Fertilizer & Lime Application Rate Calculations

Hands-On Learning Day Worksheet

Cornell Cooperative Extension Master Gardener Volunteer Program

Name:	Date:

As Master Gardener Volunteers, you will frequently help community members interpret soil test results and calculate how much fertilizer or lime to apply. Cornell soil test recommendations are reported in lbs per 100 sq ft. This worksheet will build your confidence with these essential calculations.

```
KEY CONCEPTS TO REMEMBER

Fertilizer Analysis (N-P₂O₅-K₂O):
  The three numbers on a fertilizer bag represent the percentage by weight
  of nitrogen (N), phosphate (P₂O₅), and potash (K₂O).

  Example: A 50-lb bag of 10-10-10 contains:
    10% N    = 5.0 lbs nitrogen
    10% P₂O₅ = 5.0 lbs phosphate
    10% K₂O  = 5.0 lbs potash

Cornell Soil Test Reports:
  Recommendations are given in lbs per 100 sq ft.
  You must scale up or down based on your actual garden size.

Calcium Carbonate Equivalent (CCE):
  CCE measures a liming material's neutralizing power compared to
  pure calcium carbonate (CaCO₃), which has a CCE of 100%.
  Materials with CCE > 100% are more effective pound-for-pound.
  Materials with CCE < 100% require more product to achieve the same
effect.
```

Part 1: Simple Fertilizer Application Rate Calculations

In these problems, you are given a nutrient recommendation (in lbs per 100 sq ft) and a single fertilizer. Calculate how many pounds of that fertilizer to apply per 100 sq ft to meet the recommended rate for the specified nutrient.

```
THE FORMULA
```

> Lbs of fertilizer = Lbs of nutrient needed per 100 sq ft
> per 100 sq ft   —————————————————————————————————————
>   Nutrient % in fertilizer ÷ 100

Worked Example

A soil test recommends applying 0.1 lb of nitrogen (N) per 100 sq ft to your lawn. You have a bag of 20-5-10 fertilizer. How much fertilizer do you need to apply per 100 sq ft?

Step 1: Identify the nutrient percentage. The first number in the analysis is N = 20%.

Step 2: Convert percentage to decimal: 20% ÷ 100 = 0.20

Step 3: Divide: 0.1 lb N ÷ 0.20 = 0.5 lb of fertilizer per 100 sq ft

***Check your work:** 0.5 lb fertilizer × 0.20 = 0.1 lb N ✓*

Problem 1

Your soil test recommends applying 0.1 lb of nitrogen (N) per 100 sq ft to a vegetable garden. You purchase a bag of 10-10-10 fertilizer.

a) How many pounds of 10-10-10 should you apply per 100 sq ft?

b) How many pounds of P_2O_5 and K_2O will also be delivered at this rate?

Problem 2

A lawn care recommendation calls for 0.1 lb of nitrogen (N) per 100 sq ft for a fall feeding. You have ammonium sulfate (21-0-0) on hand.

a) How many pounds of ammonium sulfate per 100 sq ft?

b) Ammonium sulfate also contains 24% sulfur (S). How many pounds of sulfur will be applied at this rate?

Problem 3

Your soil test recommends 0.15 lb of K_2O per 100 sq ft for your perennial flower bed. The bed measures 10 ft × 2 ft (20 sq ft). You purchase muriate of potash (0-0-60).

a) How many pounds of muriate of potash should you apply per 100 sq ft?

b) How many pounds do you actually need for your 20 sq ft bed?

_____

_____

_____

_____

Problem 4

You are establishing a new 2,500 sq ft lawn area and need to apply 0.1 lb of P_2O_5 per 100 sq ft at seeding based on your soil test. You have triple superphosphate (0-46-0).

a) How many pounds of triple superphosphate per 100 sq ft?

b) How many total pounds do you need for the entire 2,500 sq ft lawn area?

c) Why is it important to base phosphorus applications on a soil test rather than applying it routinely?

_____

_____

_____

_____

Part 2: Choosing the Right Fertilizer — Avoiding Overapplication

In these problems, your soil test recommends specific amounts of N, P_2O_5, and K_2O (in lbs per 100 sq ft). You have several fertilizer options. Your job is to determine which fertilizer best meets ALL the recommended nutrient needs without significantly overapplying any single nutrient. Calculate the application rate based on the nitrogen (N) need, then check whether P_2O_5 and K_2O delivered at that rate match the recommendations.

Remember: Overapplying nutrients wastes money, can harm plants, and can pollute waterways. Excess phosphorus is a particular concern for water quality in the Finger Lakes and other New York waterbodies.

```
THE METHOD

  1. Calculate the application rate based on N:
     Lbs fertilizer per 100 sq ft = Lbs N needed ÷ (N% ÷ 100)

  2. Check P₂O₅ delivered at that rate:
     P₂O₅ delivered = Lbs fertilizer × (P₂O₅% ÷ 100)

  3. Check K₂O delivered at that rate:
     K₂O delivered = Lbs fertilizer × (K₂O% ÷ 100)

  4. Compare delivered amounts to recommendations.
     Choose the fertilizer that meets or closely matches all three needs.
```

Worked Example

Soil test recommends: 0.1 lb N, 0.05 lb P_2O_5, 0.1 lb K_2O per 100 sq ft

Option	Fertilizer	Analysis (N-P_2O_5-K_2O)
A	General purpose	10-10-10
B	Garden blend	10-5-10
C	High-P blend	10-20-10

Evaluate Option A (10-10-10): Apply 0.1 ÷ 0.10 = 1.0 lb for 0.1 lb N.
   P_2O_5 delivered: 1.0 × 0.10 = 0.10 lb (need 0.05 — **OVERAPPLIES P by 0.05 lb**)
   K_2O delivered: 1.0 × 0.10 = 0.10 lb (need 0.10 — matches!)

Evaluate Option B (10-5-10): Apply 0.1 ÷ 0.10 = 1.0 lb for 0.1 lb N.
   P_2O_5 delivered: 1.0 × 0.05 = 0.05 lb (need 0.05 — **matches!**)
   K_2O delivered: 1.0 × 0.10 = 0.10 lb (need 0.10 — **matches!**)

Evaluate Option C (10-20-10): Apply $0.1 \div 0.10 = 1.0$ lb for 0.1 lb N.

P_2O_5 delivered: $1.0 \times 0.20 = 0.20$ lb (need 0.05 — **OVERAPPLIES P by 0.15 lb!**)

K_2O delivered: $1.0 \times 0.10 = 0.10$ lb (matches)

Best choice: Option B (10-5-10) — It meets all three nutrient needs without overapplying any nutrient.

Problem 5

Soil test recommends: 0.1 lb N, 0.1 lb P_2O_5, 0.2 lb K_2O per 100 sq ft

Option	Fertilizer	Analysis (N-P_2O_5-K_2O)
A	All-purpose	10-10-10
B	Garden special	10-10-20
C	High-N lawn	30-10-20

Show your calculations for each fertilizer option. Which fertilizer is the best choice and why?

_____
_____
_____
_____
_____
_____

Problem 6

Soil test recommends: 0.2 lb N, 0.1 lb P_2O_5, 0.15 lb K_2O per 100 sq ft

The vegetable garden measures 20 ft × 20 ft (400 sq ft).

Option	Fertilizer	Analysis (N-P_2O_5-K_2O)
A	Balanced all-purpose	10-10-10
B	Vegetable garden blend	20-15-15
C	Lawn & garden	20-10-20

Show your calculations for each fertilizer option. For each, calculate the application rate based on the N recommendation, then determine how much P_2O_5 and K_2O will be delivered at that rate. Compare to the soil test recommendations.

Which fertilizer is the best choice and why? Consider both the total amount of overapplication and which specific nutrient is being overapplied. Then calculate the total pounds of your chosen fertilizer needed for the 400 sq ft garden.

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

Problem 7

Soil test recommends: 0.1 lb N, 0 lbs P_2O_5, 0.05 lb K_2O per 100 sq ft

The lawn is approximately 5,000 sq ft.

Note: The soil test shows phosphorus is already at optimum levels. No additional P_2O_5 is recommended.

Option	Fertilizer	Analysis (N-P_2O_5-K_2O)
A	Starter blend	20-5-10
B	Fall lawn food	10-0-15
C	No-phosphorus turf food	10-0-10

Show your calculations for each fertilizer option. For each, calculate the application rate based on the N recommendation, then determine how much P_2O_5 and K_2O will be delivered.

Which fertilizer is the best choice and why? Hint: The answer is not simply the one with the lowest total overapplication — think about which nutrient is being overapplied and what the soil test is telling you. Then calculate the total pounds of your chosen fertilizer needed for the entire 5,000 sq ft lawn.

_____
_____
_____
_____
_____
_____
_____
_____
_____

Part 3: Liming Application Rates — Adjusting for CCE

Soil test lime recommendations are typically based on pure calcium carbonate ($CaCO_3$), which has a Calcium Carbonate Equivalent (CCE) of 100%. However, the actual liming materials you purchase may have a higher or lower CCE. You must adjust the application rate so you apply the correct amount of neutralizing power. Cornell soil test lime recommendations are reported in lbs per 100 sq ft.

```
THE FORMULA


  Adjusted lime rate    =    Recommended rate (lbs/100 sq ft)
  (lbs/100 sq ft)            —————————————————————————————————
                             CCE ÷ 100


  If CCE < 100%: You need MORE material than the recommended rate.
  If CCE > 100%: You need LESS material than the recommended rate.
  If CCE = 100%: Apply exactly the recommended rate.
```

Common Liming Materials and Typical CCE Ranges:

Liming Material	Typical CCE (%)	Notes
Calcitic limestone	85–100	*Most common*
Dolomitic limestone	95–108	*Also supplies Mg*
Hydrated lime ($Ca(OH)_2$)	120–135	*Fast-acting, caustic*
Wood ash	25–50	*Variable; also supplies K*
Pelletized lime	85–100	*Easy to spread*
Marl	50–90	*Naturally deposited*

Worked Example

Your soil test recommends 5 lbs of lime per 100 sq ft. You purchase pelletized calcitic limestone with a CCE of 90%. How much should you actually apply?

Step 1: Identify the recommended rate: 5 lbs/100 sq ft

Step 2: Convert CCE to decimal: 90% ÷ 100 = 0.90

Step 3: Divide: 5 ÷ 0.90 = 5.56 lbs per 100 sq ft

Interpretation: Because this limestone is slightly less effective than pure $CaCO_3$, you need to apply about 11% more material to achieve the recommended pH adjustment.

Problem 8

Your soil test recommends 7.5 lbs of lime per 100 sq ft to raise pH from 5.5 to 6.5 in your silt loam garden soil. You purchase agricultural calcitic limestone with a CCE of 95%.

How many pounds of this limestone should you apply per 100 sq ft?

_____

_____

_____

_____

Problem 9

Your soil test recommends 6 lbs of lime per 100 sq ft. A community gardener asks you about two liming materials they found at the garden center:

Option	Liming Material	CCE (%)
A	Dolomitic limestone	105%
B	Wood ash	40%

a) Calculate the application rate for each material.

b) Which material requires less product? What is an advantage of the other option?

_____

_____

_____

_____

_____

Problem 10

A homeowner has a 3,000 sq ft lawn. Their soil test recommends 8 lbs of lime per 100 sq ft. They purchase bags of pelletized dolomitic lime labeled with a CCE of 108%.

a) How many pounds of this lime are needed per 100 sq ft?

b) How many total pounds are needed for the entire 3,000 sq ft lawn?

c) If the pelletized lime comes in 40-lb bags, how many bags should they buy?

_____

_____

_____

_____

_____

Challenge Problem 11

A community gardener wants to use wood ash from their fireplace instead of purchasing lime. Their soil test recommends 5 lbs of lime per 100 sq ft for a 500 sq ft raised bed area. The wood ash has an estimated CCE of 35%.

a) How many pounds of wood ash per 100 sq ft would be needed?

b) How many total pounds for the 500 sq ft bed?

c) Wood ash also contains approximately 5–7% K_2O. If you assume 6% K_2O content, how many lbs of K_2O would be delivered to the 500 sq ft bed? Is this a concern? Why or why not?

Reflection

Take a few minutes to discuss the following with a partner or your small group:

1. A homeowner shows you a bag of 10-10-10 and says they apply it to everything in their yard every spring. Based on what you learned today, what questions would you ask them? What advice would you give?

_____
_____
_____
_____

2. Why is it important to always start with a soil test before recommending fertilizer or lime applications?

_____
_____
_____
_____

3. A gardener tells you they heard wood ash is a "free" substitute for lime. What would you explain to them about using wood ash, including both benefits and potential concerns?

_____
_____
_____
_____

Answer Key

Fertilizer & Lime Application Rate Calculations

Part 1: Simple Fertilizer Application Rate Calculations

Problem 1 — 10-10-10 for vegetable garden

    a) Lbs of fertilizer = 0.1 lb N ÷ 0.10 = 1.0 lb of 10-10-10 per 100 sq ft

    b) P_2O_5 delivered: 1.0 lb × 0.10 = 0.1 lb P_2O_5

      K_2O delivered: 1.0 lb × 0.10 = 0.1 lb K_2O

Problem 2 — Ammonium sulfate (21-0-0) for lawn

    a) Lbs of fertilizer = 0.1 lb N ÷ 0.21 = 0.476 lb (round to 0.48 lb) per 100 sq ft

    b) Sulfur delivered: 0.476 lb × 0.24 = 0.114 lb S per 100 sq ft

Problem 3 — Muriate of potash (0-0-60) for 20 sq ft perennial bed

    a) Lbs of fertilizer = 0.15 lb K_2O ÷ 0.60 = 0.25 lb per 100 sq ft

    b) For 200 sq ft: 0.25 × (20 ÷ 100) = 0.25 × 2 = 0.05 lb muriate of potash

Problem 4 — Triple superphosphate (0-46-0) for 2,500 sq ft lawn

    a) Lbs of fertilizer = 0.1 lb P_2O_5 ÷ 0.46 = 0.217 lb (round to 0.22 lb) per 100 sq ft

    b) For 2,500 sq ft: 0.217 × (2,500 ÷ 100) = 0.217 × 25 = 5.4 lbs triple superphosphate

    c) Phosphorus can contribute to eutrophication of waterbodies when applied in excess.
      Soil tests may show P is already adequate, making additional P unnecessary and
      potentially harmful to water quality. Always base P applications on a current soil test.

Part 2: Choosing the Right Fertilizer

Problem 5 — Need: 0.1 lb N, 0.1 lb P_2O_5, 0.2 lb K_2O per 100 sq ft

Option A (10-10-10): 0.1 ÷ 0.10 = 1.0 lb → P_2O_5 = 0.10 ✓, K_2O = 0.10 (need 0.20 — NOT ENOUGH K)

Option B (10-10-20): 0.1 ÷ 0.10 = 1.0 lb → P_2O_5 = 0.10 ✓, K_2O = 0.20 ✓ ← BEST CHOICE

Option C (30-10-20): 0.1 ÷ 0.30 = 0.33 lb → P_2O_5 = 0.033 (not enough), K_2O = 0.067 (not enough)

Problem 6 — Need: 0.2 lb N, 0.1 lb P_2O_5, 0.15 lb K_2O per 100 sq ft (400 sq ft garden)

Option A (10-10-10): 0.2 ÷ 0.10 = 2.0 lbs/100 sq ft

  P_2O_5 = 2.0 × 0.10 = 0.20 (OVER by 0.10), K_2O = 2.0 × 0.10 = 0.20 (OVER by 0.05)

** Total overapplication: 0.15 lbs — overapplies BOTH P and K**

Option B (20-15-15): 0.2 ÷ 0.20 = 1.0 lb/100 sq ft

  P_2O_5 = 1.0 × 0.15 = 0.15 (OVER by 0.05), K_2O = 1.0 × 0.15 = 0.15 (matches ✓)

Total overapplication: 0.05 lbs — overapplies P only

Option C (20-10-20): 0.2 ÷ 0.20 = 1.0 lb/100 sq ft
P_2O_5 = 1.0 × 0.10 = 0.10 (matches ✓), K_2O = 1.0 × 0.20 = 0.20 (OVER by 0.05)
Total overapplication: 0.05 lbs — overapplies K only

Best choice: Option C (20-10-20)
B and C both overapply by the same total amount (0.05 lbs). However, B overapplies
phosphorus while C overapplies potassium. Excess phosphorus is a greater environmental
concern because it contributes to eutrophication of lakes and waterways (particularly
relevant in the Finger Lakes region). Potassium overapplication at this modest level is
less environmentally harmful. Therefore, C is the better choice.
Total for 400 sq ft: 1.0 lb × (400 ÷ 100) = 1.0 × 4 = 4.0 lbs of 20-10-20

Problem 7 — Need: 0.1 lb N, 0 lbs P_2O_5, 0.05 lb K_2O per 100 sq ft (5,000 sq ft lawn)

Option A (20-5-10): 0.1 ÷ 0.20 = 0.5 lb/100 sq ft
P_2O_5 = 0.5 × 0.05 = 0.025 (OVER — adds P when none is recommended!)
K_2O = 0.5 × 0.10 = 0.05 (matches ✓)
Total overapplication: 0.025 lbs — lowest total, but adds unnecessary phosphorus

Option B (10-0-15): 0.1 ÷ 0.10 = 1.0 lb/100 sq ft
P_2O_5 = 0 (matches ✓), K_2O = 1.0 × 0.15 = 0.15 (OVER by 0.10)
Total overapplication: 0.10 lbs — no P added, but significant K overapplication

Option C (10-0-10): 0.1 ÷ 0.10 = 1.0 lb/100 sq ft
P_2O_5 = 0 (matches ✓), K_2O = 1.0 × 0.10 = 0.10 (OVER by 0.05)
Total overapplication: 0.05 lbs — no P added, moderate K overapplication

Best choice: Option C (10-0-10)
This problem is tricky! Option A has the lowest total overapplication (0.025 lbs), but
it adds phosphorus to soil where P is already at optimum. When a soil test recommends
zero P_2O_5, adding ANY phosphorus is poor practice. Excess P accumulates in soil and
contributes to water quality degradation through runoff.

Option C avoids P entirely and overapplies K by only 0.05 lb/100 sq ft — a modest
amount that is far less environmentally concerning than adding unnecessary phosphorus.
Option B also avoids P but overapplies K twice as much as C.

*Key takeaway: The "best" fertilizer is not always the one with the lowest total
overapplication. WHICH nutrient is overapplied matters as much as HOW MUCH.*
Total for 5,000 sq ft: 1.0 lb × (5,000 ÷ 100) = 1.0 × 50 = 50 lbs of 10-0-10

Part 3: Liming Application Rates

Problem 8 — 7.5 lbs lime per 100 sq ft, CCE = 95%

Adjusted rate = 7.5 ÷ 0.95 = 7.89 lbs per 100 sq ft (round to 7.9 lbs)

Problem 9 — 6 lbs lime per 100 sq ft, two material options

a) Option A (Dolomitic limestone, CCE 105%): 6 ÷ 1.05 = 5.71 lbs per 100 sq ft
   Option B (Wood ash, CCE 40%): 6 ÷ 0.40 = 15.0 lbs per 100 sq ft
b) Dolomitic limestone requires far less material (5.7 vs. 15 lbs per 100 sq ft).
   Advantage of dolomitic limestone: also supplies magnesium (Mg), which may be
   beneficial if soil Mg is low. Wood ash has the advantage of also supplying K and
   is a way to recycle a waste product, but the large quantity needed and variable
   composition make it less practical as a primary liming material.

Problem 10 — 8 lbs lime per 100 sq ft, 3,000 sq ft lawn, CCE = 108%

a) Adjusted rate = 8 ÷ 1.08 = 7.41 lbs per 100 sq ft
b) Total for 3,000 sq ft = 7.41 × (3,000 ÷ 100) = 7.41 × 30 = 222.2 lbs
c) Number of 40-lb bags = 222.2 ÷ 40 = 5.56 → Round up to 6 bags

Challenge Problem 11 — Wood ash (CCE 35%), 500 sq ft raised bed

a) Adjusted rate = 5 ÷ 0.35 = 14.29 lbs wood ash per 100 sq ft
b) For 500 sq ft: 14.29 × (500 ÷ 100) = 14.29 × 5 = 71.4 lbs wood ash
c) K_2O delivered to 500 sq ft bed: 71.4 lbs × 0.06 = 4.3 lbs K_2O
   Per 100 sq ft equivalent: 4.3 ÷ 5 = 0.86 lb K_2O per 100 sq ft
   This IS a concern. Typical K_2O recommendations rarely exceed 0.2–0.3 lb/100 sq ft.
   Applying 0.86 lb K_2O/100 sq ft is a significant overapplication of potassium,
   which could cause nutrient imbalances (e.g., interfering with Mg and Ca uptake).
   This illustrates why wood ash should be used cautiously as a lime substitute and
   why a soil test is essential before applying it.

Reflection — Discussion Points

Question 1 — The "10-10-10 on everything" homeowner

Key questions to ask: Have you had a soil test done? What are you growing in each area?
Key advice: Without a soil test, you may be overapplying P and K (especially P, which can
accumulate in soil and contribute to water quality problems). Different plants have different
nutrient needs. A balanced fertilizer only makes sense if the soil is equally deficient in all
three nutrients, which is rarely the case. Recommend a soil test first.

Question 2 — Why soil testing matters

Soil tests reveal what nutrients are already present and at what levels. Without this baseline,

you are guessing, which can lead to: under-application (poor plant performance), overapplication (wasted money, potential plant damage, environmental harm), or applying nutrients that are already at adequate or high levels. Soil tests also reveal pH, which determines nutrient availability regardless of fertilizer additions.

Question 3 — Wood ash as a lime substitute

Benefits: Free/recycled material, supplies K and micronutrients, does have liming value. Concerns: Highly variable CCE (25–50%), much larger quantity needed compared to limestone, can supply excessive K_2O (as shown in Problem 11), can raise pH rapidly if over-applied, may contain heavy metals if source wood was treated. Should be used in moderation, based on a soil test, and the K_2O contribution should always be accounted for.