How much of what and how often…

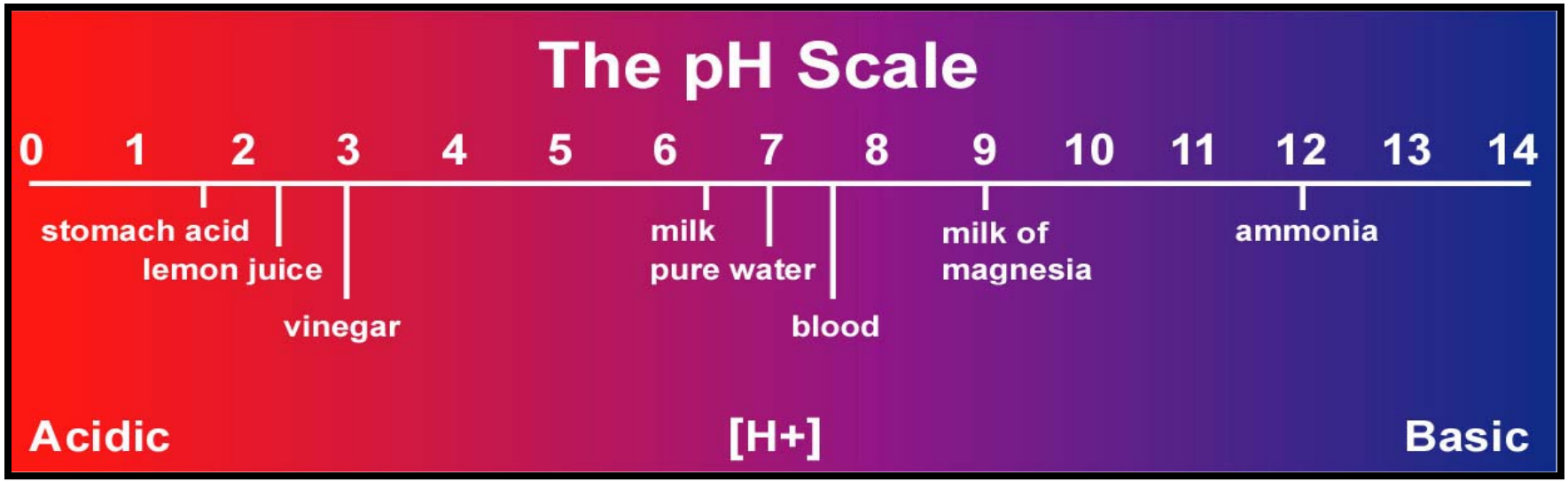
Larry Forero and Alan Bower

What about pH?

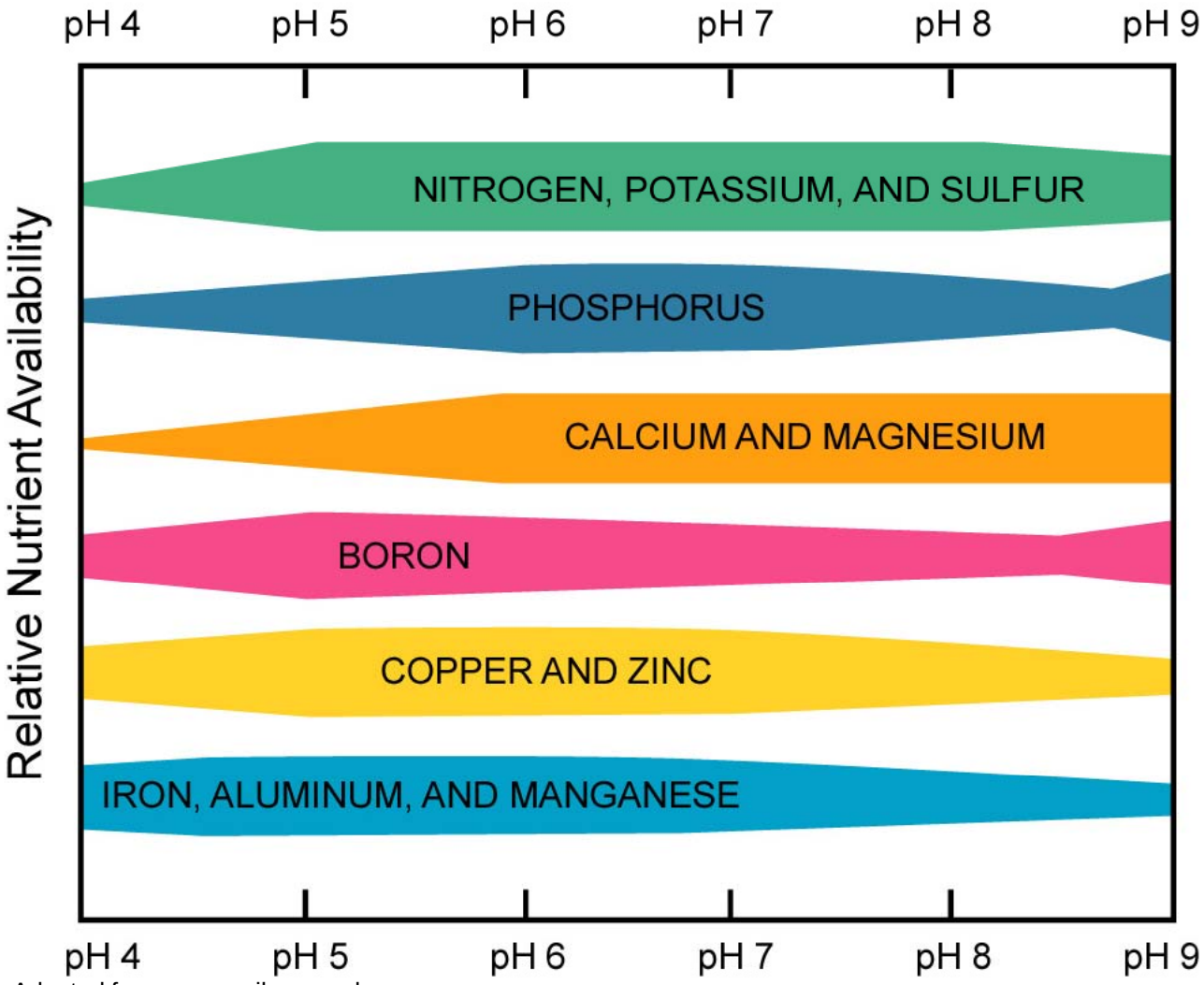
- Generally speaking, for pastures, if pH is in the 6-8 range it is not economical to adjust it
- When considering pH the unit of currency is CaCo3 Equivalents

pH

- Indicates relative acidity or alkalinity
- pH 7 = neutral; less than 7 = acid; more than 7 = alkaline or basic



Adapted from library.thinkquest.org



Adapted from www.soil.ncsu.edu

Soil pH and nutrients

Widest part of the bar indicates maximum availability

Common liming materials include:

Table 2. Common liming materials.

Name	Chemical formula	($CaCO_3$) equivalent (%)	Source
Burned lime	CaO	150–175	Kiln burned
Hydrated lime	$Ca(OH)_2$	120–135	Steam burned
Dolomite*	$CaCO_3$, $MgCO_3$	110	Natural deposit
Limestone	$CaCO_3$	100	Pure form, finely ground
Sugar beet lime	$CaCO_3$	80–90	Sugar beet byproduct
Power plant ash	CaO, K_2O, MgO, Na_2O	5–50	Wood-fired power plants

Source: *Western Fertilizer Handbook* (1995), p. 219.

*High-magnesium dolomite should not be applied where magnesium exceeds calcium in soil.

How much material needs to be added to change pH?

Table 3. Amount of lime needed to change soil pH (soil reaction).

Change in pH desired	Tons of lime (100% of $CaCO_3$ equiv.) required per acre (6-inch depth) for various soil textures*					
	Sand	Sandy loam	Loam	Silt loam	Clay loam	Muck
4.0 to 6.5	1.3	2.5	3.5	4.2	5	9.5
4.5 to 6.5	1.1	2.1	2.9	3.5	4.2	8.1
5.0 to 6.5	0.9	1.7	2.3	2.8	3.3	6.3
5.5 to 6.5	0.6	1.3	1.7	2	2.3	4.3
6.0 to 6.5	0.3	0.7	0.9	1.1	1.2	2.2

Source: Western Fertilizer Handbook (1995), p. 218.

* This table gives the amount of 100% $CaCO_3$ equivalent required to change the soil pH of a 6-inch layer of soil. To alter the pH of the surface 12 inches of soil, twice the amount of lime should be applied.

Figure 2. Liming rate calculation.

Step 1. These steps determine the amount of ash to apply as a liming material to neutralize soil acidity and raise soil pH. First, obtain the lime ($CaCO_3$) equivalent from the ash analysis (table 1). We will assume 11% for our example.

Liming capacity
Lime equivalent = 11%
Percentage lime = 0.11

Step 2. From the soil test report, obtain the CEC and estimate the soil texture. In our example, the CEC is 6, which indicates that the soil has a sand or loamy sand texture (table 4). An alternative way to determine soil texture is to obtain the SP from the soil test report (table 4).

CEC of 6 = sand or loamy sand

Step 3. Use Table 3 to determine the amount of 100% $CaCO_3$ equivalent lime needed to raise the soil pH to the desired level by using the soil pH and texture. Obtain the soil pH from the soil test report. In our example, assume the pH is 4.6. To change the pH from 4.6 to 6.5 for a soil of sand texture, an application of 1.1 tons/acre of 100% limestone is required.

Change in pH desired in 6" plow depth layer = 4.5 to 6.5
Tons of lime required for different soil texture = Sand = 1.1 tons/acre

Step 4. Determine the amount of ash to apply. Divide the amount of 100% limestone by the percentage $CaCO_3$ equivalent of the ash. In our example, divide 1.1 from step 3 by 0.11 (the $CaCO_3$ equivalent of this ash) from step 1. We find 10.0 tons/acre of dry ash should be applied to get the desired pH change.

1.1 tons/acre ÷ 0.11 = 10.0 tons/acre of dry ash

Step 5. Adjust the amount of ash to apply for moisture percentage. Divide the amount of applied ash by the percentage of dry matter in the ash. In our example, if we assume that the percent moisture is 20%, then the percent dry matter is 80% (100% minus 20%). Divide 10.0 tons/acre of dry ash by 0.8 to determine that 12.5 tons/acre of ash with 20% moisture should be applied to raise the pH from 4.5 to 6.5.

10 tons/acre ÷ 0.8 (percentage dry matter) = 12.5 tons/acre of moist ash

Nitrogen…

- This is a tough question. The general rule is that pasture will take up about a pound of nitrogen per acre per day (about 150 lbs/year)
- Pasture gets nitrogen from a variety of sources including legumes
- Tissue tests will nearly always show a deficiency in nitrogen and pasture will nearly always respond to an application of it—the question is generally economic

Sulfur…

- This is an easier question. Book values show sulfur needs to be added tissue tests indicate there is less than .10%

Phosphorus…

- This is an easier question. Book values show phosphorus needs to be added soil tests indicate there is less than 20 ppm present

Remember this slide?

Table 6. Interpreting the results of soil tests and rates of fertilizer required to amend deficient soils

Nutrient	If soil test is . . .*	Suggested fertilizer rate
Phosphorus (HCO3 extractable)	< 5 ppm 5–10 ppm 10–20 ppm > 20 ppm	100 lb P2O5/acre 50 lb P2O5/acre 25 lb P2O5/acre none
Potassium (ammonium acetate extractable)	< 40 ppm 40–60 ppm > 60 ppm	200 lb K2O/acre 100 lb K2O/acre 0–50 lb K2O/acre
Zinc (DTPA extractable)	< 0.5 ppm (soil pH < 7.0) < 0.5 ppm (soil pH > 7.0)	5 lb Zn as ZnSO4/acre 10 lb Zn as ZnSO4/acre

* Source: Soil and Plant Tissue Testing in California (UC ANR Bulletin 1879).

Based on our soil test, assume we need to add 50 lbs of P205 equivalent/acre

- How much 11:52/acre do I need to apply to achieve this?
  - Answer-about 100 lbs
- Assuming 11:52 costs $660/ton, what is the per acre cost?
  - Answer-about $33/acre
- At the 100 lbs rate, how many units of N were applied?
  - Answer-About 11 lbs

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Based on our soil test, assume we need to add 50 lbs of P205 equivalent/acre

- How much 16:20/acre do I need to apply to achieve this?
  - Answer-about 250 lbs
- Assuming 16:20 costs $416/ton, what is the per acre cost?
  - Answer-about $52/acre
- How many units of N are being applied at this rate?
  - Answer-about 40 lbs

Potassium…

- This is an easier question. Book values show potassium needs to be added if soil tests indicate there is less than 40 ppm present
  - Sources of Potassium include:
    - Potassium chloride-KCl-0-62-0
    - Potassium nitrate-KNO3-13-45

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* Source: Soil and Plant Tissue Testing in California (UC ANR Bulletin 1879).

Based on our soil test, assume we need to add 50 lbs of K20 equivalent/acre

- How much KCl (60%) do I need to apply to achieve this?
  - Answer-about 100 lbs
- Assuming KCl costs $822/ton, what is the per acre cost?
  - Answer-about $41/acre
- At the 100 lbs rate, how many units of N were applied?
  - Answer-About 0 lbs

Six questions to ask yourself before you add fertilizer:

1. Which elements do I need? (N, P, K, S, Ca)
2. How much do I apply?
3. What type of material do I use?
4. Which application method is best?
5. When is the best time to apply it?
6. Will I get a return on my investment?

What about Manure: Relative values of manure…

Table 3b. Approximate Nutrient Composition of Selected Types of Manure at Time of Application[1] Type of Manure	**Moisture Content %**	**Total N**	**NH4-N**	**P2O5**	**K2O**
		Pounds per Ton			
Swine	82	10	6	9	8
Beef	32	23	7	24	41
Dairy Cattle	46	13/0.65% DM	5/0.25% DM	16/0.80% DM	34/1.7% DM
Sheep	31	29	5	26	38
Chicken w/o litter	55	33	26	48	34
Turkey w/o litter	78	27	17	20	17
Horse w/o bedding	22	19	4	14	36

1 These values are derived from the USDA, SCS, Agricultural Waste Management Field Handbook (1992), and modified with data collected from Colorado feeding operations when possible. Nutrient composition of manure will vary with age, breed, feed rations and manure handling practices.

ANR ANALYTICAL LABORATORY
UNIVERSITY OF CALIFORNIA
COOPERATIVE EXTENSION

SUBMITTED BY: MARCUM, DAN
DANR SECTION: CTY: SHASTA-LASSEN
COPY TO: SCHNEIDER, STACY
COMMODITY: Fly Ash Wood
DRY MATTER: Results reported on 100% Dry basis. Dry Matter = 94%.

http://danranlab.ucanr.org

WORK REQ #: 10P328
OF SAMPLES: 1
DATE RECEIVED: 02/05/10
DATE REPORTED: 02/17/10
DANR CLIENT #: MARD1C
TURN AROUND TIME IN WORKING DAYS: 8

Sample Type: PLANT Date Sampled: 2/2/10; Grower/Location/Project: Sierra Pacific Ash

SAMPLE #	DESC	N (Total) [SOP 525.03] %	P (Total) [SOP 590.01] %	K (Total) [SOP 590.01] %
1		0.29	0.782	1.27
1 dup		0.28	0.762	1.24
Analysis Date:		2/11/2010	2/17/2010	2/12/2010
Method Detection Limit:		0.02	0.010	0.01
Blank Concentration:		0.00	0.000	0.00
Standard Ref as Tested:		3.18	0.41	2.40
Standard Ref Acceptable:		3.19±0.21	0.42±0.04	2.50±0.18
Standard Reference:		WAL 182	UCD 187	UCD 187

NOTE: The SOP # (Standard Operating Procedure number) is a reference to the laboratory method used.
The SOP heading in this Excel file is linked to the method summary on the Laboratory website. http://danranlab.ucanr.org

NOTE: No result within this report is accurate to more than 3 significant figures. More figures may be present due to software rounding rules.

Checked and Approved: *{electronically signed by Traci Francis}*
Traci Francis, Laboratory Supervisor

Reviewed and Approved: *{electronically signed by Dirk Holstege}*
Dirk Holstege, Director

Please address questions regarding these results to Lab Director Dirk Holstege at (530) 752-0148 or dmholstege@ucdavis.edu.

Samples for this Work Request (10P328) will be discarded on 3/19/10.

What about some other organic sources?

Approximate Nutrient Composition of Selected Types of fertilizers	Moisture Content %	Total N	NH4-N	P2O5	K2O
		Pounds per Ton			
Cogeneration ash	4%	.29%		1.79%	1.27%
Organic Dry Fertilizer	0	9%		3%	0
Guano plus	0	11		5	2
Seabird Guano	0	12		12	2.5
Rock Phosphate	0	0		3% Available	

1 These values are derived from a variety of sources

How many pounds of each product on a dry matter basis would need to be applied to equate to 100 lbs/acre of P205?

Approximate Nutrient Composition of Selected fertilizers	Moisture Content %	Total N	NH4-N	P2O5	K2O	How much product?
		Percent				
Mono Ammonium Phosphate	0	11	N/A	52	0	200 lbs
Dairy Manure	0	.65%	N/A	.80%	1.7%	12,500 lbs
Cogeneration ash	4%	.29%	N/A	1.79%	1.27%	5,882 lbs
Organic Dry Fertilizer	0	9%	N/A	3%	0	3,333 lbs
Rock Phosphate	0	0	N/A	3% Available		3,333

1 These values are derived from a variety of sources

How many pounds of each product on a dry matter basis would need to be applied to equate to 100 lbs/acre of P205?*

Approximate Nutrient Composition of Selected fertilizers	Moisture Content %	P2O5	How much product?	Cost/Ton	Cost/Acre
Mono Ammonium Phosphate	0	52	200 lbs	$660	$66
Dairy Manure	0	.80%	12,500 lbs	Free?	0?
Cogeneration ash	4%	1.79%	5,882 lbs	Free?	0?
Guano plus	0	5%	2000 lbs	$1600	$1600
Sea Bird Guano	0	12% Available	833	$997	$415

*Does not include application cost

Fertilizing with manures

- Good source of nutrients and organic matter
- Protects soil from raindrop impact and erosion
- Local supply often available at no cost

OSU Extension Service

Different sources of manure have different amounts of nutrients

- Poultry manure is high in nitrogen
- Beef and horse manure tends to be lower in nitrogen
- Sheep manure is high in potassium (K)

UNCE, Reno, NV

Cautions for fertilizing with manures

- Watch out for weeds and pathogens
- Know the manure nutrient content
- Consider the salt content

OSU Extension Service

Cautions for fertilizing with manures

- Incorporate or apply evenly to avoid smothering plants
- Don’t apply on frozen slopes
- Avoid leaching nutrients into waterways

UNCE, Reno, NV

Six questions to ask yourself before you add fertilizer:

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