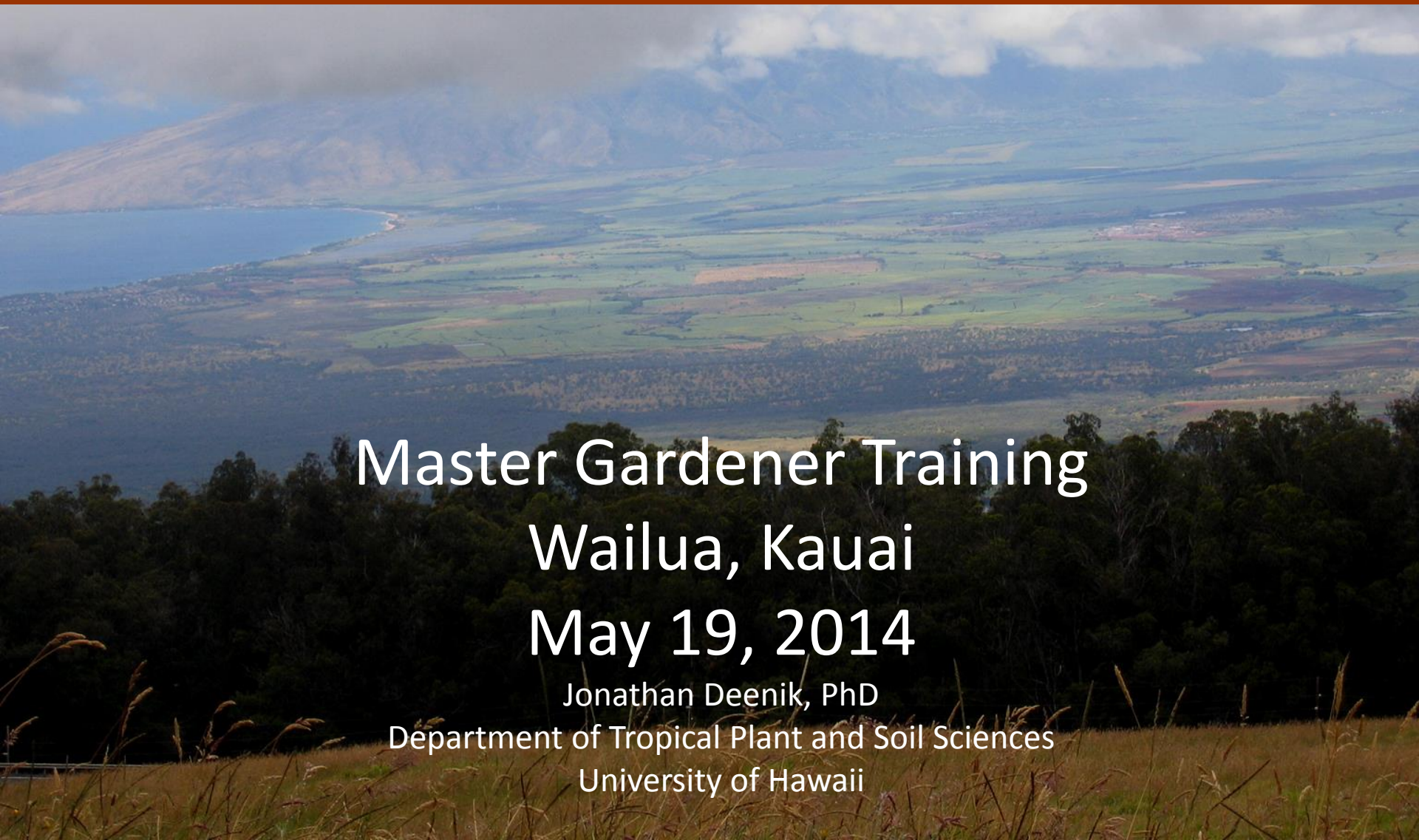
Concepts in Soil Nutrient Management for a Healthy Landscape

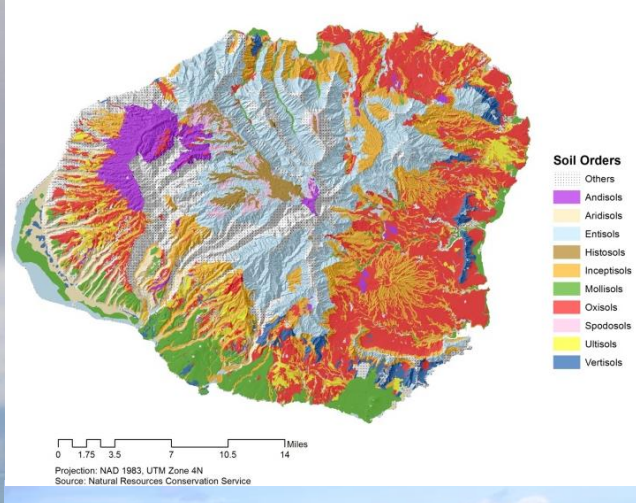


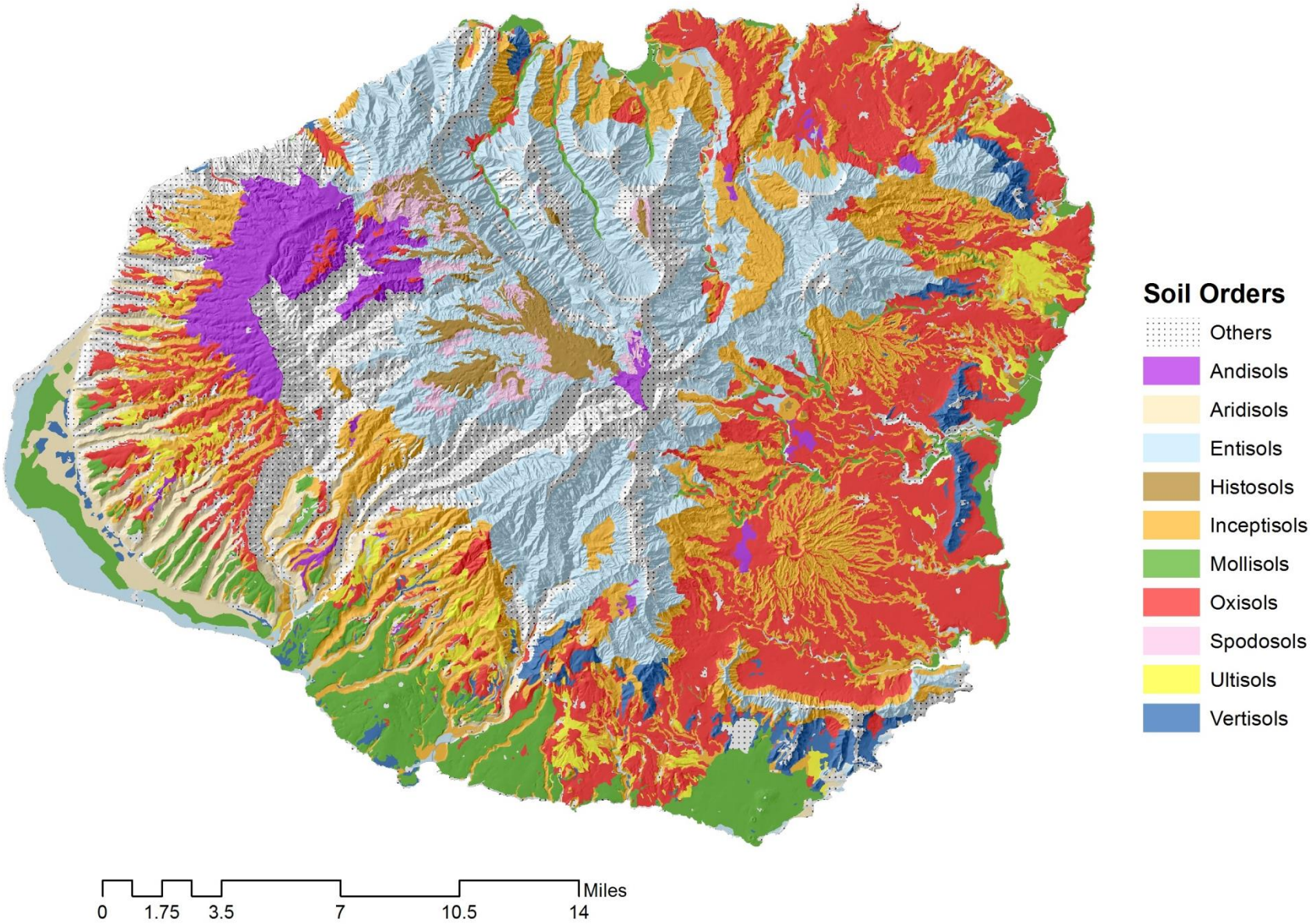
Master Gardener Training
Wailua, Kauai
May 19, 2014

Jonathan Deenik, PhD
Department of Tropical Plant and Soil Sciences
University of Hawaii

Outline

- Essential Plant Nutrients
- 4R Nutrient Management
- Soil Tests
- Liming
- Compost
- Fertilizers





Projection: NAD 1983, UTM Zone 4N
Source: Natural Resources Conservation Service

Essential Plant Nutrients

Macronutrients

Mineral/ Element	Chemical symbol	Main requirement/use by the plant
Macronutrients		
Nitrogen	N	Plant growth; proteins; enzymes; hormones; photosynthesis
Sulphur	S	Amino acids and proteins; chlorophyll; disease resistance; seed production
Phosphorus	P	Energy compounds; root development; ripening; flowering
Potassium	K	Fruit quality; water balance; disease resistance
Calcium	Ca	Cell walls; root and leaf development; fruit ripening and quality
Magnesium	Mg	Chlorophyll (green colour); seed germination

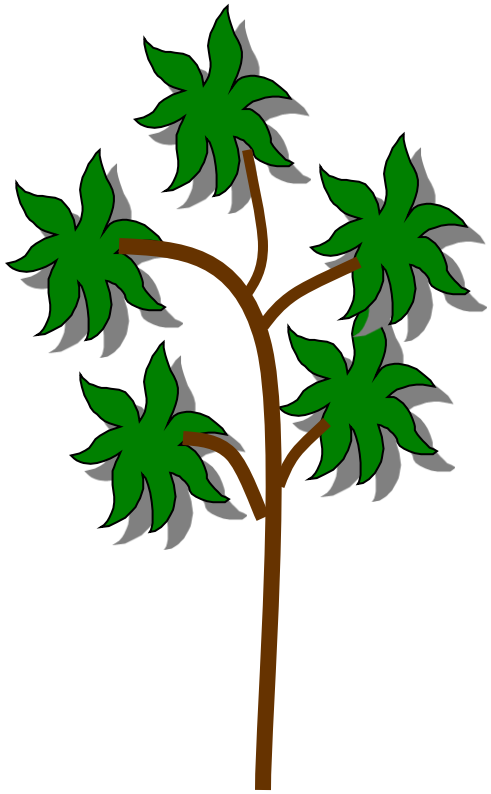
Micronutrients: B, Cu, Fe, Mn, Zn, Mo, Ni, Co, Cl

Table 5: Role of specific nutrients

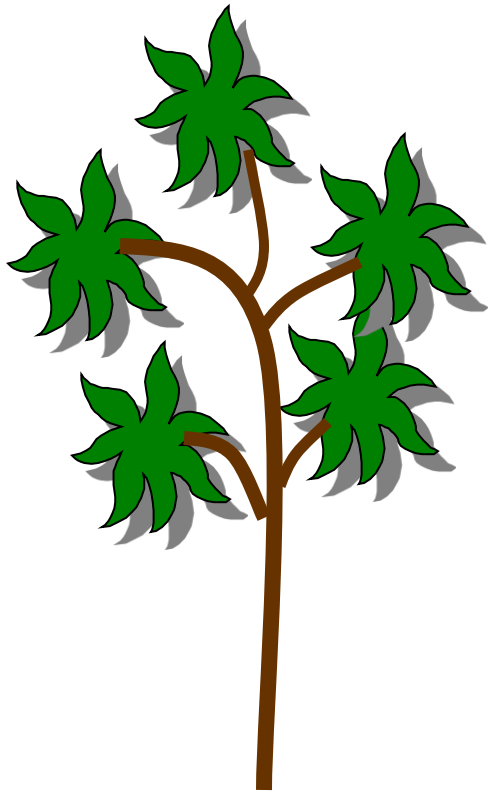
	N	P	K	Mg	Ca	S	B	Cu	Fe	Mn	Zn
Yield parameters											
Yield	+	+	+	+	+	+	+	+	+	+	+
Bunch weight	+	+	+	+			+	+			
Hands / Bunch	+		+					+			
Fruit/Hand			+								
Fruit number			+								
Fruit weight			+				+	+			+
Fruit diameter			+				+	+			+
Fruit length			+								
Quality parameters											
Starch	+	+	+								
Sugars			+				+				+
Acid	+						+				+
Sugar / Acid ratio			+								+
Total Soluble Solids	+		+				+	+			+
Ascorbic Acid (Vit. C)			+				+	+			+
Peel Disorders					-						

Nutrient Mobility in Plants

Mobile



Immobile



Nutrient Mobility in Plants

Mobile

Symptoms appear in older leaves first

- nitrogen
- phosphorous
- potassium
- magnesium

Immobile

Symptoms appear in younger leaves first

- sulfur
- calcium
- boron, iron, manganese, zinc, copper, molybdenum, chloride

Nutrient Deficiency Symptoms in Plants

9 Nutrient Management Module No. 9

CCA
1.5 NM
CEU

Plant Nutrient Functions and Deficiency and Toxicity Symptoms

by Ann McCauley, Soil Scientist;
Clain Jones, Extension Soil Fertility Specialist; and
Jeff Jacobsen, College of Agriculture Dean

Introduction

This module is the ninth in a series of extension materials designed to provide extension agents, Certified Crop Advisers (CCAs), consultants, and producers with pertinent information on nutrient management issues. To make the learning 'active,' and to provide credits to CCAs, a quiz accompanies this module. In addition, realizing that there are many other good information sources including previously developed extension materials, books, web sites, and professionals in the field, we have provided a list of additional resources and contacts for those wanting more in-depth information about plant nutrient functions and deficiency and toxicity symptoms.

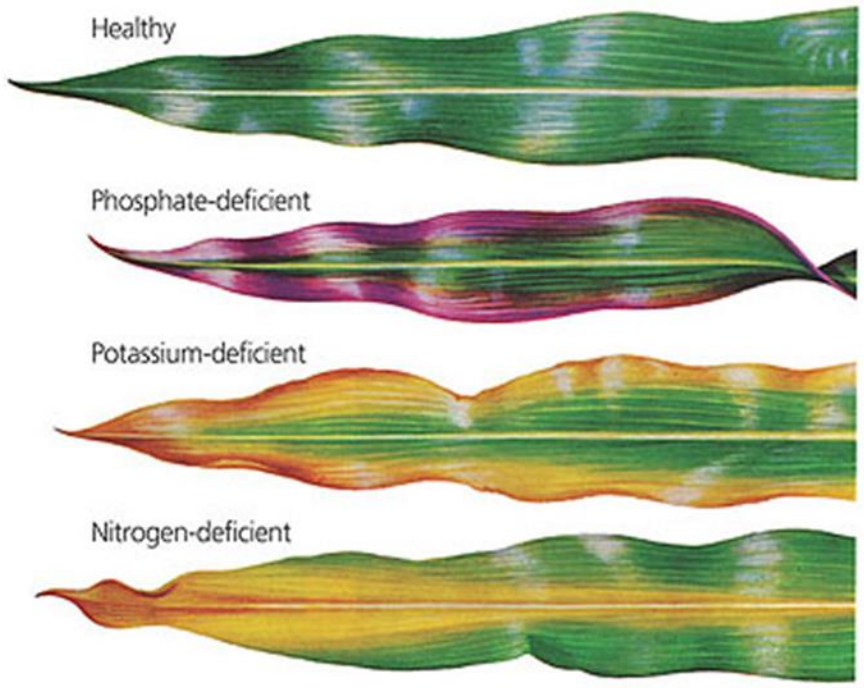
Objectives

After reading this module, the reader should be able to:

1. Identify and diagnose common plant nutrient deficiency and toxicity symptoms
2. Know potential limitations of visual diagnosis
3. Understand how to use a key for identifying deficiency symptoms
4. Distinguish between mobile and immobile nutrient deficiencies

Nutrient Management
a self-study course from the MSU Extension Service Continuing Education Series

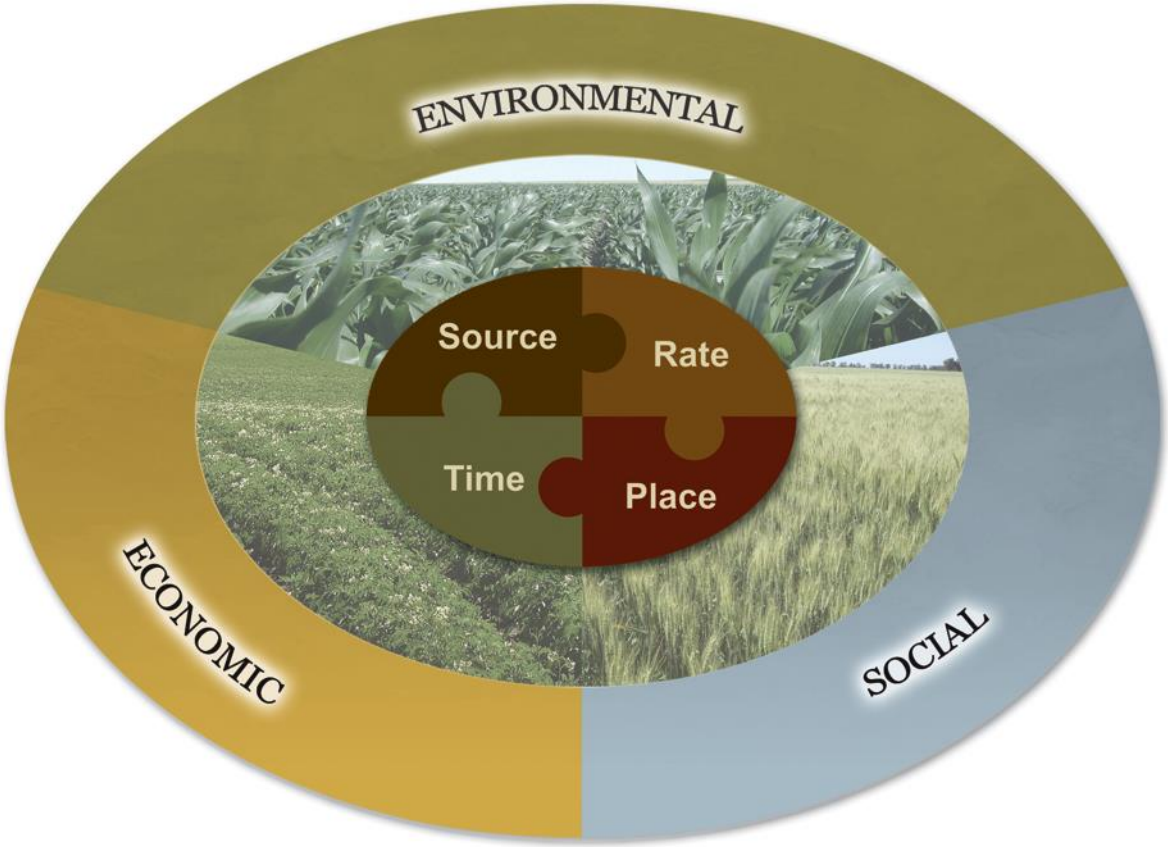
MONTANA STATE UNIVERSITY EXTENSION
4449-9
May 2009



http://landresources.montana.edu/NM/Modules/Module9.pdf

4R Nutrient Stewardship Concept

1. Right Source
   - What type of fertilizer?
2. Right Rate
   - How much?
3. Right Time
   - When & How often?
4. Right Place
   - Where?



Scientific Principles

	The Four Rights (4Rs)			
	Source	Rate	Time	Place
Key Scientific Principles	• Ensure balanced supply of nutrients • Suit soil properties	• Assess nutrient supply from all sources • Assess plant demand	• Assess dynamics of crop uptake and soil supply • Determine timing of loss risk	• Recognize crop rooting patterns • Manage spatial variability

Practical Choices

	The Four Rights (4Rs)			
	Source	Rate	Time	Place
Practical Choices	• Commercial fertilizer • Livestock manure • Compost • Crop residue	• Test soils for nutrients • Calculate economics • Balance crop removal	• Pre-plant • At planting • At flowering • At fruiting	• Broadcast • Band/drill/inject • Variable-rate application

- Ensure practices are in accord with principles

Diagnosis

1. Visual symptoms
2. Soil test
3. Tissue test

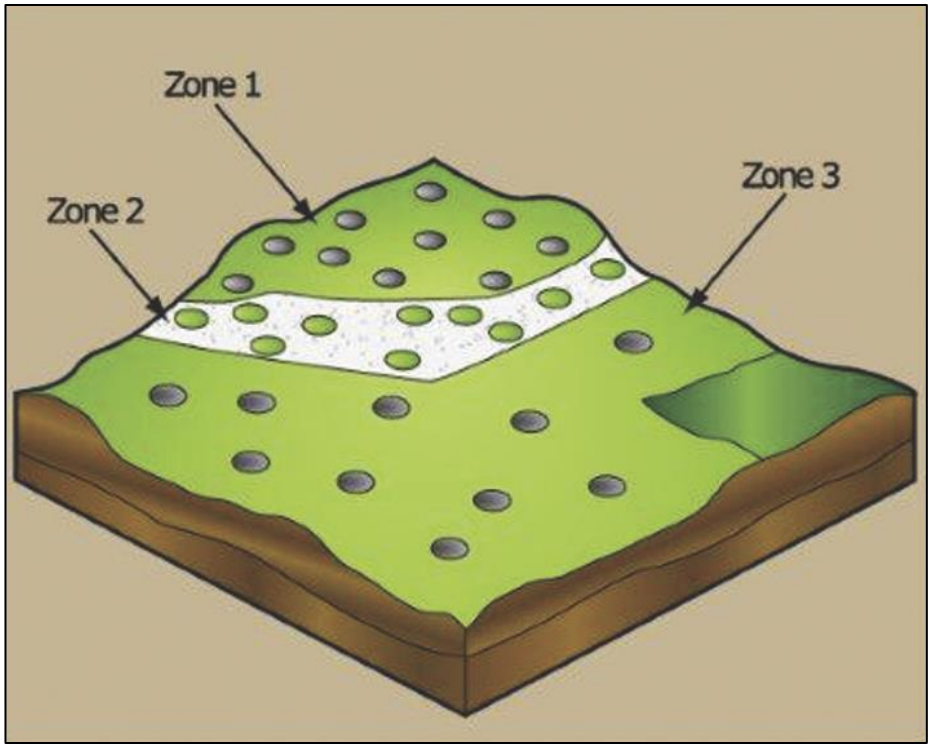
Soil Testing

- Most common method of predicting nutrient deficiencies/toxicities

- Can be used
  - to identify yield limiting factors
  - to indicate soil nutrient supply capacity
  - as part of a nutrient management plan
  - to monitor soil fertility trends over time
  - to manage risk

Collecting a Soil Sample

- Separate sample for distinct management area
- Sample the root zone (0-6” or 0-12”)
- Collect multiple samples
  - Samples can be composited



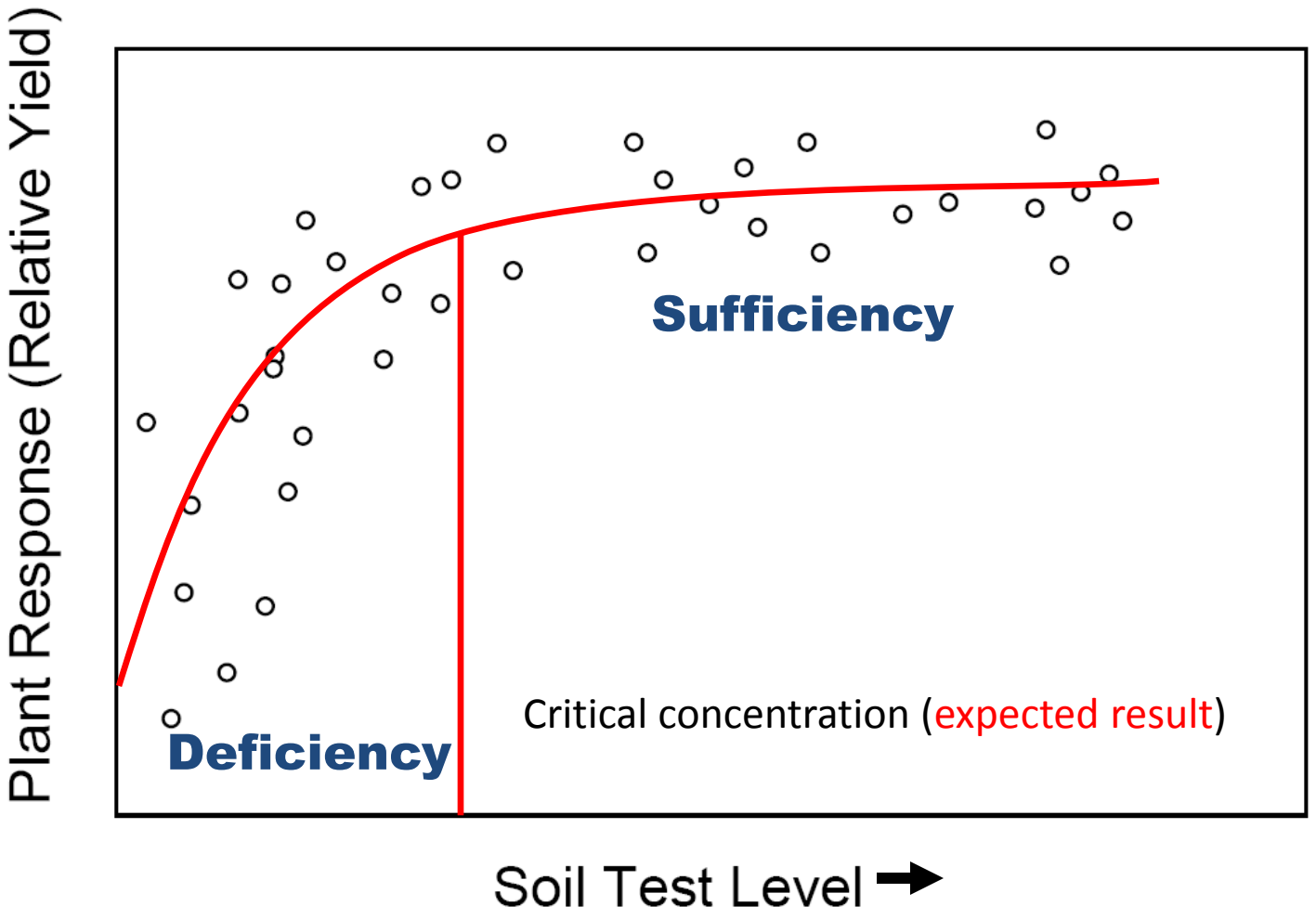
Soil Tests

What is a soil test?

- a dilute extracting solution that removes “plant available” nutrients.
- extractant is chosen depending on soil chemical properties.
- extractant does not measure total nutrient content
- Result of soil test is the basis for fertilizer recommendation

Calibration Experiments to determine optimum soil nutrient concentrations

Soil Test Calibration



Soil Test Printout

CTAHR
College of Tropical Agriculture & Human Resources
University of Hawaii at Manoa

Soil/Plant Analysis Report

Agricultural Diagnostic Service Center
Department of Agronomy and Soil Science
1910 East-West Road, Honolulu, HI 96822
Ph: (808) 956-6706/7980 FAX: (808) 956-2592
Email: adsc@ctahr.hawaii.edu

Date Reported: 03/15/2006

Client: PUA LEHUA FARM
P.O. Box 959 Attn: Eric Schott
Honokaa, Hawaii 96727

Agent: SATO, DWIGHT, Office: HILO
875 KOMOHANA STREET
HILO, HI 96720
981-5199, Fax: 981-5211

Sample Information

Job Control No:	06-036767-001	Map Unit:	KuC	Plant Grown:	OTHER CROP
Sample Label:	1	Soil Series:	KUKAIAU	Plant to be grown:	OTHER CROP
Date Received:	3/15/1906	Soil Category:	LIGHT SOIL	Can you till 4~6 in.?	Yes
Send Copy To		Soil Depth (in):		Test Results Only?	No
Elevation (ft.):		Latitude:		Longitude:	

Test Results and Interpretation

LIGHT SOIL — **INTERPRETATION**

Soil Analysis	Results	Expected	Very Low	Low	Sufficient	High	Very High
_pH	6.8	6.15					
P_ppm	2002	67.5					
K_ppm	374	300					
Ca_ppm	4488	3500					
Mg_ppm	649	700					
OC_%		No criteria found					
Total_N_%		No criteria found					
Salinity_EC		1.25					
S_ppm		No criteria found					
Fe_ppm	48	No criteria found					
Mn_ppm	14	No criteria found					
Zn_ppm	7.9	No criteria found					
Cu_ppm	9.7	No criteria found					
B_ppm		No criteria found					
Mo_ppm		No criteria found					
Al_ppm		No criteria found					

OTHER CROP — **INTERPRETATION**

Plant Analysis	Results	Expected	Very Low	Low	Sufficient	High	Very High
N_%		No criteria found					
P_%		No criteria found					
K_%		No criteria found					
Ca_%		No criteria found					
Mg_%		No criteria found					
S_%		No criteria found					
Fe_ppm		No criteria found					
Mn_ppm		No criteria found					
Zn_ppm		No criteria found					
Cu_ppm		No criteria found					
B_ppm		No criteria found					
Mo_ppm		No criteria found					
Al_ppm		No criteria found					
NO3_ppm		No criteria found					

Job Control No: 06-036767-001

Problem Description

Peppers to be grown.

Fertilizer and Lime Recommendations

Total Nutrient Requirement (lbs/Acre):	Nitrogen: 175	Phosphorus: 0	Potassium: 0
Fertilizer / Lime Material	Total Amount (lbs/Acre)	Applications	Cost Estimate ($/Acre)
Fertilizer: 46-0-0	389	split into 2 applns.	82

Comments

---- GENERAL INFORMATION ----

o Knowing levels of sulfur and micronutrients in plants is also important. For proper diagnosis, tissue analysis is needed.

o Split the fertilizer into several applications, at planting and thereafter once every 3~4 weeks until the total amount has been applied.

o We recommend that you adopt a nutrient monitoring approach by retaining this sample report for comparison with future samples.

NOTE:

The interpretations are based on Fact Sheet No. 3 "Adequate Nutrient Levels in Soils and Plants in Hawaii."
To help improve future recommendations, please answer the following questions, photocopy this form and return it to above address.
1. Did you need to modify the recommendation? if so, how?
2. Did your plants improve? Please give unit area yield before and after the recommendation was applied.

FEEDBACK

Soil Test Printout

Sample Information

Job Control No:	06-036767-001	Map Unit:	KuC	Plant Grown:	OTHER CROP
Sample Label:	1	Soil Series:	KUKAIAU	Plant to be grown:	OTHER CROP
Date Received:	3/15/1906	Soil Category:	LIGHT SOIL	Can you till 4~6 in.?	Yes
Send Copy To		Soil Depth (in):		Test Results Only?	No
Elevation (ft.):		Latitude:		Longitude:	

Test Results and Interpretation

LIGHT SOIL — **INTERPRETATION**

Soil Analysis	Results	Expected	Very Low	Low	Sufficient	High	Very High
_pH	6.8	6.15					
P_ppm	2002	67.5					
K_ppm	374	300					
Ca_ppm	4488	3500					
Mg_ppm	649	700					
OC_%		No criteria found					
Total_N_%		No criteria found					
Salinity_EC		1.25					
S_ppm		No criteria found					
Fe_ppm	48	No criteria found					
Mn_ppm	14	No criteria found					
Zn_ppm	7.9	No criteria found					
Cu_ppm	9.7	No criteria found					
B_ppm		No criteria found					
Mo_ppm		No criteria found					
Al_ppm		No criteria found					

Soil Test Printout

Job Control No: 06-036767-001

Problem Description
Peppers to be grown.

Fertilizer and Lime Recommendations			
Total Nutrient Requirement (lbs/Acre):	Nitrogen: 175	Phosphorus: 0	Potassium: 0
Fertilizer / Lime Material	Total Amount (lbs/Acre)	Applications	Cost Estimate ($/Acre)
Fertilizer: 46-0-0	389	split into 2 applns.	82

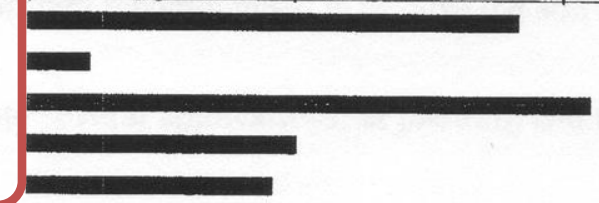
- Only urea recommended because other nutrients and pH not limiting

Soil Test Printout

Test Results and Interpretation

LIGHT SOIL

Soil Analysis	Results	Expected	INTERPRETATION
			Very Low | Low | Sufficient | High | Very High
_pH	5.6	6.15	
P_ppm	9.8	67.5	
K_ppm	223	300	
Ca_ppm	795	3500	
Mg_ppm	280	700	
OC_%		No criteria found	
Total_N_%		No criteria found	
Salinity_EC		1.25	

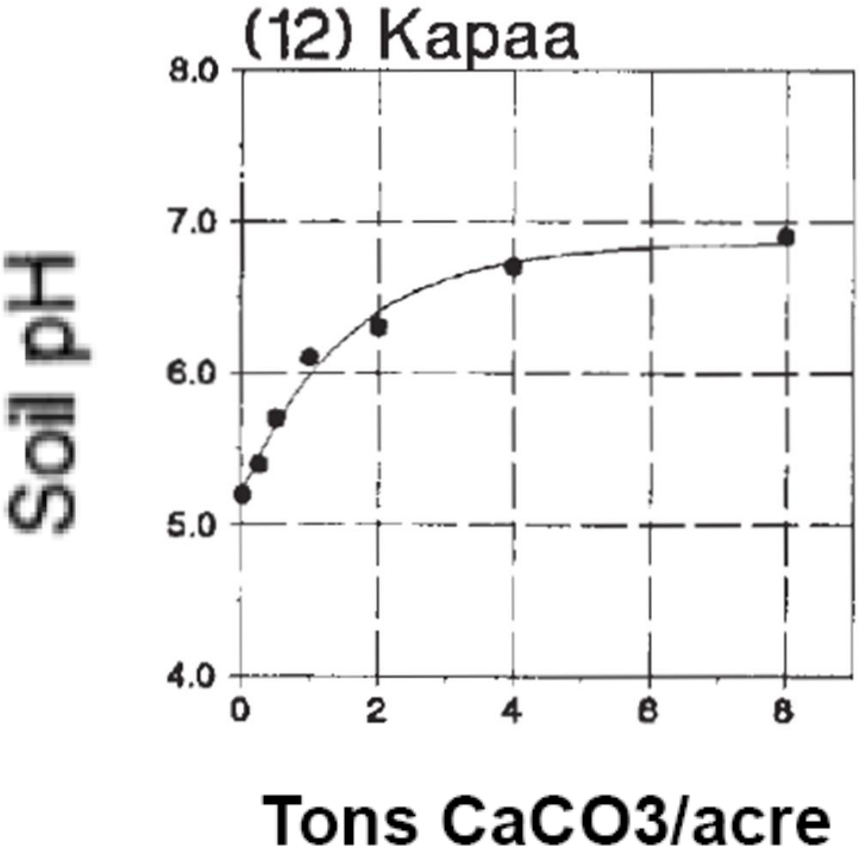


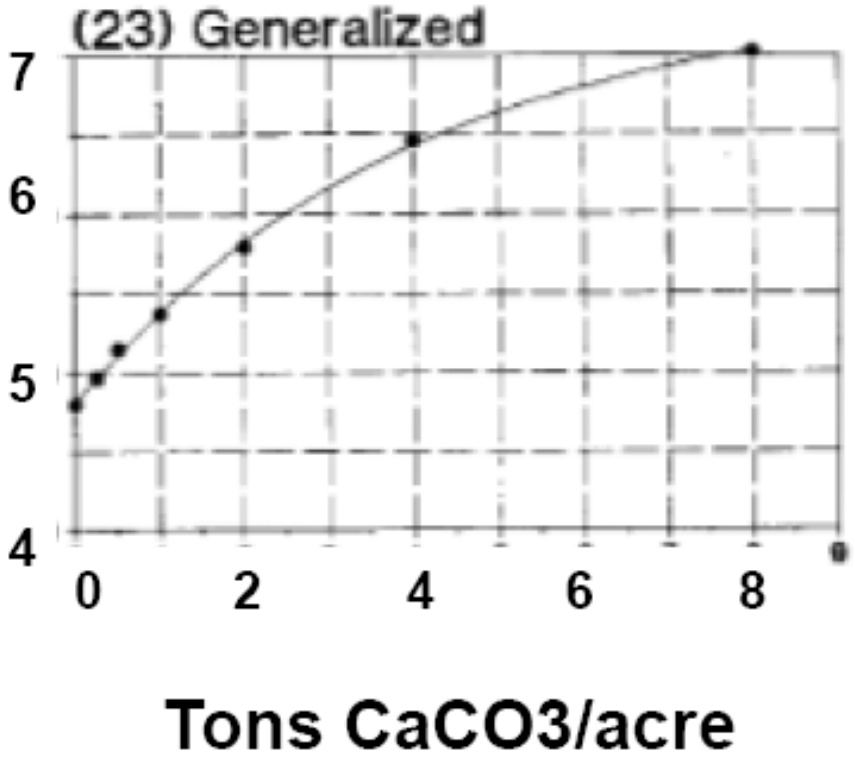
Fertilizer and Lime Recommendations

Total Nutrient Requirement (lbs/Acre):		Nitrogen: 300	Phosphorus: 989	Potassium: 92
Fertilizer / Lime	Material	Total Amount (lbs/100sq-ft.)	Applications	Cost Estimate ($/100sq-ft.)
Fertilizer:	10-30-10	6.88	split into 5 applns.	1.38
Lime Material:	Dolomite	3.33	split into 1 applns.	0.734
Ca Material:	Gypsum	16.5	split into 1 applns.	2.98
Mg Material:	Mg-Sulfate	4.52	split into 1 applns.	1.81

Liming Corrects Soil Acidity

- To raise pH
  - Reduce existing/potential toxicities (Al & Mn)
  - Increases P availability (reduces P fixation)
  - Supply of Ca & Mg
  - Target pH 6.0 – 6.5
  - Liming can be expensive because soils are buffered (clay content and OM)
- Liming Materials
  - Calcium carbonate ($CaCO_3$)
  - Dolomite
  - Organic matter detoxifies Al



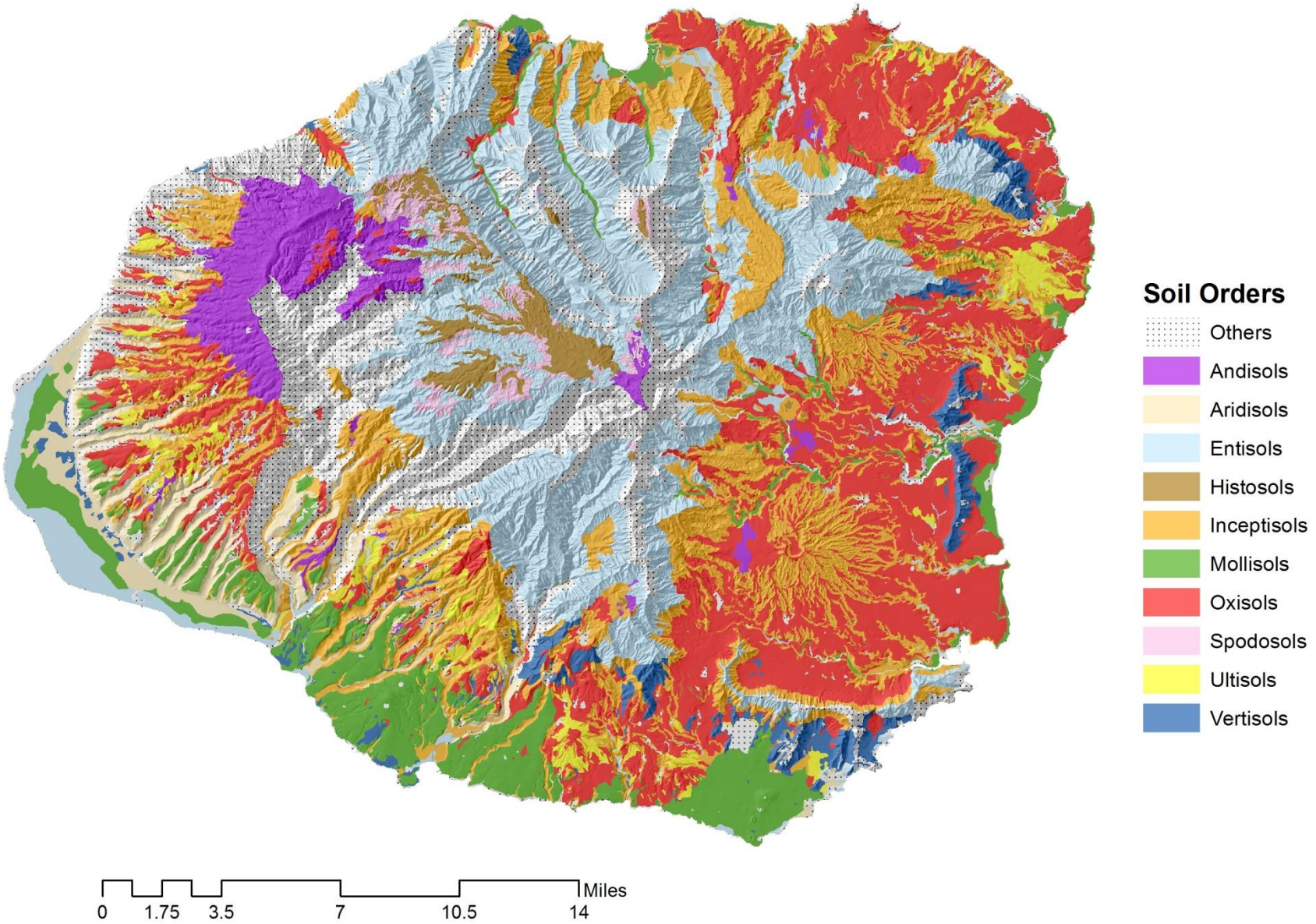


Liming curves for many soil series in Hawaii available online

http://www.ctahr.hawaii.edu/oc/freepubs/pdf/AS-1.pdf

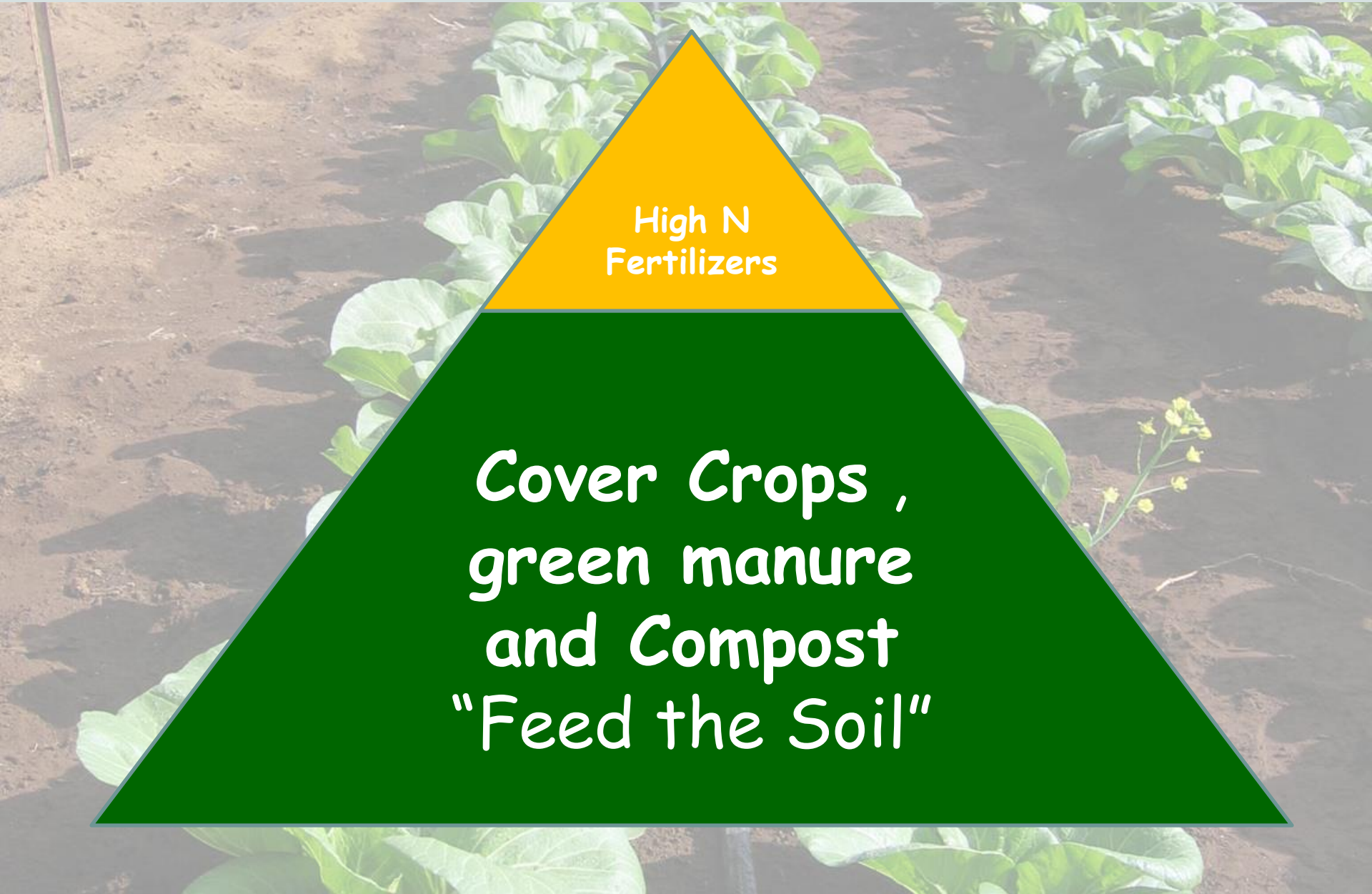
TABLE 9.2 Common Liming Materials: Their Composition and Use

Common name of liming material	*Chemical formula (of pure materials)*	*% $CaCO_3$ equivalent*
Calcitic limestone	$CaCO_3$	100
Dolomitic limestone	$CaMg(CO_3)_2$	95–108
Burned lime (oxide of lime)	CaO (+ MgO)[a]	178
Hydrated lime (hydroxide of lime)	$Ca(OH)_2$ (+ $Mg(OH)_2$)[a]	134
Basic slag	$CaSiO_3$	70
Marl	$CaCO_3$	40–70
Wood ashes	CaO, MgO, K_2O, K(OH), etc.	40
Misc. lime-containing by-products	Usually $CaCO_3$ with various impurities	20–100



Projection: NAD 1983, UTM Zone 4N
Source: Natural Resources Conservation Service

“Feed the Soil”



Compost Properties

- Decomposed organic materials
- Dark material with particle size < 2.5 cm
- No foul odor
- pH = 6.0 – 7.0
- Contains most essential nutrients

Benefits of Compost

Soil Physical Properties

- Improve soil structure
- Increase water retention
- Decrease bulk density

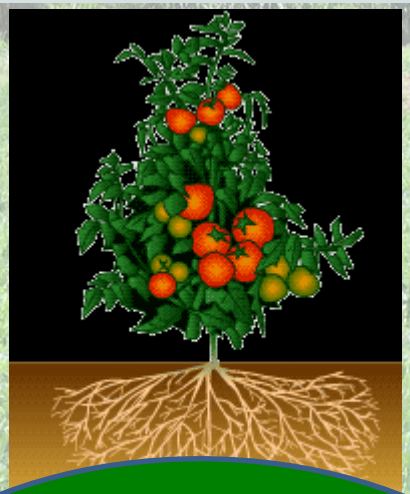
Soil Chemical Properties

- Source of essential nutrients
- Increase nutrient retention (CEC)
- Detoxify Al
- Buffer pH

Soil Biological Properties

- Increase microbial abundance and diversity
- Create disease suppressive soils

Soil Nutrient Pools



Soil organisms

Soil organisms

HPO_3^-

NO_3

Mg^{2+}

Soil Solution

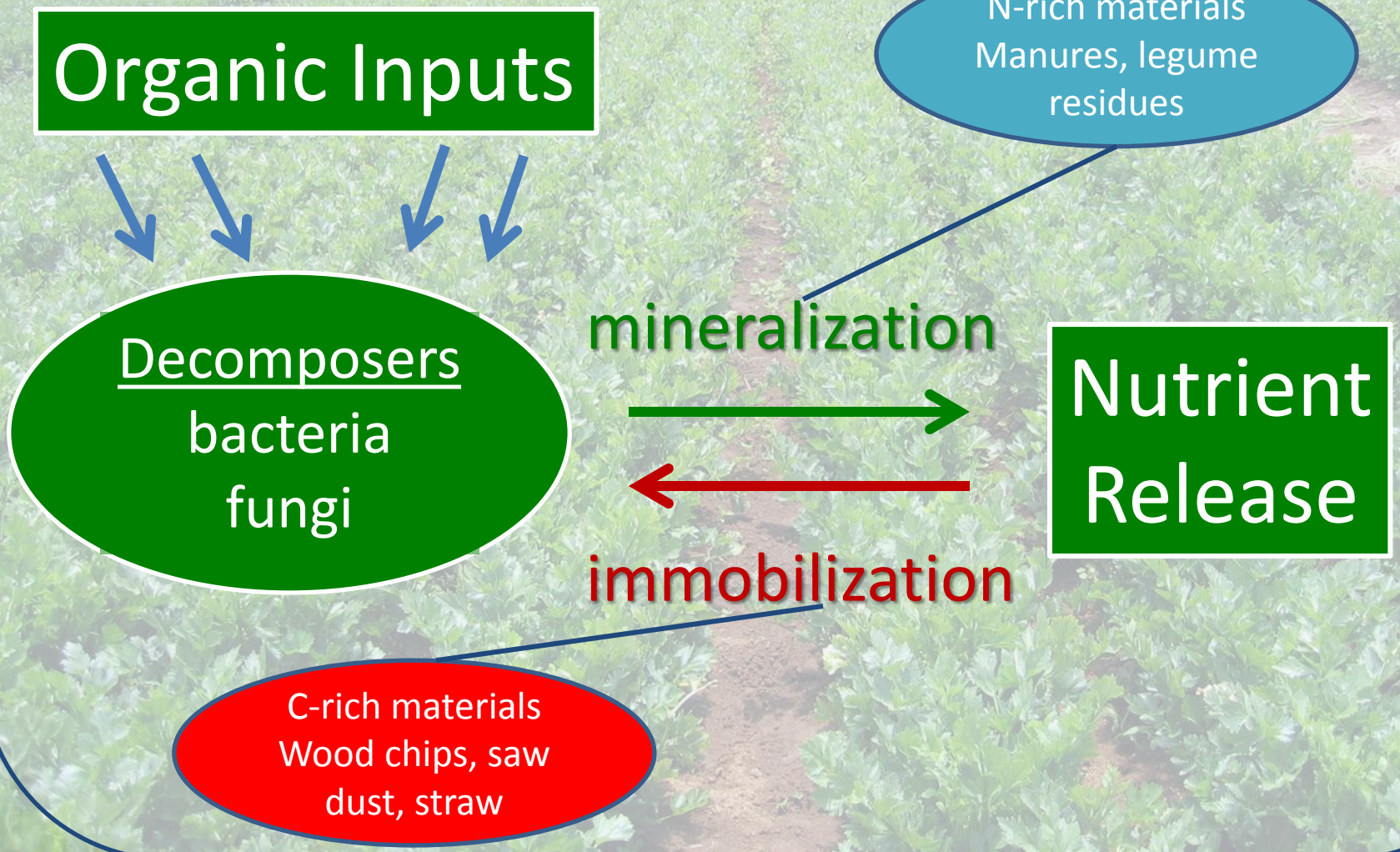
K^+

Ca^{2+}

Soil Organic Matter

Clay Minerals

Organic Matter and Nutrient Dynamics



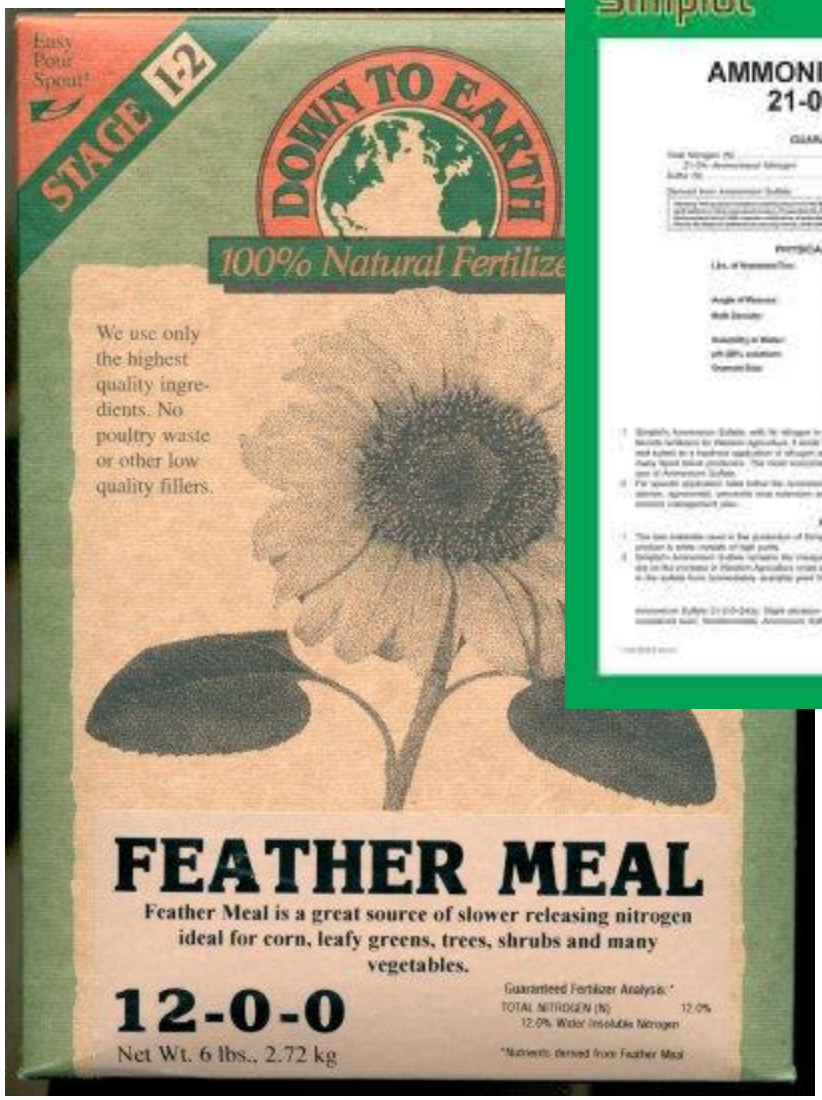
N Fertilizers

Organic

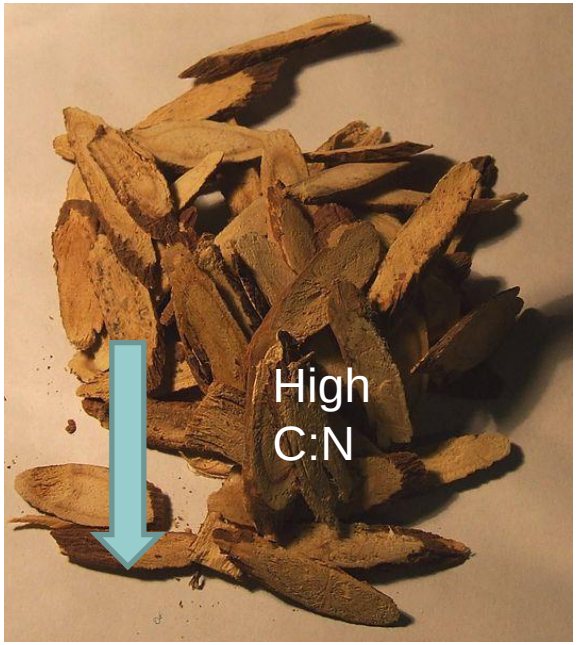
- Fish meal (≈10% N)
- Feather meal (12 - 13% N)
- Chicken manure (≈3% N)

Conventional

- Urea (46-0-0)
- Ammonium sulfate (21-0-0)
- 16-16-16
- Calcium nitrate
- Potassium nitrate

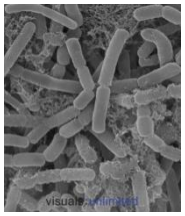


Nitrogen Mineralization/Immobilization



Organic matter – NH_2

soil microorganisms

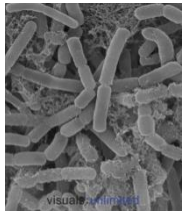


NH_4^+

NO_3^-

mineralization

immobilization



NH_4^+ NO_3^-

Gain of plant available N

Loss of plant available N

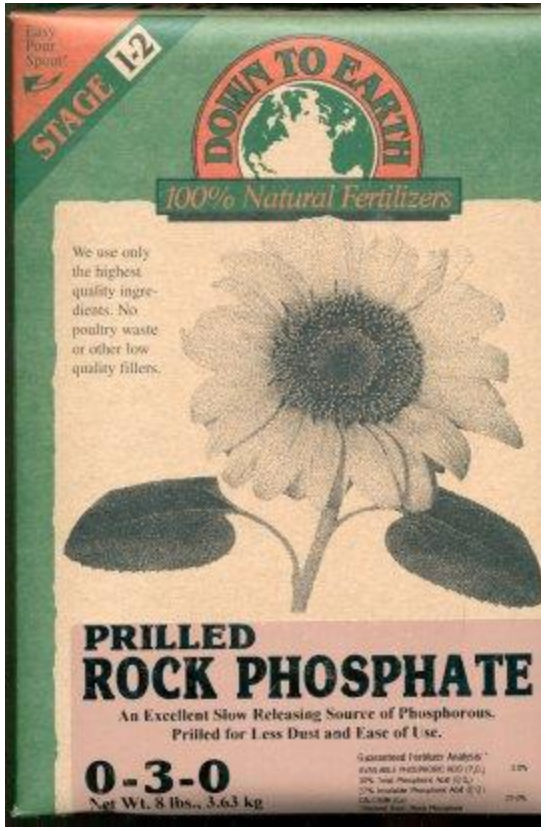
P Fertilizers

Organic

- Bone meal (≈12-15% P)
- Rock phosphate (2-5% P)
- Chicken manure (2-3% P)

Conventional

- TSP (0-45-0)
- DAP (18-46-0)
- 10-30-10



K Fertilizers

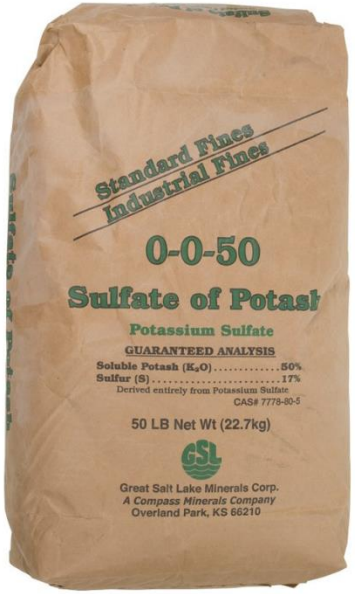
Organic

- Hardwood ashes
- Seaweed
- Sulfate of potash (0-0-50)

Conventional

- Muriate of potash (0-0-60)


Hardwood ashes



Source, Rate, Time, Placement

1. Source
   a. Diagnosis
      - Visual symptoms
      - Soil test
2. Rate
   a. Recommendation
      - Soil test
      - Plant nutrient requirements
3. Time
   a. Crop/plant
   b. Type of amendment
4. Placement
   a. Crop/plant
   b. Type of amendment


ALL-PURPOSE
Soy Sauce
NATURALLY BREWED
MORE THAN 100 YEARS OF EXCELLENCE