

USER GUIDE

ORGANIC FERTILIZER CALCULATOR

A tool for comparing the cost, nutrient value, and nitrogen availability of organic materials

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Choosing an organic fertilizer can be difficult, as nutrient ratios, nitrogen availability, ease of use, and cost can vary widely among materials. This Excel-based calculator can help you save time and money and avoid excessive or deficient fertilizer applications. You can easily compare the cost, nutrient value, and nitrogen availability of organic materials and plan the most balanced and cost-effective fertilizer program for your farm. After you have determined your fertilizer requirements and collected the necessary information, it takes only a few minutes to perform calculations that, if done by hand, would be time-consuming and prone to errors. The following examples illustrate some uses for the calculator.

Example 1 You are comparing bone meal and rock phosphate as sources of phosphate (P_2O_5) for your tomatoes. The bone meal costs \$0.35/lb and has a guaranteed analysis of 3-20-0.5. The rock phosphate costs \$0.20/lb with an analysis of 0-2-0. The calculator shows that available phosphate costs \$1.75/lb from the bone meal and \$10.00/lb from the rock phosphate.

Example 2 How much of the nitrogen from alfalfa meal (2.5 percent total nitrogen from the label) and soy meal (6.5 percent nitrogen) will be available to your crops? Using a model to estimate plant-available nitrogen (PAN), the calculator predicts that 26 percent of the nitrogen in the alfalfa meal and 75 percent of the nitrogen in the soy meal will be available by the end of the season. PAN estimates for 28 days are also provided.

Example 3 You want to supply 80 lb nitrogen, 40 lb phosphate, and 40 lb potash (K_2O) to your field. Can this be supplied with manure alone (lab analysis is 3.5-2-2 on an “as-is” basis)? The calculator estimates that 2.5 tons manure per acre would supply about 80 lb available nitrogen and 100 lb each of phosphate and potash during the season. However, 1 ton manure per acre plus 500 lb feather meal or blood meal per acre would supply approximately the desired amounts of nitrogen, phosphate, and potash. Costs of different fertilizer programs are also calculated.

USING THE CALCULATOR

The calculator can be downloaded at no cost from <http://smallfarms.oregonstate.edu/organic-fertilizers-calculator>. It was developed using Microsoft Excel 2003; the file is about 360k.

There are two versions of the calculator. The *commercial calculator* uses pounds, acres, and U.S. dollars. The *small farm/garden calculator* uses square feet instead of acres in the *nutrients provided* worksheet. Any units can be used with either version without changing the formulas as long as units are kept consistent. The small farm/garden calculator includes a *conversions* worksheet that helps you convert per-acre fertilizer recommendations to square-foot quantities for smaller plots.

The calculator contains five worksheets, which can be selected using the tabs along the bottom of the screen.



Use the first three worksheets to develop a fertilizer program. The last two worksheets show the background data used to estimate the percentage of total nitrogen available to plants.

yellow cells

Enter your information in the yellow cells.

green cells

Results appear in the green cells. These cells are protected so the formulas cannot be deleted accidentally.

The figures in this user's guide show shortened versions of the three main worksheets. The calculator includes more generic fertilizers and a few brand-name fertilizers, and it has more space for adding other fertilizers. In addition to the nutrients shown in the figures below, the calculator includes magnesium (Mg), sulfur (S), boron (B), copper (Cu), iron (Fe), manganese (Mn), and zinc (Zn).

The Quick User's Guide found on the last page of this publication can walk you through the steps needed to use the calculator.

Fertilizer analysis worksheet



The *fertilizer analysis* worksheet is shown in Figure 1. Use this worksheet to enter the nutrient analysis and percent dry matter of organic fertilizers.

1	MATERIAL		FERTILIZER ANALYSIS (%) (ppm)						
2		Total % N from label ("as-is" basis) (% of product)	Total % dry matter (% of product)	PAN at 28 days (% of amendment total N, dry wt basis) from Table 1	PAN after full season (% of amendment total N, dry wt basis) from Table 1	P ₂ O ₅ (%)	K ₂ O (%)	Ca (%)	M (%)
3	UNCOMPOSTED MATERIALS								
4	Alfalfa meal (2.5-0.5-2)	2.5	92	11	26	0.5	2.0		
5	Bat guano - high N (10-3-1)	10.0	90	60	75	3.0	1.0		
6	Blood meal (12.5-1.5-0.6)	12.5	91	60	75	1.5	0.6		
7	Bone meal (3-20-0.5)	3.0	95	17	32	20.0	0.5		
8	Chicken manure - dried (3.5-2-2)	3.5	85	32	47	2.0	2.0	7.0	1.0
9	Feather meal (12-0-0)	12.0	93	60	75	0.0	0.0		
10	Fish meal (10-6-2)	10.0	92	60	75	6.0	2.0		
11	Kelp meal (1.2-0.2-2.5)	1.2	88	0	5	0.2	2.5		
12	Meat and bone meal (7-8-0)	7.0	93	60	75	8.0	0.0		
13	Sulfate of potash (0-0-50)	0.0	99	0	0	0.0	50.0		0.0
14	Sulfate of potash magnesia (0-0-22)	0.0	99	0	0	0.0	22.0		10.0
15				0	0				
16	COMPOSTED MATERIALS								
17	Composted Dairy Manure (1.5-0.5-0)	1.5	60	5	10	0.5	0.5	1.8	
18				0	0				

Figure 1. Fertilizer analysis worksheet.

Step 1. Check the nutrient analyses of the materials you plan to evaluate. Most of the values provided in the calculator are estimates from generic materials available in Oregon. Many organic materials, especially manures and compost, have highly variable nutrient contents, so we recommend using analyses for the materials you are considering. Enter your values in column B and in columns I–R.

Note that the calculator distinguishes between composted and uncomposted materials. The formulas used for estimating plant-available nitrogen (PAN) are different for raw and composted materials. We use the term *compost* to mean biologically stable material that has a low respiration rate and will not decay rapidly. Normally, such materials have stopped heating up, and they look and smell like rich soil rather than the original feedstock material. Contact your supplier if you're not sure whether a material is fully composted.

If you want to evaluate materials not listed in the calculator, enter them in the blank rows at the bottom of the appropriate section.

Fertilizer labels provide guaranteed analyses in the order nitrogen–phosphorus–potassium. The values given are for total nitrogen, phosphate (P₂O₅), and potash (K₂O). They are provided on a fresh-weight basis, so the calculator uses a *fresh weight* or “*as-is*” basis for all estimates.

Analyses for other elements are sometimes available from suppliers. Micronutrient analyses often are given in parts per million (ppm). Convert these values to a percentage before entering them in the calculator ($\text{ppm} \div 10,000 = \%$).

If using manure or compost analyses, be sure to use results on an “as-is” basis. If only dry weight results are available, multiply the percent of the nutrient on a dry-weight basis (e.g., 3 percent N) by the percent dry matter.

Step 2. Enter the percent dry matter in column C. Again, some typical values are given, but it is a good idea to check with the supplier, especially if materials may contain significant moisture.

The values for percent dry matter are needed to use the PAN (plant-available nitrogen) model. PAN estimates are provided as a percent of total nitrogen. The calculator generates PAN estimates for 28 days and a full season after application. PAN is explained in more detail in the Appendix (page 8).

Nutrients provided worksheet



The *nutrients provided* worksheet is shown in Figures 2 and 3. It calculates the amount of each nutrient provided at different application rates and compares the nutrients provided with your fertilizer recommendation.

Step 1. Enter the nutrients required this season (from your fertilizer recommendation) in the *total needed* row (row 22 in Figure 2; row 46 in the calculator).* Be sure to enter the nitrogen requirement under *estimated PAN after full season* (column F) rather than under *total N applied* (column C).

1	A	B	C	D	E	F	G	H	I	
1	MATERIAL	APP'N RATE	POUNDS OF EACH NUTRIE							
2		Rate of app'n on "as-is" basis (lbs/acre)	Total N applied (lb/acre)	Total dry matter applied (lb/acre)	Estimated PAN after 28 days (lb/acre)	Estimated PAN after full season (lb/acre)	P ₂ O ₅ (lb/acre)	K ₂ O (lb/acre)	Ca (lb/acre)	M (lb/a
12	Meat and bone meal (7-8-0)		0	0	0	0	0	0	0	
13	Sulfate of potash (0-0-50)		0	0	0	0	0	0	0	
14	Sulfate of potash magnesia (0-0-22)		0	0	0	0	0	0	0	
15			0	0	0	0	0	0	0	
16	COMPOSTED MATERIALS									
17	Composted Dairy Manure (1.5-0.5-0.5)		0	0	0	0	0	0	0	
18			0	0	0	0	0	0	0	
19										
20	Total applied		130	2165	58	78	40	40	140	2
21										
22	Total needed					80	40	40		
23										
24	Balance		130	2165	58	-2	0	0	140	2
25										

Figure 2. Nutrients provided worksheet: nutrients needed.

*Note that the row numbers in Figures 2 and 4 are different than those in the full online version of the calculator.

Step 2. Enter fertilizer application rates that you think will provide the required nutrients. The calculator will show the nutrients provided by this amount of fertilizer. For example, Rows 8 and 9 in Figure 3 show the nutrients provided by 1 ton of dried chicken manure and 500 lb of feather meal. In Figure 4, the *total applied* row (row 20 in Figure 4; row 44 in the calculator) sums the total nutrients provided, and the *balance* row (row 24 in Figure 4; row 48 in the calculator) compares the total nutrients provided with the nutrients needed.

1	MATERIAL	APP'N RATE	POUNDS OF EACH NUTRIENT								
2		Rate of app'n on "as-is" basis (lbs/acre)	Total N applied (lb/acre)	Total dry matter applied (lb/acre)	Estimated PAN after 28 days (lb/acre)	Estimated PAN after full season (lb/acre)	P ₂ O ₅ (lb/acre)	K ₂ O (lb/acre)	Ca (lb/acre)	Mg (lb/acre)	
3	UNCOMPOSTED MATERIALS										
4	Alfalfa meal (2.5-0.5-2)		0	0	0	0	0	0	0	0	
5	Bat guano - high N (10-3-1)		0	0	0	0	0	0	0	0	
6	Blood meal (12.5-1.5-0.6)		0	0	0	0	0	0	0	0	
7	Bone meal (3-20-0.5)		0	0	0	0	0	0	0	0	
8	Chicken manure - dried (3.5-2-2)	2000	70	1700	22	33	40	40	140	2	
9	Feather meal (12-0-0)	500	60	465	36	45	0	0	0	0	
10	Fish meal (10-6-2)		0	0	0	0	0	0	0	0	
11	Kelp meal (1.2-0.2-2.5)		0	0	0	0	0	0	0	0	
12	Meat and bone meal (7-8-0)		0	0	0	0	0	0	0	0	
13	Sulfate of potash (0-0-50)		0	0	0	0	0	0	0	0	
14	Sulfate of potash magne...		0	0	0	0	0	0	0	0	

Figure 3. Nutrients provided worksheet: pounds of fertilizer applied and nutrients provided.

1	MATERIAL	APP'N RATE	POUNDS OF EACH NUTRIENT								
2		Rate of app'n on "as-is" basis (lbs/acre)	Total N applied (lb/acre)	Total dry matter applied (lb/acre)	Estimated PAN after 28 days (lb/acre)	Estimated PAN after full season (lb/acre)	P ₂ O ₅ (lb/acre)	K ₂ O (lb/acre)	Ca (lb/acre)	Mg (lb/acre)	
12	Meat and bone meal (7-8-0)		0	0	0	0	0	0	0	0	
13	Sulfate of potash (0-0-50)		0	0	0	0	0	0	0	0	
14	Sulfate of potash magne...		0	0	0	0	0	0	0	0	
15			0	0	0	0	0	0	0	0	
16	COMPOSTED MATERIALS										
17	Composted Dairy Manure (1.5-0.5-0.5)		0	0	0	0	0	0	0	0	
18			0	0	0	0	0	0	0	0	
19											
20	Total applied		130	2165	58	78	40	40	140	2	
21											
22	Total needed					80	40	40			
23											
24	Balance		130	2165	58	-2	0	0	140	2	
25											

Figure 4. Nutrients provided worksheet: nutrients provided and balance after fertilizer application.

Costs worksheet



The *costs* worksheet is shown in Figure 5. Enter the price per pound of the fertilizer under *product price* (column B) to compare the cost of different fertilizers and fertilizer programs. Prices vary considerably, so be sure to obtain current local prices from your suppliers. The prices shown here are hypothetical only and are not provided with the online calculator.

The *total cost* column (column C) calculates the cost of each fertilizer at the application rates chosen in the *nutrients provided* worksheet. *Total program cost* (cell C20) shows the total cost per acre of the fertilizer program. The individual nutrient columns (beginning with column D) show the cost per pound of each nutrient. For example, total nitrogen costs \$5.00/lb in meat and bone meal at the price and nutrient analyses given.

The calculations attribute the entire cost of the fertilizer to the particular nutrient being evaluated. For example, \$1.75/lb for phosphorus in the bone meal represents the entire cost of the material; it does not take into account the fact that bone meal also supplies some nitrogen and potassium. This way of estimating costs is most useful when you're looking for the most economical material to supply one deficient nutrient, but do not use it to estimate the overall value of a fertilizer.

The calculator estimates the quantities and costs of mineral nutrients only. It does not estimate the value of the microorganisms or organic matter in some organic materials. Amounts of dry matter applied can provide a rough estimate of the relative ability of different materials to contribute to soil organic matter.

As you plan a fertilizer program, it may be helpful to switch back and forth between the *nutrients provided* worksheet and the *costs* worksheet to find balanced and cost-effective programs for your farm.

1	A	B	C	D	E	F	G	H	I
2	MATERIAL	Product price (\$/lb)	Total Cost (\$/acre)	Total N (\$/lb)	Total dry matter (\$/lb)	28 day PAN (\$/lb)	full season PAN (\$/lb)	P ₂ O ₅ (\$/lb)	K ₂ O (\$/lb)
5	Bat guano - high N (10-3-1)	\$0.65	\$0.00	6.50	0.72	10.83	8.67	21.67	65.00
6	Blood meal (12.5-1.5-0.6)	\$0.55	\$0.00	4.40	0.60	7.33	5.87	36.67	91.67
7	Bone meal (3-20-0.5)	\$0.35	\$0.00	11.67	0.37	67.17	36.04	1.75	70.00
8	Chicken manure - dried (3.5-2-2)	\$0.04	\$80.00	1.14	0.05	3.60	2.44	2.00	2.00
9	Feather meal (12-0-0)	\$0.35	\$175.00	2.92	0.38	4.86	3.89	0.00	0.00
10	Fish meal (10-6-2)	\$0.60	\$0.00	6.00	0.65	10.00	8.00	10.00	30.00
11	Kelp meal (1.2-0.2-2.5)	\$0.70	\$0.00	58.33	0.80	0.00	1,069.44	350.00	28.00
12	Meat and bone meal (7-8-0)	\$0.35	\$0.00	5.00	0.38	8.33	6.67	4.38	0.00
13	Sulfate of potash (0-0-50)	\$0.30	\$0.00	0.00	0.30	0.00	0.00	0.00	0.60
14	Sulfate of potash magnesia (0-0-22)	\$0.30	\$0.00	0.00	0.50	0.00	0.00	0.00	1.36
15			\$0.00	0.00	0.00	0.00	0.00	0.00	0.00
16	COMPOSTED MATERIALS								
17	Composted Dairy Manure (1.5-0.5-0)	\$0.02	\$0.00	1.33	0.03	26.67	13.33	4.00	4.00
18			\$0.00	0.00	0.00	0.00	0.00	0.00	0.00
19									
20	TOTAL PROGRAM COST		\$255.00						

Figure 5. Costs worksheet.

DEVELOPING A FERTILIZER PLAN

The following table lists some information you can use to develop a fertilizer plan with the Organic Fertilizer Calculator and some other helpful resources.

Information needed	Useful resources
Organic Fertilizer Calculator	http://smallfarms.oregonstate.edu/organic-fertilizer-calculator
Soil testing	<i>Soil Sampling for Home Gardens and Small Acreages</i> (EC 628) ^{1, 2} <i>Monitoring Soil Nutrients Using a Management Unit Approach</i> (PNW 570-E) ¹ <i>Laboratories Serving Oregon</i> (EM 8677) ^{1, 2}
Fertilizer recommendation	<i>Soil Test Interpretation Guide</i> (EC 1478) ^{1, 2} OSU Commercial Vegetable Production Guides : http://oregonstate.edu/dept/NWREC/ OSU Fertilizer Guides ¹ <i>Nutrient Management for Commercial Fruit and Vegetable Crops in Minnesota</i> . http://www.extension.umn.edu/distribution/cropsystems/components/5886_full.pdf
Fertilizer analyses, % dry weight, and prices	Fertilizer suppliers

¹Available at <http://extension.oregonstate.edu/catalog/>

²Available from OSU Extension and Station Communications: 800-561-6719 or 541-737-2513

FURTHER READING

- Bary, A., C. Cogger, and D.M. Sullivan. 2004. *Fertilizing With Manure*. PNW 533. Washington State University Cooperative Extension. Pullman, WA. <http://cru.cahe.wsu.edu/CEPublications/pnw0533/pnw0533.pdf>
- Cogger, C. 2000. *Soil Management for Small Farms*. EB 1895. Washington State University Cooperative Extension. Pullman, WA. <http://cru.cahe.wsu.edu/CEPublications/eb1895/eb1895.pdf>
- Gale, E.S., D.M. Sullivan, C.G. Cogger, A.I. Bary, D. Hemphill, and E.A. Myhre. 2006. Estimating plant-available nitrogen release from manures, composts, and specialty products. *Journal of Environmental Quality*, 35: 2321–2332.
- Gale, E.S., D.M. Sullivan, D. Hemphill, C.G. Cogger, A.I. Bary, and E.A. Myhre. 2005. Predicting nitrogen availability from organic amendments: Laboratory, field and computer simulation. pp. 236–243 in B. Stevens (ed.). *Western Nutrient Management Conference Proceedings* (Vol. 6). Mar 3–4, 2005. Salt Lake City, UT. Potash and Phosphate Institute, Brookings, SD. http://isnap.oregonstate.edu/WCC103/2005_Proceedings/Sullivan%20Predicting%20N.pdf.
- Gilmour, J.T. 1998. Carbon and nitrogen mineralization during co-utilization of biosolids and composts. pp. 89–112 in S. Brown, J.S. Angle, and L. Jacobs (eds.). *Beneficial Co-utilization of Agricultural, Municipal and Industrial By-products*. Kluwer Academic Publishing, Dordrecht, The Netherlands.

APPENDIX. TABLE 1 AND DATA SET WORKSHEETS

Fertilizer analysis	Nutrients provided	Costs	Table 1	Data set
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The guaranteed analyses on fertilizer labels list the amounts of phosphate (P_2O_5) and potash (K_2O) in forms that are available to plants. Nitrogen is provided as total nitrogen, some of which is not immediately available to plants. In agricultural systems, most nitrogen is believed to be absorbed by plants in the mineral forms ammonium (NH_4^+) or nitrate (NO_3^-). We refer to these forms as *plant-available nitrogen* (PAN). Nitrogen in organic fertilizers is held in organic forms as proteins and amino acids. It must be mineralized to become readily available to plants. This process generally occurs as organic materials decompose.

The carbon:nitrogen (C:N) ratio of a raw material is probably the greatest single factor determining the rate of decomposition and mineralization. Microorganisms that consume organic fertilizer have a C:N ratio that ranges from about 10:1 to 15:1. If the C:N ratio in the organic material is below about 15:1, the material provides more nitrogen (hence protein) than the microorganisms need to develop and reproduce, so they excrete mineral forms of nitrogen that are easily taken up by plants.

If the C:N ratio is higher than about 20:1, the microorganisms supplement the protein in their food source with mineral nitrogen in the soil solution. They convert ammonium and nitrate-nitrogen into an organic form (proteins and amino acids) in their bodies, thus immobilizing the nitrogen that plants otherwise would use.

The amount of carbon in organic materials generally is about 40 percent, while the amount of nitrogen varies from less than 1 percent to more than 12 percent. This variation in nitrogen content has a greater influence on the C:N ratio than does carbon content. Therefore, total nitrogen content, as shown on fertilizer labels, can be used to estimate percent PAN. For an amendment with high levels of nonorganic material (e.g., compost made with soil), C:N ratio is probably more useful than total N in estimating PAN.

Laboratory and field trials at Oregon State University and Washington State University have shown a relationship between the total percent nitrogen and the rate of nitrogen mineralization. The results of these studies are shown in the *data set* worksheet and Figure 5.

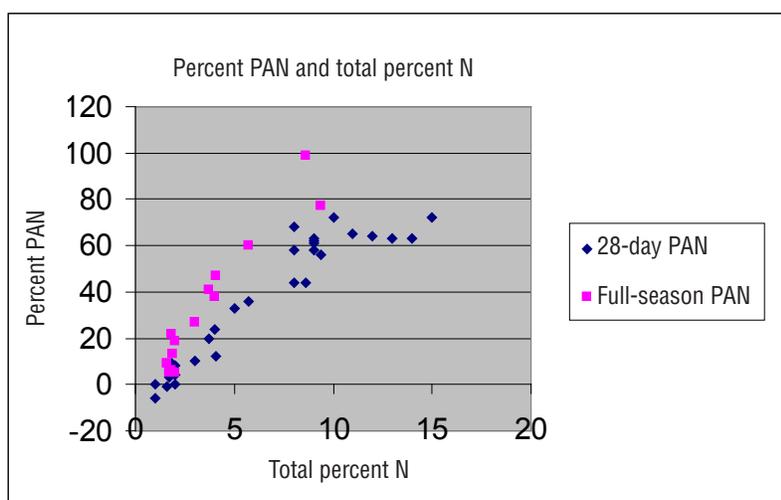


Figure 5. Relationship between the total percentage of nitrogen and the percentage of plant-available nitrogen after 28 days and after a full season. A full season is approximately 125 calendar days or 2,200 degree days ($0^{\circ}C$ base). Percent PAN is shown as a percentage of the total percent N.

These results have been converted into a table showing the relationship between the total percent nitrogen and PAN (Table 1). This table is found in the calculator's *Table 1* worksheet. The algorithm representing this relationship is incorporated into the calculator so that the 28-day and full-season PAN estimates are automatically provided in the green columns E and F in the *fertilizer analysis* and *nutrients provided* worksheets (Figures 1 and 2).

The full-season results are from field trials. The 28-day PAN results are from a combination of field trials and laboratory incubation studies. The field studies were done in Corvallis, Oregon. The laboratory incubation studies were done at 70°F. Field conditions such as soil moisture and temperature, agronomic practices such as the timeliness of fertilizer incorporation, and climatic conditions such as rainfall, air temperature, and wind can affect the rate of mineralization and nutrient loss to the environment.

Data for this PAN model were from solid organic fertilizers applied to soil. These PAN estimates are not designed for use with liquid fertilizers, but calculations for other nutrients based on guaranteed label analyses are valid.

Table 1. Relationship between the total percentage of nitrogen, C:N ratio, and PAN that is used in the calculator. Shown here as a percentage of dry weight.

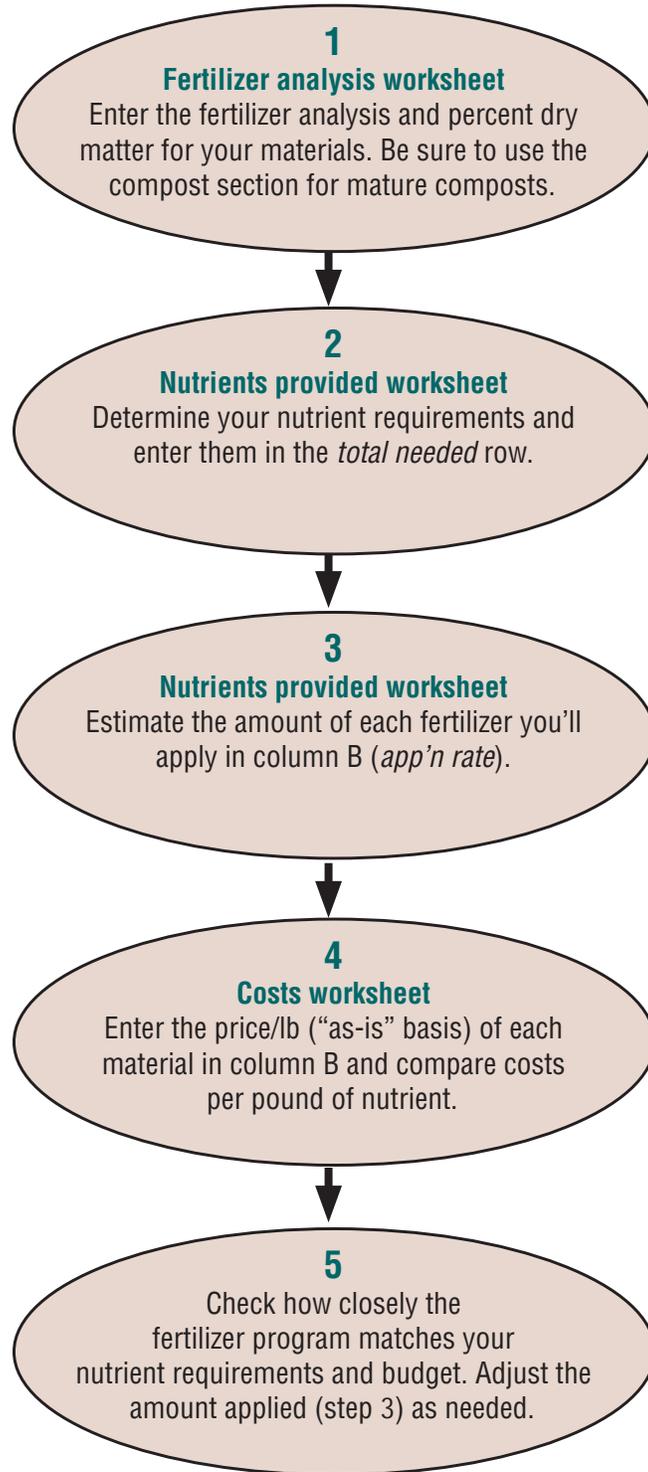
Amendment total N % dry weight	Amendment C:N	Plant-available N estimate	
		28 days % of total N	Full-season % of total N
Uncomposted materials			
1	35:1	<0	0
2	18:1	0	15
3	12:1	15	30
4	9:1	30	45
5	7:1	45	60
6	<6:1	60	75
7	<6:1	60	75
8+	<6:1	60	75
Composts			
1	30:1	0	5
2-3	10:1 to 15:1	5	10

ADDITIONAL INFORMATION

We invite you to use the fertilizer calculator and let us know how it works for you. We will continue to update the calculator based on your input and new research, so be sure to use the most recent version by registering to receive updates or regularly checking the OSU Small Farms website. *We encourage you to register using the online form so that you can receive information about updates.* It is also helpful for us to know who is using the calculator so that we can make improvements that meet your needs. If you would like help using the calculator, please contact Nick Andrews at OSU Extension. Phone: 503-678-1264, ext. 149. E-mail: nick.andrews@oregonstate.edu

ORGANIC FERTILIZER CALCULATOR QUICK USER'S GUIDE

<http://smallfarms.oregonstate.edu/organic-fertilizer-calculator>



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