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Determining Fertilizer Needs for Small-Scale Crop Production

This fact sheet is designed to help you calculate how much fertilizer you will need to grow your selected crops. This will first help you determine the nutrient recommendations for your crops adjusted to the scale you will be planting. Then you will calculate how much fertilizer of you choosing you will need to apply to meet that recommendation. Finally you will determine how much total fertilizer you will need to purchase for the growing season.

Using appropriate crop nutrient recommendations and planning your fertilizer applications to match those recommendations for two reasons. First, when you overapply nutrients to your farm or garden, you are paying for nutrients that do not influence your final yield, which affects your overall farm or garden budget. Second, nutrients not used by the crops are often leached out of the field and often end up in ground or surface waters and affect their quality. Nitrogen and phosphorus in particular contribute to a process called eutrophication. Excess nitrogen and phosphorus contribute to algae growth in surface waters, which is unsightly and can affect recreation directly, especially if the algae blooms include toxic species. Worse, when the algae dies, the bacteria that break it down use up the oxygen in the water. When oxygen levels get too low, or hypoxic, it can cause fish and invertebrates to die giving those areas the name “dead zones”. These areas of low or not oxygen are sometimes called dead zones. Agriculture is one of the largest contributors of nutrients that lead to eutrophication and hypoxia. The Gulf of Mexico dead zone is one of the world’s largest dead zones and reached a record size of 8,776 square miles in 2017. While the size of the dead zone fluctuates from year to year, it averages 5,364 square miles, which is the size of the State of Connecticut.

The following instructions will help you gather the information you need to calculate your fertilizer needs. Before getting started, it may be helpful to have a planting calendar and planting plan, these will include what crops and how much of each crop you plant to grow. It is also a good idea to have tested your soil for nutrient content and have the test results on hand. If you have not tested your soil yet this year, or have not gotten the results back, access to a soil test that was submitted in the last three years would also be helpful. Most nutrient recommendations are based on crop family and soil nutrient content, so this information will help you tailor your nutrient applications to your farm. Soil tests are available for free to Connecticut residents here at the Agricultural Experiment Station: https://portal.ct.gov/caes/soil-office/soil-office/soil-testing-offices-instructions.

Instructions for Table 1: Converting Growing Area into Square Feet for Each Crop

A. If you are planning a small mixed vegetable garden and plan to follow fertilizer recommendations for a mixed vegetable garden, you will just need the total area of your garden. See step B for recommendations on how to calculate this area.

B. If your farm or garden uses intensive growing practices and not row agriculture, you can measure the size of the beds or planned growing area for each crop and calculate the area with the following equation:

Width of bed x length of bed = growing area

If your beds are not evenly rectangular, you may want to take several length and width measurements and take an average. If you bed is another shape, do the same but use the area equation for that shape. Be sure to keep track of your units. If you have multiple beds in the same crop add the growing areas together. You can use the first and last columns of Table 1 to keep track of the growing areas for each of your crops. This information will be needed in Table 4.

C. If your farm or garden uses row agriculture, you can calculate area one of two ways. If you already have the space planned out that you will plant in a given crop, you can measure the length and width of that area. This may be easier if you plan to plant multiple rows of a crop or a whole field of that crop. If you plan to plant smaller areas, single rows or partial rows of a crop, you can use Table 1 to convert feet of row into square feet using the following instructions:

1. Enter all of the crops you will be growing in the first column.
2. Enter the total number of row feet that will be planted for each crop in column 2. Consult your planting plan or map to get the number of row feet that will be planted for each crop. If you have multiple plantings of a crop through the growing season, add up all of the row feet for each planting.
3. Enter the recommended distance between rows for each crop in column 3. This information can be found under the "Panting" header for each crop type in the New England Vegtetable Management Guide (Available at https://nevegetable.org) or another source. This distance may be given in inches, for our calculation convert it into feet by dividing by 12 before entering it into the table.
4. Multiply columns 2 and 3 and enter the growing area in square feet in column 4. This information will be needed in Table 4.

Instructions for Table 2: Fertilizer Application Rate Recommendations

If you are planning on fertilzier for specific crops, either in larger or small areas, follow these instructions for each crop:

1. Enter the name of the crop you plan to grow into the first column of Table 2. Note that some crops may require additional applications of fertilizers throughout the growing season. These additional applications, or side dressings should receive a separate line in the table.
2. Enter the nutrient recommendations in lb/acre into columns 2-4 in Table 2. These can be found in a table titled "Plant Nutrient Recommendation According to Soil Test Results" in the section for that crop in the New England Vegteable Management Guide. (Available at https://nevegetable.org), where each crop is listed separately. For some crops, multiple applications of nutrients may be recommended. For applications taking place before or at planting, add the recommendations numbers together and enter them on one line. For all subsequent applications, such as side dressings, enter these on separate lines. For P and K, use the rate for the appropriate soil test value. If you have done a soil test and are still waiting on the results, use a low soil test rate as a conservative estimate for budgeting and planning purposes.
3. If you are growing crops in smaller areas, convert the nutrient recommendations to ounces per square feet by multiplying by 16 (oz/lb) and dividing by 43,560 (square feet per acre), or multiplying by 0.0003673. You can enter this number in the "Unit conversion rate" column of Table 2. Enter the resulting recommendations for each nutrient in ouces per square foot in columns 6-8 of Table 2. If your operation is large enough that your growing areas is in acres, you can skip this step and continue with the lb/acre units.

If you are planting a small mixed vegetable garden and plan to follow those fertilizer recommendations follow these instructions:

1. Enter mixed vegetable garden under crops in the first column of Tables 2 and 3.
2. Enter the nutrient recommendations in lbs/1,000 sq ft.
   a) If you have done a soil test and are still waiting on the results, use a low soil test rate for nitrogen as a conservative estimate for budgeting and planning purposes. You will need to recalculate your applications once the soil test results come in.
   b) If your soil test for phosphorus and potassium are below optimum use the following recomemendations from CAES Circular 150 "The Home Vegetable Garden" in the table in lbs/1,000 square feet:

Garden Condition	Nitrogen	P_2O_5	K_2O
Unmanured soils	1.4-2.5	3.5-6	0.14-5
If manure is applied	0.7-1.25	1.75-3	0.07-2.1
Rich "old garden" soils	1.75-2.1	1.75-2.1	1.75-2.1

   c) If your soil test for phosphorus and potasium are above optimum the recomendatoin is 1 lb of nitrogen per 1,000 squre feet.

3. Convert the nutrient recommendations to oz per square feet by multiplying by 16 (oz/lb) and dividing by 1,000.

Instructions for Table 3: Fertilizer Application Rates

Follow these instructions for each line of Table 2:

1. Enter the crop from Table 2 in the first column in Table 3.
2. Choose the fertilizer that you want to use. If you do not have to add any P or K, or very little P or K, consider using a single nutrient fertilizer to provide the N. Additional single nutrient fertilizers can be used to add small amounts of P or K if they are needed. You can also select fertilizer with more than one nutrient in it, then apply it for the smaller amount of P or K that you need and add additional N from a single nutrient fertilizer. You can also look for a fertilizer that has a higher N content than P and K content. If you wish to determine which combination of fertilizers will be most cost effective, or compare fertilizers to be sure that you are supply enough one nutrient without supplying too much of the others, you can complete Tables 3, 4, and 5 for each fertilizer choice and compare them.
3. Enter the name and nutrient analysis of your fertilzier into columns 2 and 3 of Table 3. Commercial fertilizers, both conventional and organic, will have the nutrient analysis on the packaging. This should appear as three numbers representing the percent by weight of Nitrogen-Phosphorus-Potassium (N-P-K).
4. Calculate the amount of fertilizer needed for your first nutrient. Making the calculation for the nutrient that will be supplied in the highest quantity by the fertilizer will prevent over application of the other nutrients in the fertilizer. You will need to start with the application recommendation (lb/acre) or nutrient requirement (oz/sq ft) from Table 2. Multiply this by 100 and divide by the amount of that nutrient in your fertilizer. In the equation A below, y will come from the nutrient analysis of the fertilizer. Enter the nutrient name and the amount of fertilizer required into column 4 of Table 3.

Equation A:

$$\text{Application recommendation for nutrient y} \times \frac{100}{\text{Amount of nutrient y in fertilzier}} = \text{amount of fertilzier required}$$

5. Calculate the amount of the other nutrients supplied by that fertilizer using the following equation for both of the remaining nutrients:

$$\text{Amount of fertilizer applied} \times \frac{\text{content of nutrient y}}{100} = \text{amount nutrient supplied}$$

   Enter the nutrient name and amount supplied into column 5 and 6 of Table 3.
6. Determine if your fertilizer supplies all of the needed nutrients for your crops. Subtract the amount of each nutrient supplied (calculated in the precious step and entered in columns 5 and 6) from their recommended application rate (lbs/acre) or nutrient requirement (oz/sq ft) from Table 2. If additional nutrients are needed, choose a second fertilizer and enter its name and analysis into column 7 of Table 3.

7. Repeat steps 5-7 for the second fertilizer and enter the information into columns 8 and 9 of Table 3.
8. If needed, repeat steps 5 and 6 for a third fertilizer.

You now know how much fertilizer to put down in your garden for each of your crops. To determine how much fertilizer you need to purchase for a growing season continue with Tables 4 and 5.

Instructions for Table 4: Amount of Fertilizers Needed for Each Crop

1. Transfer the fertilizer name and fertilizer application rates calculated in Table 3 to columns 3 and 4 in Table 4 for each crop you are going to grow. Keep in mind that you may have more than one fertilizer for each crop and growing area. Each fertilizer used for each crop should have its own row.
2. As you do this, enter the crop names in column 1.
3. Add the growing areas for each crop from column 4 of Table 1 into column 2 of Table 4. Remember that each crop may appear more than once in the table.
4. Multiply the growing area by the fertilizer application rates to determine the total amounts of fertilizer needed for each crop. Enter this in column 5.

Instructions for Table 5: Total Amount of the Fertilizers Needed

1. Write each fertilizer that you need to purchase (from Table 4) into column 1 of Table 5. In this table, each fertilizer should only appear once.
2. Add up the total quantity of fertilizer needed (column 5 of Table 4) to get a total amount of fertilizer needed for each fertilizer you plan to use. If your operation is large enough that your growing areas are in acres and you completed tables 3 and 4 in lbs/acres instead of oz/square feet, write the total in column 3. If you are working in ounces, write the total in column 2.
3. If you were working in pounds, you are finished and have the amount of fertilizer you need to purchase. If you are working in ounces, you still need to convert this quantity into pounds. Divide the values in column 2 by 16 to get the total pounds of fertilizer needed and write this value in column 3. This is the amount of each fertilizer you will need to purchase for the growing season.

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Table 1: Converting Growing Area into Square Feet for Each Crop

Crop	Growing Area (feet of row)	Distance between rows (feet)	Growing area

Table 2: Fertilizer Application Rate Recommendations

Crop	N application rate (lbs/acre)	P_2O_4 application rate (lbs/acre)	K_2O application rate (lbs/acre)	Unit conversion	N requirement (oz/square feet)	P_2O_4 requirement (oz/square feet)	K_2O requirement (oz/square feet)

Table 3. Fertilizer Application Rates

Crop	Fertilizer choice	Fertilizer analysis	Amount required/ for which nutrient (nutrient A)	Amount of nutrient B supplied	Amount of nutrient C supplied	Fertilizer B choice and analysis	Amount required	Amount of other nutrient(s) supplied

Table 4: Amount of Fertilizers Needed

Crop	Growing area (sq ft)	Fertilizer	Quantity to apply (oz/sq ft)	Total Quantity need (oz)

Table 5: Total Amount of the Fertilizers Needed

Fertilizers to be used	Total amount needed (oz)	Total amount needed (lb)