounts of high-carbon bedding (straw or wood shavings) may immobilize N during the early stages of decomposition, and should be composted prior to application, or be applied long enough prior to planting to reduce the risk of immobilization.

Cover crop incorporation can be considered a fertilizer application and as Figure 6 shows, the peak PAN generally occurs after four weeks. That may be two or more weeks before the crop has its highest demand for N. Attempting to plant too soon after cover crop incorporation risks pest and pathogen problems associated with the decomposing cover crop.

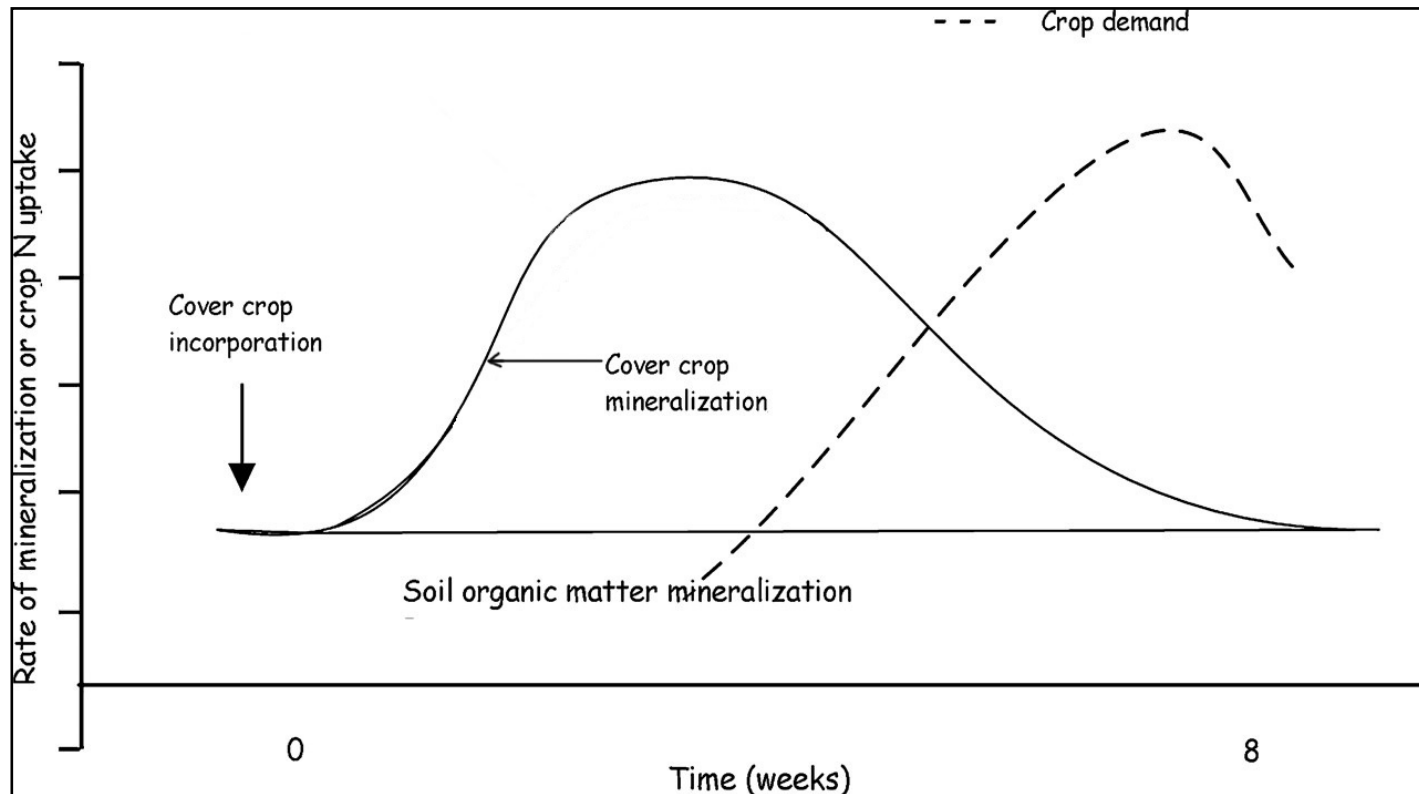


Figure 6. Timing of nitrogen (N) mineralization from cover crop residue in relation to crop N uptake (adapted from Gaskell et al., 2006). From Gaskell, M., and R. Smith. 2007. "Nitrogen Sources for Organic Vegetable Crops." *HortTechnology* October-December 2007 vol. 17 no. 4, 431-441) Note: Soil temperature plays an important role in the rate of N mineralization from soil organic matter.

Section 4.

Evaluating Risk of Leaching and Runoff

Risk factors associated with N leaving the field are not quite the same as P leaving the field, although erosion and runoff are risks common to both nutrients. These elements act differently in the environment—P does not volatilize and typically does not leach in significant quantities.

Soils with active biology and good aggregate stability will tend to absorb rainfall more easily. While this might reduce the likelihood of P runoff through soil erosion, leaching of N may still be a problem. Good aggregate stability also encourages airflow into the soil, reducing the risk of anaerobic conditions which cause denitrification and loss of soil N.

Assessing Risk of N Leaving the Field

Nitrates (NO_3), and ammonium (NH_4^+) are both easily dissolved in water. As noted above in the 'Timing' section, application and incorporation of manures close to time of planting will help reduce risks from volatilization, leaching, and runoff. Fall manure applications risk significant N loss even if incorporated.

Oregon Phosphorus Index

The interim index (Agronomy Technical Note no. 26), along with worksheets and samples is available in Section IV of the Oregon FOTG under CPS 590 Nutrient Management.

Risk Factors for P Leaving Field

- Soil texture (sandy vs. clay)
- Slope of land
- Amount of cover on the soil
- Amount and timing of nutrient application
- Amount and timing of rainfall events and irrigation
- Distance to perennial surface water
- High P levels in the soil

Mitigation Practices to Reduce P Loss from Field

- Keep crop residues on soil surface.
- Minimize duration of bare soil exposure to weather.
- Reduce length of slope using terraces, berms (vegetated with grass or hedgerows).
- Tailwater ponds reduce sediment in runoff.
- Reduce amount of P in soil surface over time by reducing the application rates for manure, compost or other products with high P content.
- No-till or minimum till may increase water soluble P loss from a field via heavy rainfall or irrigation events, even though no-till does reduce total P loss from erosion.



Figure 7. Organic management builds a soil full of aggregates and organic matter. Photo: Oregon Tilth

Section 5.

Calculating Nutrient Application Rates Based on Risk Analysis

In previous sections, you developed numbers for nutrient levels already in the ground from previous manure/compost applications, cover crops, and irrigation water. You also developed numbers for nutrient levels required by the crop. If crop nutrient requirements exceed your nutrient availability estimates, then additional nutrients are required. Refer to Tables 4-6, Appendix A for a listing of organic nutrient sources and their N-P-K values. Review the P-Index for your state for detailed guidance.

 Estimates for PAN and nutrient applications should be reviewed, and sources and amounts of nutrients to be applied should be revised as appropriate in light of P-Index policy. Add up lines 7, 8, and 9 under *Nutrient Sources* for “planned” and follow instructions in line 11, and the text in red at the bottom of the table.

Record keeping

Organic farmers are required to maintain extensive records about their crops, crop rotations, inputs, and other practices used on their farms, including a soil fertility management plan. The 590 implementation requirement developed by following this guide

can likely be used to meet many of the requirements related to soil fertility. Additionally, this information can be used to help organic growers track the trajectory of the SOM because organic rules state that the grower must maintain or improve SOM content.



Figure 8. A diversified organic farm manages nutrients in blocks to ensure the varying conditions and crops are appropriately considered.
Photo: Sarah Brown (Oregon Tilth)

Appendix A. Tables

Table 4. Nutrient analysis (percent by weight) of common organic fertilizer materials (Gaskell et al., 2007)

Material	Nitrogen (% N)	Phosphorus (% P ₂ O ₅)	Potassium (% K ₂ O)
Chilean nitrate	16	0	0
Blood meal	12	0	0
Feather meal	12	0	0
Fish meal/powder	10-11	6	2
Seabird & bat guano	9-12	3-8	1-2
Meat and bone meal	8	5	1
Soybean meal	7	2	1
Processed liquid fish residues*	4	2	2
Alfalfa meal	4	1	1
Pelleted chicken manure	2-4	1.5	1.5
Bone meal	2	15	0
Kelp	<1	0	4
Soft rock phosphate	0	15-30**	0
Potassium-magnesium sulfate	0	0	22
Cocoa shells	1	1	3
Cottonseed meal	6	2	2
Granite dust	0	0	5
Hoof & horn meal	11	2	0
Seaweed, ground	1	0.2	2
Muriate of potash (KCl)	0	0	60
Values given for general information purposes only. Use the actual N-P ₂ O ₅ -K ₂ O analyses provided by supplier in preparing the nutrient management plan.			
* All analyses are % by weight, as specified in state fertilizer laws. For liquids, product density (weight per gallon) should be used to calculate nutrient application rate: (g/ac)*(lb nutrient/g)=(lb nutrient/ac)			
* *Soft rock phosphate provides only 1-3% of its P in acid soils, and little or no P in soils with pH over 7.			

Table 5. Nutrient Content of Common Animal Manures and Manure Composts

This table includes general estimates of nutrient availability for manures and composts. These can vary widely depending on animal feed, management of grazing, the age of the manure, amount and type of bedding, and many other factors. Manure applications must be done in accordance with NOP 205.203 C.1-3. See page 4.

Production Guide for Organic Snap Beans for Processing. 2012. (A. Seaman, ed.) Cornell University Cooperative Extension. 50 p. http://nysipm.cornell.edu/organic_guide/bean.pdf

	Total N	P ₂ O ₅	K ₂ O		N1 ¹	N2 ²	P ₂ O ₅	K ₂ O
Nutrient content lbs/ton				Available nutrients lbs/ton in first season				
Dairy (with bedding)	9	4	10		6	2	3	9
Horse (with bedding)	14	4	14		6	3	3	13
Poultry (with litter)	56	45	34		45	16	36	31
Composted dairy manure	12	12	26		3	2	10	23
Composted poultry manure	17	39	23		6	5	31	21
Pelleted poultry manure ³	80	104	48		40	40	83	43
Swine (no bedding)	10	9	8		8	3	7	7
Nutrient content per 1000 gal				Available nutrients per 1000 gal in first season				
Swine finishing (liquid)	50	55	25		25 *	20 +	44	23
Dairy (liquid)	28	13	25		14 *	11 +	10	23

1. N1 is an estimate of the total available for plant uptake when manure is incorporated within 12 hours of applications.

2. N2 is an estimate of the total N available for plant uptake when manure is incorporated after 7 days.

3. Pelletized poultry manure compost.

* injected

+ incorporated

Table 6. Pounds of fertilizer/acre needed to provide 20 to 100 pounds of N, P, K per acre.
This table is divided into three sections. Production Guide for Organic Snap Beans for Processing, 2012. (A. Seaman, ed.) Cornell University Cooperative Extension. 50 p. http://nysipm.cornell.edu/organic_guide/bean.pdf

Sources of Nitrogen	Pounds of fertilizer per acre to provide 20 to 100 pounds of N per acre				
	20# N	40	60	80	100
Blood meal 13% N	150	310	460	620	770
Soy meal 6% N (x 1.5*) also contains 2% P and 3% K ₂ O	500	1,000	1,500	2,000	2,500
Fish meal 9% N (also contains 6% P ₂ O ₅)	220	440	670	890	1,100
Alfalfa meal 2.5% N also contains 2% P and 2% K ₂ O	800	1,600	2,400	3,200	4,000
Feather meal, 15% N (x 1.5*)	200	400	600	800	1,000
Chilean nitrate 16% N cannot exceed 20% of crop's need.	125	250	375	500	625
Sources of Phosphorus	Pounds of fertilizer per acre to provide 20 to 100 pounds of P ₂ O ₅ per acre				
	20# P ₂ O ₅	40	60	80	100
Bonemeal 15% P ₂ O ₅	130	270	400	530	670
Rock Phosphate 30% total P ₂ O ₅ (x 4*)	270	530	800	1,100	1,300
Fish meal 6% P ₂ O ₅ (also contains 9% N)	330	670	1,000	1,330	1,670
Sources of Potassium	Pounds of fertilizer per acre to provide 20 to 100 pounds of K ₂ O per acre				
	20# K ₂ O	40	60	80	100
Sul-Po-Mag 22% K ₂ O (also contains 11% Mg)	90	180	270	360	450
Wood ash (dry, fine, grey) 5% K ₂ O, also raises pH	400	800	1,200	1,600	2,000
Alfalfa meal 2% K ₂ O also contains 2.5% N	1,000	2,000	3,000	4,000	5,000
Greensand or Granite dust 1% K ₂ O (x 4*)	8,000	16,000	24,000	32,000	40,000
Potassium sulfate 50% K ₂ O	40	80	120	160	200
* Application rates for some materials are multiplied to adjust for their slow-to-very-slow release rates.					

Table 7. Plant-Available Nitrogen (PAN) Estimates for Uncomposted Manure

This table is based on Oregon State University's organic fertilizer calculators, which compare the nutrient values and cost of cover crops, organic and synthetic fertilizers, and compost. One calculator is for larger acreages, providing numbers on a per-acre basis, and one is for smaller plots, providing numbers on a per-square-foot basis. These tools help calculate organic fertilizer needs and can be accessed at <http://smallfarms.oregonstate.edu/node/175833/done?sid=476>

Total N analysis (percent dry weight) of uncomposted fresh manure or other uncomposted organic fertilizer product	PAN Estimate		Total N analysis (lbs N per dry ton) of uncomposted fresh manure or other uncomposted organic fertilizer product	PAN Estimate	
	Your value			Your value	
	After 4 weeks	After 10 weeks		After 4 weeks	After 10 weeks
Total N (% dry weight)	% PAN	% PAN	lb total N per dry ton	lbs PAN per dry ton	lbs PAN per dry ton
0.5	-23	-8	10	-2	-1
1.0	-15	0	20	-3	0
1.5	-8	8	30	-2	2
2.0	0	15	40	0	6
2.5	8	23	50	4	11
3.0	15	30	60	9	18
3.5	23	38	70	16	26
4.0	30	45	80	24	36
4.5	38	53	90	34	47
5.0	45	60	100	45	60
5.5	53	68	110	58	74
6.0	60	75	120	72	90
7.0	60	75	140	84	105
8.0	60	75	160	96	120
9.0	60	75	180	108	135
10.0	60	75	200	120	150
11.0	60	75	220	132	165
12.0	60	75	240	144	180

Table 8. Estimated Plant Available Nitrogen (PAN) from Finished Compost

This table is based on the PAN equation used with the Oregon State University Organic Fertilizer and Cover Crop Calculator, <http://smallfarms.oregonstate.edu/calculator>

Total N analysis of finished compost	PAN Estimate		Total N analysis of finished compost	PAN Estimate
Your value	10 wk		Your value	10 wk
Total N (% dry wt)	% PAN		lb total N per dry ton	lb PAN per dry ton
1.0	0		20	0
1.5	5		30	1.5
2.0	10		40	4.0
2.5	10		50	5.0
3.0	10		60	6.0

Source: OSU Fertilizer & Cover Crop Calculator (online; 2013)

Instructions

1. Find %N analysis of the compost in "Total N analysis" column.
2. PAN estimates are listed on the same row in units of "%PAN" or "lb PAN per dry ton."
3. To get PAN estimate for "as-is" moisture content, multiply Table PAN estimate (given for oven dry product; 100% dry matter) x %DM/100 in "as-is" manure.

Example

Lab analysis of a compost is 1.5% N or 30 lb N per ton (dry weight basis).

The "as-is" fertilizer product contains 40% dry matter and 60% moisture.

From the Table above, PAN released in soil after 10 wk is estimated to be 5% of product total N analysis (dry weight basis), or 2 lb PAN per dry ton.

At "as-is" dry matter content (40% in this example), the product provides about 0.8 lb PAN per "as-is" ton (calculated as 2 lb PAN per dry ton x 0.4).

Use this table only when you are sure that compost is "finished". Many poultry litter "composts" that smell of ammonia are not "finished" and they have PAN similar to fresh manure.

Additional Considerations

Compost analysis for mineral N (ammonium + nitrate-N) can provide useful data to guide application rate.

First year PAN release from compost is approximately equal to the sum of ammonium + nitrate-N applied.

Very little first-year PAN comes from mineralization of organic N in finished compost.

Composts usually contain less than 3% total N. "Composts" with more than 3% N are often not finished, they are dried manure.

Table 9. Estimated Plant Available Nitrogen (PAN) from Cover Crops

Table from PNW 636, Estimating Plant-available Nitrogen Release from Cover Crops (Sullivan and Andrews, 2012),
©Oregon State University. Used by permission.

Total N analysis of cover crop	PAN Estimate		Total N analysis of cover crop	PAN Estimate
Your value	After 10 weeks		Your value	After 10 weeks
Total N (% dry wt)	% PAN		lb total N per dry ton	lb PAN per dry ton
1.0	0		20	0
1.5	13		30	4
2.0	23		40	9
2.5	32		50	16
3.0	40		60	24
3.5	47		70	33
4.0	54		80	43

Rationale

Cover crop PAN can be estimated by a variety of methods.

A general approach to estimating cover crop PAN is provided in the SARE publication "Managing Cover Crops Profitably."

The SARE approach uses "rule of thumb" estimates of cover crop biomass and N concentration and PAN.

The approach described here is for growers who are willing to make some on-site measurements to estimate PAN from cover crops.

Considerations

- A laboratory analysis for cover crop total N as a percentage in dry matter (DM) is a good predictor of a cover crop's capacity to release PAN for the summer crop. See "Biomass determination" on page 8 for a discussion of estimating the percent of dry matter.
- When cover crops contain a low N percentage (<1.5% N in DM), they provide little or no PAN.
- When cover crops contain a high N percentage (3.5% N in DM) they provide approximately 35 lb PAN per ton of dry matter.
- PAN release increases linearly, as cover crop N percentage (in DM) increases from 1.5 to 3.5%.
- Cover crops decompose rapidly, and release or immobilize PAN rapidly. Most PAN is released in 4 to 6 weeks after cover crop kill.
- Values for cover crop PAN listed here are most applicable to winter cover crop/summer vegetable crop rotations in western Oregon and Washington.
- The timing of PAN release will differ in regions outside of western WA and OR, but we expect a strong relationship between cover crop N% and PAN to be found in most locations.

Instructions

The table above is reproduced from PNW Extension publication 636, Estimating Plant-available Nitrogen Release from Cover Crops. To use these tables you will need to have either taken a lab analysis of your cover crop to identify the total %N or will be using an estimate based on Table 3.

1. Find %N analysis of the cover crop in "Total N analysis" column (far left). PAN estimates are listed on the same row in units of "%PAN" expressed as a percentage of total %N, or "lb PAN per dry ton."

Example

The fresh weight of a rye/vetch cover crop is about 16.5 tons/ac (33,000 lbs/ac). With 15% dry matter the cover crop produced 4,950 lbs dry matter/ac.

If total %N is analyzed or estimated to be 3%, percent PAN is approximately 40% (table 9). Multiply 4,950 lbs dry matter x (3/100) x (40/100) = 59 lbs PAN/ac.

Appendix B. Conversion Tables

Table 10. Converting pounds per acre to pounds per 1000 square feet

Pounds per acre	Pounds per 1000 square feet
50	1.1
75	1.7
100	2.3
125	2.9
150	3.4
175	4.0
200	4.6
225	5.2
250	5.7
275	6.3
300	6.9
325	7.5
350	8.0
375	8.6
400	9.2

One acre = 43,560 square feet

$X \text{ lbs per acre} = Y \text{ lbs per 1000 square feet}$

Example

Example 100 lbs per acre = 3.7 oz per 100 square feet

(100 lbs = 1,600 oz;

1,600 divided by 43,560 = .037 oz per sq. ft.; multiply by 100 to get 3.7 oz per 100 sq. ft.)

Table 11. Converting percentages of material per dry ton to pounds of material per dry ton

Percent of material dry weight basis	Pounds of material per dry ton
0.5	10
1	20
1.5	30
2	40
2.5	50
3	60
3.5	70
4	80
4.5	90
5	100
5.5	110
6	120
6.5	130
7	140
7.5	150
8	160
8.5	170
9	180
9.5	190
10	200
10.5	210
11	220
11.5	230
12	240

$X \text{ percent of material per dry ton} = Y \text{ lbs of material per dry ton}$

Example

.5% per dry ton = 10 lbs per dry ton

(.5% of material per dry ton =

.005 x 2,000 lbs per dry ton =

10 lbs of material per dry ton)

Table 12. Nutrient Management Conversion Factors

Measurement	Unit	Symbol	Multiply by	To Obtain	Symbol
Volume	acre-inch	ac-in	27000	gallon	gal
	gallon	gal	8.35	pound	lb
Concentration	parts per million	ppm or mg/kg	0.002	pound/ton	lb/t
	parts per million	ppm or mg/L	0.00835	pound/1000 gallon	lb/1000 gal
	parts per million	ppm or mg/L	0.227	pound/acre-inch	lb/ac-in
	percent	%	20	pound/ton	lb/t
	percent	%	83.5	pound/1000 gallon	lb/1000 gal
	percent	%	2266	pound/acre-inch	lb/ac-in
	percent	%	10000	parts per million	ppm
	pound/1000 gallon	lb/1000 gal	27	pound/acre-inch	lb/ac-in
Dry or wet	percent dry matter (total solids)	% DM	0.01	solids fraction	DM
	percent moisture	% moisture	0.01	moisture fraction	MF
	manure, dry wt. basis		100/(%DM)	manure, "as-is" basis	
Nutrients	phosphorus	P	2.29	phosphate	P ₂ O ₅
	potassium	K	1.20	potash	K ₂ O
	nitrogen in nitrate form	NO ₃ - N	1	nitrogen	N
	nitrogen in ammonium form	NH ₄ - N	1	nitrogen	N

Appendix C.

References to NRCS Publications and Other Resources

National Organic Program

www.ams.usda.gov/AMSv1.0/nop

Section 1. Determining Crop's Need for N, P, and K (page 5)

Baldwin et al. Crop Rotations on Organic Farms. www.cefs.ncsu.edu/resources/organicproductionguide/croprotationsfinaljan09.pdf

California Department of Food and Agriculture's (CDFA) Fertilizer Research & Education Program. www.cdffa.ca.gov/is/flders/frep.html

Collins, D. Washington State University, Soil Testing: A Guide for Farms with Diverse Vegetable Crops. <https://pubs.wsu.edu/ItemDetail.aspx?ProductID=15520&SeriesCode=&CategoryID=&Keyword=EM050E>

Cornell Guides for Organic Fruits, Vegetables and Dairy. http://nysipm.cornell.edu/organic_guide/
Gaskell, M., R. Smith, J. Mitchell, S.T. Koike, C. Fouche, T. Hartz, W. Horwath, and L. Jackson. 2006. Soil Fertility Management for Organic Crops. University of California. 8 p. <http://anrcatalog.ucdavis.edu/pdf/7249.pdf>

Idaho Nutrient Management, www.extension.uidaho.edu/nutrient. Look under *Crop Nutrient Requirements*.

Oregon State University Nutrient Management Guidelines for Crops. <http://extension.oregonstate.edu/catalog/details.php?search=nutrient+management&submit.x=0&submit.y=0>

Nutrient Management for Commercial Fruit & Vegetable Crops in Minnesota. <http://www.extension.umn.edu/garden/fruit-vegetable/nutrient-management-for-commercial-fruit-and-vegetables-in-mn/>

Mohler, et al. 2009. Crop Rotation on Organic Farms. http://palspublishing.cals.cornell.edu/nra_order.taf?function=view&ct_id=40

Section 2. Developing Nutrient Credits (pages 6-9)

Andrews, N., D. Sullivan, J. Julian, and K. Pool. Oregon State University Organic Fertilizer and Cover Crop Calculators. <http://http://smallfarms.oregonstate.edu/calculator>

Bowman, G., C. Shirley, and C. Cramer. 1998. Managing Cover Crops Profitably. SARE Publication. 212 p. www.sare.org/publications/covercrops/covercrops.pdf

California Department of Food and Agriculture's (CDFA) Fertilizer Research & Education Program. www.cdffa.ca.gov/is/flders/frep.html

Cornell Guides for Organic Fruits, Vegetables and Dairy. http://nysipm.cornell.edu/organic_guide/

Gaskell, M., R. Smith, J. Mitchell, S.T. Koike, C. Fouche, T. Hartz, W. Horwath, and L. Jackson. 2006. Soil Fertility Management for Organic Crops. University of California. 8 p. <http://anrcatalog.ucdavis.edu/pdf/7249.pdf>

Horneck, D.A., Sullivan, D.M., Ownen, J.S., and Hart, J.M. 2011. Soil Test Interpretation Guide. Oregon State University. 9 p. http://extension.oregonstate.edu/sorec/sites/default/files/soil_test_interpretation_ec1478.pdf

Idaho Nutrient Management. www.extension.uidaho.edu/nutrient, look under *Crop Nutrient Requirements*

Jackson, B.P., P.M. Bertsch, M.L. Cabrera, J.J. Camberato, J.C. Seaman, C.W. Wood. 2003. Trace element speciation in poultry litter. J Environ Qual. 2003 Mar-Apr., 32(2):535-40.

Magdoff, F., and H. Van Es. 2009. Building Soils for Better Crops. SARE. 292 p. www.sare.org/Learning-Center/Books/Building-Soils-for-Better-Crops-3rd-Edition

Miyao, G., P. Robbins, and M. Cain. 2001. Winter cover crops before late-season processing tomatoes for soil quality and production benefits. Final Report

Summary, CDFA Fertilizer Research and Education Program (FREP).

Oregon State University Fertilizer/Nutrient Management Guidelines for Crops
<http://extension.oregonstate.edu/catalog/details.php?sortnum=0134&name=Fertilizer+Guides&cat=Agriculture>

Schonbeck, M.W. 1988. Cover Cropping and Green Manuring on Small Farms in New England and New York: An Informal Survey. East Falmouth, MA. New Alchemy Research Report #10.

Sullivan, D.M. and N.D. Andrews. 2012. Estimating plant-available nitrogen release from cover crops. Pacific Northwest Extension Publication 636. Oregon State University Extension. Corvallis, OR. 23 p.

Zimmer, Gary F. 2000. The Biological Farmer. Acres, USA. 352 p.

Section 3. Determining Nutrient Application Rates (pages 10-11)

Andrews, N., D. Sullivan, J. Julian, and K. Pool. Oregon State University Organic Fertilizer and Cover Crop Calculators. <http://http://smallfarms.oregonstate.edu/calculator>

Gaskell, M., and R. Smith. 2007. Nitrogen Sources for Organic Vegetable Crops. HortTechnology October-December 2007 vol. 17 no. 4, 431-441)

Section 4. Evaluating Risk of Leaching and Runoff (page 12)

Magdoff, F., and H. Van Es. 2009. Building Soils for Better Crops. SARE. 292 p.
www.sare.org/Learning-Center/Books/Building-Soils-for-Better-Crops-3rd-Edition

Section 5. Calculating Nutrient Application Rates Based on Risk Analysis (page 13)

Organic Fertilizer Association of California.
www.organicfertilizerassociation.org

Available N, P and K in Organic Fertilizer

Available N in Organic Fertilizers (in Production Guide for Organic Snap Beans for Processing). 2012. Cornell University Cooperative Extension. 50 p. http://nysipm.cornell.edu/organic_guide/bean.pdf

NRCS Agricultural Waste Management Field Handbook. www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/technical/ecoscience/mnm/?&cid=stelprdb1045935

Plant-Available Nitrogen (PAN) from Cover Crops

Selected characteristics of important cover crops for California, in: Selecting the right cover crop gives multiple benefits, Ingels, C., et al. October 1994.
<http://ucce.ucdavis.edu/files/repository/calag/tab4805p45.jpg>

Sullivan, D.M. and N.D. Andrews. 2012. Estimating plant-available nitrogen release from cover crops. Pacific Northwest Extension Publication 636. Oregon State University Extension. Corvallis, OR. 23 p. http://smallfarms.oregonstate.edu/sites/default/files/WNMC11_Sullivan_p55.pdf

Other Resources

eOrganic provides resources for people seeking information about organic agriculture. The website is part of eXtension, which draws on the expertise of staff at American land-grant universities and extension programs. www.eorganic.info

ATTRA's Sources of Organic Fertilizers and Amendments Database.

https://attra.ncat.org/attra-pub/org_fert/

Building Soils for Better Crops

and

Crop Rotation on Organic Farms: A Planning Manual.

These and many other useful publications are free to download from the USDA's Sustainable Agriculture Research and Education SARE.

www.sare.org/Learning-Center/Books

Cornell's Soil Health Assessment Training Manual

Free to download at: <http://soilhealth.cals.cornell.edu/extension/manual.htm>

Manures for Organic Crop Production.

George Kuepper. 2003. ATTRA publication IP127.

www.attra.ncat.org/soils.html

Ohio State University's The Biology of Soil

Compaction Fact Sheet (2009).

ohioline.osu.edu/sag-fact/pdf/0010.pdf

Organic Center's Assessing Soil Quality in Organic

Agriculture (2006). [www.organic-center.org/reportfiles/](http://www.organic-center.org/reportfiles/SoilQualityReport.pdf)

[SoilQualityReport.pdf](http://www.organic-center.org/reportfiles/SoilQualityReport.pdf)

NRCS Soil Quality/Soil Health website.

www.soils.usda.gov/sqi

Soil Fertility in Organic Systems: A Guide for Gar-

deners and Small Acreage Farmers (2013). Pacific

Northwest Extension Publication 646.

<https://pubs.wsu.edu/ItemDetail.aspx?ProductID=15585&SeriesCode=&CategoryID=&Keyword=646>

Web Soil Survey.

<http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm>

Oregon Organic Fertilizer Vendors

Concentrates, Inc. Organic Agriculture Specialists

5505 S.E. International Way

Milwaukie, OR 97222

(503) 234-7501, (800) 388-4870

Fax: (503) 234-7502

www.concentratesnw.com

Marion Ag Supply

Farm Store: 1-888-814-5727

503-633-4281

<http://www.marionag.com/locations.htm>

Naomi's Organic Farm Supply

2615 SE Schiller St.

Portland, OR 97206

(503) 517-8551

www.naomisorganic.blogspot.com

Nature's Needs

9570 NW 307th Avenue

North Plains, OR 97133

(503) 647-9489

Fax: (503) 647-9485

NW Greenlands

2200 NE Orchard Avenue

McMinnville, OR 97128

(503) 434-1671

2140 Turner Road

Salem, OR 97302

(503) 585-4510

8712 Aumsville Hwy SE

Salem, OR 97317

(503) 749-3117

Stutzman Environmental Products

Canby, OR

888-877-7665

Fax: 503-266-8776

<http://www.stutzman-environmental.com>

Wilbur-Ellis

Multiple locations

<http://ag.wilburellis.com/>

Wilco

Multiple locations

<http://www.wilco.coop/>

Appendix D. Implementation Requirement Worksheet

590 Organic NMP Implementation Requirement (IR)

Natural Resources Conservation Service					Jan-13			
NUTRIENT MANAGEMENT SPECIFICATION SHEET								
Client:				Tract:		Date:		
County:				Fields:		Acres:		
Prepared by:								
DESIGN APPROVAL:								
Practice Code NO.	PRACTICE	LEAD DISCIPLINE	CONTROLLING FACTOR	UNITS	JOB CLASS			
					I	II	III	IV
590	Nutrient Management	CED-EE& BSCD-Agron	Area	Acres	160	320	640	All
This practice is defined as Job Class:								
Design Approved by: /s/					Date:			
Job Title:								

CLIENTS' ACKNOWLEDGEMENT STATEMENT:

The Client acknowledges that :

- a. They have received a copy of the specification and understand the contents and requirements.
- b.

The following information must be provided to NRCS by the client before this practice can be certified as applied :

- ☐ Nutrient management application records including soil, water plant and organic byproduct test results as specified in the plan;
- ☐ Documentation of quantities, analyses, sources, dates, and application methods of nutrients applied; documentation of weather conditions and soil moisture at the time of application, documentation of lapsed time to manure incorporation, rainfall, or irrigation.
- ☐ Periodic review of nutrient management including adjustments made; at a minimum this plan will be reviewed with each soil test cycle.

- c. It shall be the responsibility of the client to obtain all necessary permits and/or rights, and to comply with all ordinances and laws pertaining to the application of this practice.

Accepted by: /s/ _____ **Date:** _____

CERTIFICATION

I have completed a review of the information provided by the client and certify this practice has been applied.

Certification by: /s/ _____ **Date:** _____

Job Title: _____

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Organic Nutrient Management Specification

Natural Resources Conservation Service
NUTRIENT MANAGEMENT PLAN

Client: _____

Tract Number: _____

Field Number(s): _____

Select all purposes that apply

- ☐ Budget and supply adequate nutrients for plant production
- ☐ Minimize ag nonpoint source pollution of surface and groundwater resources (water quality)
- ☐ Properly utilize manure/organic materials as a plant nutrient source
- ☐ Maintain or improve soil condition
- ☐ Protect air quality by reducing nitrogen emissions (ammonia and NO_x compounds) and the formation of particulates
- ☐ Attach an aerial photo or site map showing fields where nutrient management is being implemented

NOTE: You may have criteria to meet that are NOT handled in this job sheet, please refer to the standard.

FIELD AND CROP INFORMATION

List crop rotation. Identify current crop with a check.

P Index: _____			Soil Map Unit: _____	
No Data				
Field	Current	Crop	Yield	units
	☐			
	☐			
	☐			
	☐			
	☐			
	☐			

SOIL TEST INFORMATION*

Date:			Laboratory Used:		
Depth:			☐	Certified Lab	
N (NO ₃ + NH ₄)	P**	K	Buffer pH	OM%	Other nutrients:
Use ppm for units, refer to last page of job sheet for conversions					

* For some crops (e.g., berries and tree fruit), Extension recommends using leaf analysis rather than soil tests.

** Use either Bray P1 or Olsen sodium bicarbonate tests consistently.

RECOMMENDED NUTRIENTS TO MEET YIELDS

	PAN (lbs/acre)	P ₂ O ₅ (lbs/acre)	K ₂ O (lbs/acre)	pH
Reference (See p.5):				
Notes on Adjustments:				

NITROGEN SOURCES

Credits	PAN (lbs/acre)
1. Adjustment to soil N Mineralization (See p. 7; Table 2)	
2. Nitrate from irrigation water (See p. 6; Table 12)	
3. Nitrogen from previous cover crop (See p.8-9; Tables 3 and 9)	
4. Other source(s)	
5. TOTAL N CREDITS	

NUTRIENTS TO APPLY

Nutrients to be applied to the field. Rate (lbs/acre)	PAN (lbs/acre)	P ₂ O ₅ (lbs/acre)	K ₂ O (lbs/acre)	Other (lbs/acre)
6. Manure** rate per acre (See p. 7; Table 7)				
7. Compost*** rate per acre (See p. 7; Table 8)				
8. Specialty Organic Fertilizer (See Table 4) Product: Analysis:				
9. Re-enter soil test results for P ₂ O ₅ for K ₂ O; not PAN (see Table 12 to convert from P and K)	/			
10. Total Organic Inputs and Credits (add lines 5-8 for PAN; 6-9 for others)				
11. Re-enter recommended nutrients to meet yields (See p.5)				
12. NUTRIENT STATUS (subtract line 9 from line 10)				

If the number on line 12 is **positive**, this indicates over application.
 If the number on line 12 is **negative**, this indicates under application.
 If the number is 0, then planned applications meet and do not exceed crop requirements.

On the next page, describe timing, application and include an explanation of these numbers, especially as they relate to the Phosphorus Index (see Agronomy Technical Note no. 26 and worksheets are in Section IV of the Oregon FOTG under CPS 590 Nutrient Management).

****Manure:** Manure can be applied to organically grown crops, but with pre-harvest interval (PHI) restrictions (See page 4).

*****Compost:** Only agricultural products can be certified. Thus, soil and compost are not eligible for organic certification. However, see page 4, §205.203, C.2i-iii relating to how compost can be used and produced on organic farms.

Describe Timing (when organic applications are and are not going to occur)		
Describe Application Methods (surface applied with or without incorporation, time lapse until incorporation, applied at planting with tillage, injected, and other details relevant to how the organic amendments are applied).		
Other Information/ Considerations to Nutrient Management Plan: 1) Calibration of application equipment is required. See Calibration tab for guidance on equipment calibration. Fillable calibration worksheets are available on Oregon's eFOTG, Section IV, Conservation Practices, WasteUtilization (633) Job Sheet and shall be attached to this nutrient management plan and reviewed with the producer.		
	Additional information/requirements	
	☐	Location of sensitive areas
	☐	Soil test schedule including designation of critical fields
	Nutrient Application Bullets	
	☐	* Apply nutrient materials uniformly to application area(s).
	☐	* Nutrients shall not be applied to frozen, snow-covered, or saturated soil if the potential risk for runoff exists.
	☐	*Nutrient applications associated with irrigation systems shall be applied in a manner that prevents or minimizes resource impairment.
	☐	*Calibrate application equipment to ensure recommended rates are applied. See attached information on equipment calibration.
Operation and Maintenance		
The client is responsible for safe operation and maintenance (O&M) of the practice. O&M includes: - Periodic plan review: At a minimum, plans will be reviewed and revised with each soil test cycle. - Conduct additional manure analyses when there are significant changes in animal numbers and/or feed management. - Calibrate application equipment to within __% of the recommended rate. - Document the actual rate at which nutrients were applied. - Handle all nutrient material with caution. - Wear appropriate protective clothing. - Clean up residual materials from equipment and recycle or dispose of properly. - Recordkeeping: soil/water/organic materials analyses, quantities/analyses/sources of nutrients applied, dates and methods of application, weather conditions and soil moistures at the time of application, lapsed time to incorporation/rainfall/irrigation, crops planted, planting/harvest dates, crop yields, crop residues removed, and the specifics of plan reviews.		

The Waste Utilization Worksheet below can be used to develop estimates for the lbs/acre of nutrients applied to a field in the form of "waste," an unfortunate term in this context. Proper calibration of application machinery is needed to know how much material has been applied, but the nutrient analysis of the material must also be known in order that the lbs nutrient/acre can be calculated.

633 OR-Specification

Natural Resources Conservation Service

May 2003

WASTE UTILIZATION WORKSHEET

Spreader Equipment Calibration

(Using a Full Spreader Load)

Name: _____ Date: _____

Operator: _____ Spreader ID: _____

Perform the following operations to calibrate the solids spreader equipment:						
✓ Determine the weight of the waste material loaded in the spreader by using truck scales to weigh the spreader equipment when it is empty and full.						
✓ Spread the loaded spreader on the field using consistent speed and spreader settings to cover the field uniformly. Spread in a rectangular pattern so the area calculation will be simple. Record engine rpm and gear settings used.						
✓ Measure the length and width covered by the full load and compute the application rate in tons per acre using this worksheet.						
Data and Calculations:						
Steps	ID of Calibration Test					
	A	B	C	D	E	F
1. Date of calibration test-						
2. Engine RPM during spreading -						
3. Gear selected during spreading -						
4. Weight of empty spreader (lb) =						
5. Weight of loaded spreader (lb) =						
6. Weight of Waste in spreader (lb) - line 5 – line 4 =						
7. Length of spreading area (ft) =						
8. Width of spreading area (ft) =						
9. Area spread (sq ft) - line 7 x line 8 =						
10. Waste applied (lb/sq ft) – line 6 ÷ line 9=						
11. Convert to tons per acre - Line 10 x 21.78=						
12. Average Application Rate (tons per acre) – Sum of values in cells A11 through F11 divided by the total number of calibrations completed =						
Additional Notes:						