Nutrient Management for Class B biosolids

WASHINGTON STATE UNIVERSITY
EXTENSION

Today's Topics:

Introduction to plant nutrients

How nutrients become available to plants

Soil Testing

Biosolids N research

Agronomic rate calculations

Nutrient Management

- Meet crop nutrient needs
- Maintain soil quality
- Conserve resources
- Protect water quality - reduce leaching and runoff risk

Plant Nutrients

Major Nutrients

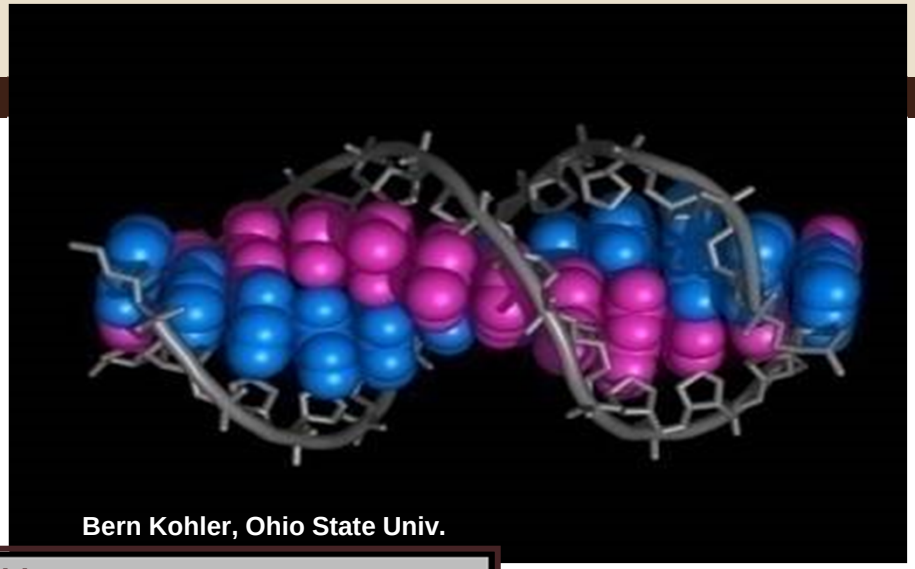
- **Nitrogen**
- Phosphorus
- Potassium
- Calcium
- Magnesium
- Sulfur

Micronutrients

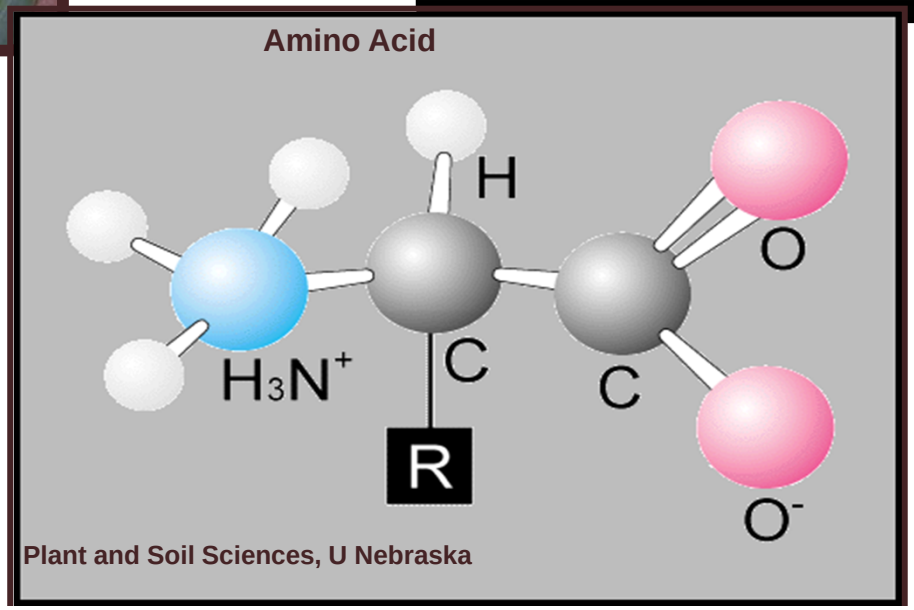
- Boron
- Iron
- Manganese
- Zinc
- Copper
- Chloride
- Molybdenum

What Do Nutrients Do?
Example: Nitrogen

Chlorophyll – photosynthesis



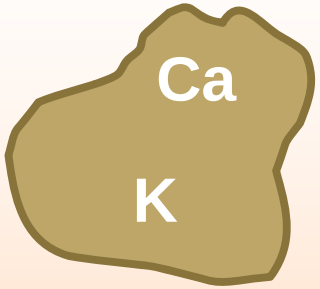
DNA



Amino acids and proteins

Soil is full of nutrients, but most are not available to plants

Mineral

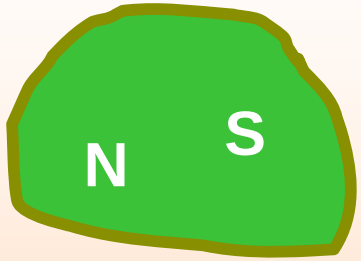


Ca^{++}, K^{+}

Insoluble, unavailable

Soluble, available

Organic

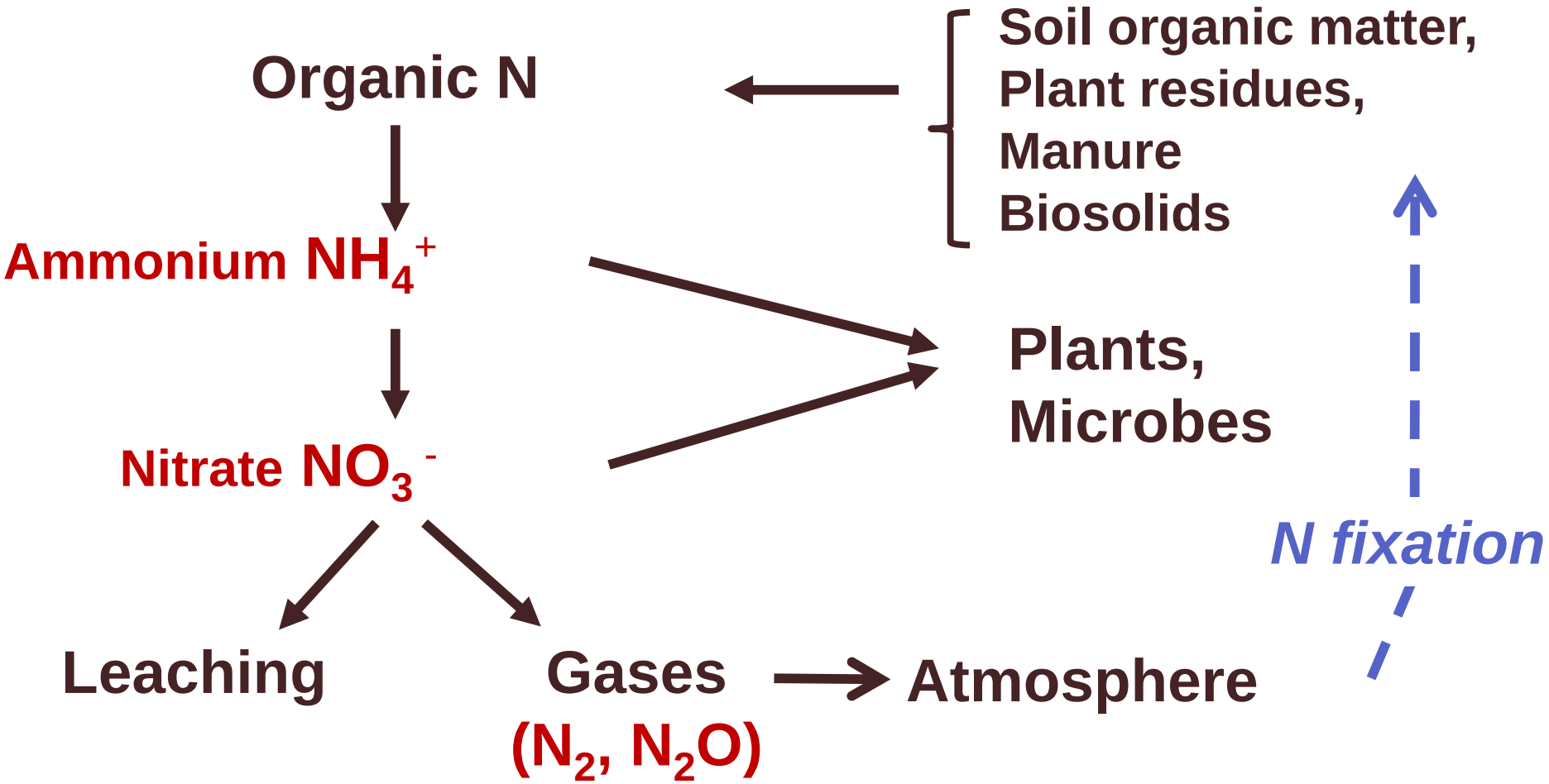


NH_4^{+}, SO_4^{--}

How Do Nutrients Become Available to Plants?

Nitrogen is the key nutrient for determining application rates

Nitrogen Cycle



Biosolids and Other Nutrients

- These nutrients accumulate in the soil when biosolids are applied to meet N needs:
  Phosphorus
  Zinc

- This nutrient will decline in soil if biosolids are the sole source of nutrients:
  Potassium

Phosphorus may limit long-term applications of biosolids

Crops benefit from P in initial biosolids application.

Repeated applications increase soil P.

Accumulation of P can harm water quality if runoff to surface water occurs.

Nutrient Uptake

The forms of nutrients taken up by plants are the same –

Whether the source of the nutrients is the soil, an organic fertilizer, or a manufactured fertilizer.

But, our management must maintain soil organic matter over the long run.

The nation that destroys its soil, destroys itself.

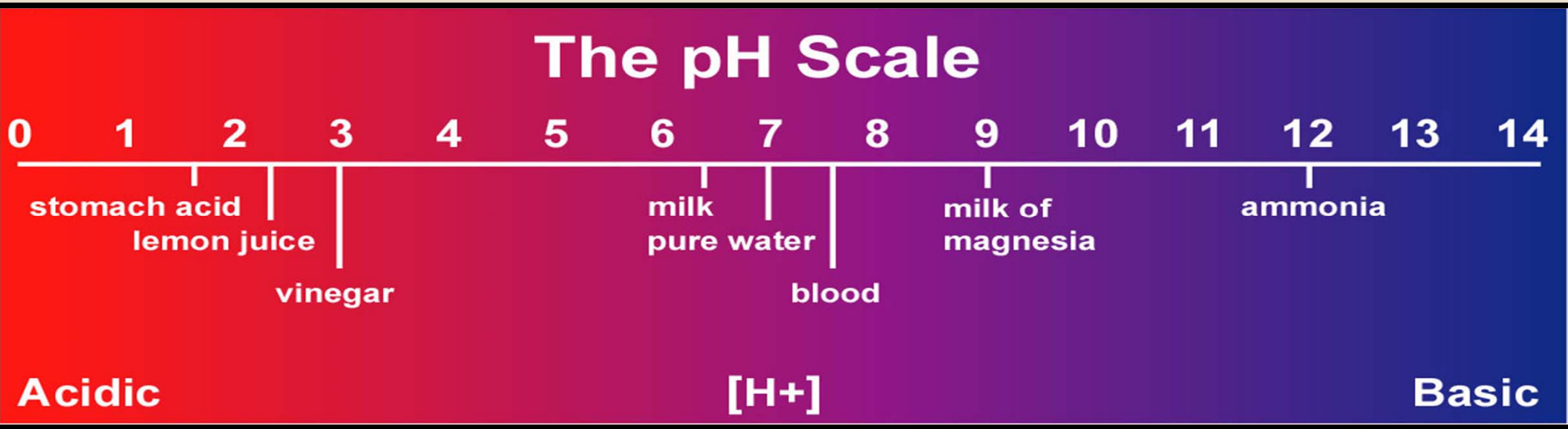
-Franklin Delano Roosevelt

Agronomic Rate Goals

- **Environmental**:
  Balance crop N demand with plant-available N to prevent nitrate leaching.
- **Economic**:
  Provide enough N for near maximum yield and quality of crop.

Soil pH

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



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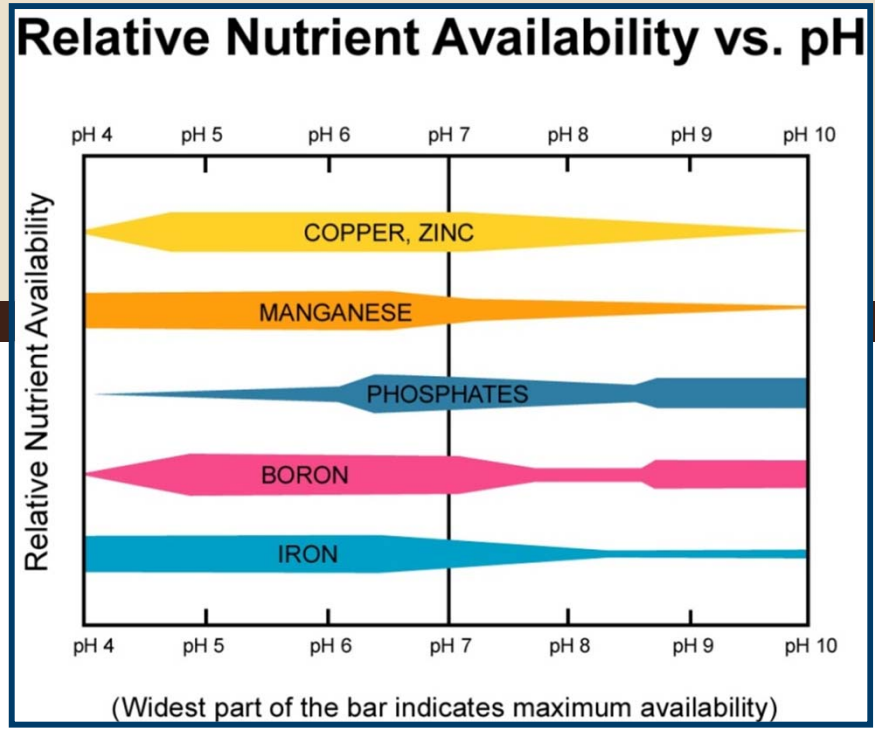
Why is pH Important?



- Nutrient availability
- Availability of toxic metals
- Microbiological activity

Biosolids and Soil pH

- Mineralization of organic N and S causes decline in pH (more acid)
- Alkaline-stabilized biosolids increase soil pH (liming effect)

Soil Testing

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What Is a Soil Test?

- A chemical evaluation of the nutrient supplying capability of the soil.
- Soil test results are calibrated with crop response research to develop fertilizer recommendations.

Soil Testing

- **Theory**: Extracts “plant-available” nutrients.
- **Results**: Used to predict nutrient availability and need.
- **Biosolids management**: Indicates which biosolids nutrients are needed. Identifies excessive nutrient levels in soil.

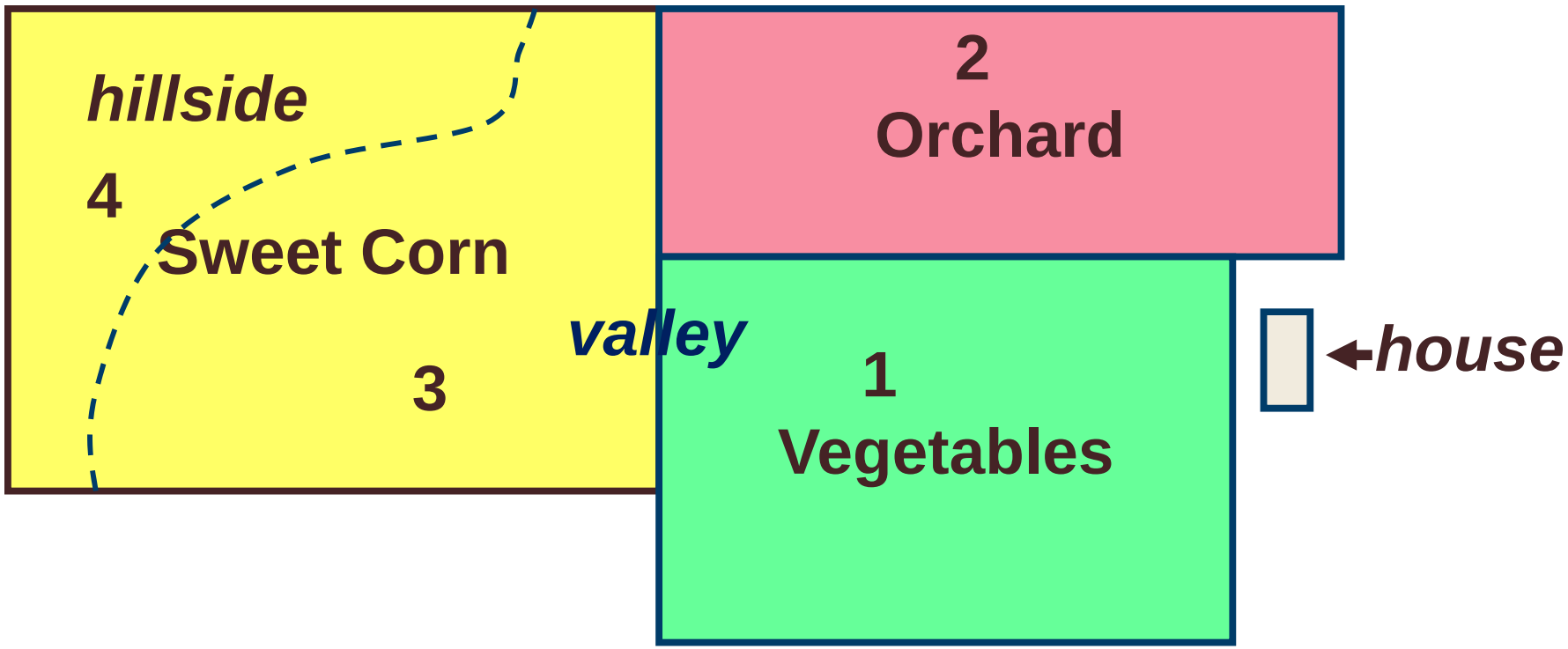
Soil Testing Requirements

- Vary, depending upon your permit
- Most soil testing is voluntary; much of it is useful for biosolids management.

Types of Tests

- **Pre-application tests**: nutrients, metals, (nitrate east of Cascades)
- **Post-harvest nitrate**: a check on application rates.
- **Nutrients**: Check on nutrient sufficiency, biosolids benefits.

Make a Sampling Plan



When to Take a Sample?

- Sample before applying biosolids or fertilizer
- Repeat every 2-3 years

How to Take a Representative Sample?

Take 15-20 small samples!

0-12 inches deep

Mix them in a plastic bucket

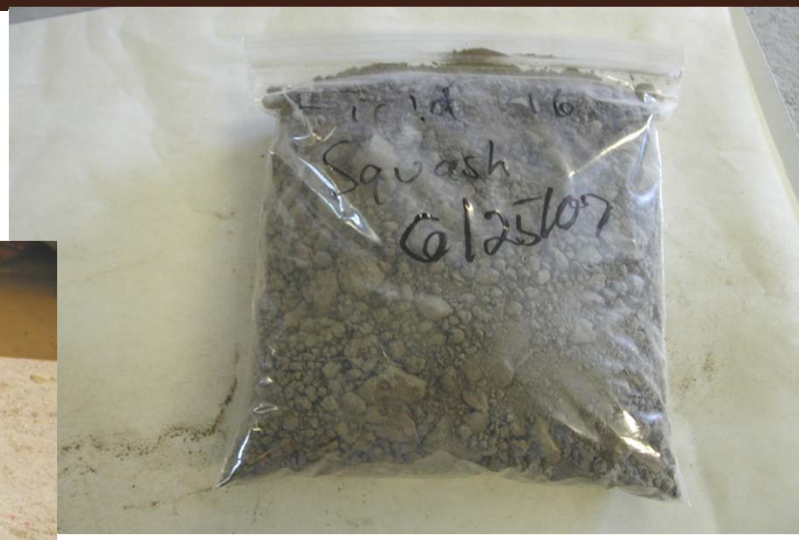
Mix the Sample and Spread It to Dry

Dry it in fresh air

When the Sample is Dry:

Mix it again

Put it in a plastic bag and close the bag



Send it to an agricultural laboratory

How Deep to Sample?

- Nutrients, typically 12 inches.
- Nitrate 12 inches, except for dryland grain production, where entire root zone is sampled.

Choosing a lab

Does the lab routinely do ag tests?

Do they use UI or OSU test methods?

Do they give fertilizer recommendations?

What information do they need?

How to send sample?

Cost?

Turn-around time?

What does report look like?

Quality Assurance

- Does lab participate in proficiency testing program or sample exchange?
- Submit a “known” sample for a check.

Interpreting soil tests

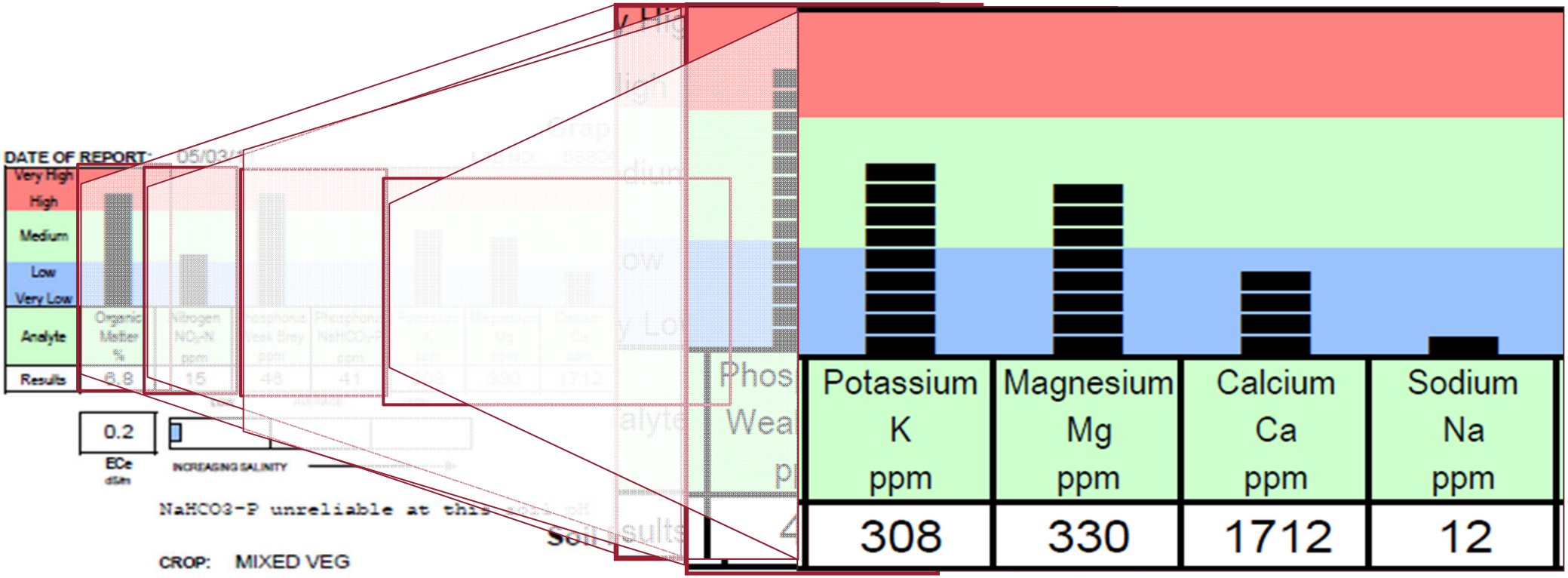
Nutrient status

- Low: fertilizer response likely
- Medium: sometimes a fertilizer response
- High: fertilizer response unlikely

Fertilizer recommendation

Reference: EC 1478. Soil Test Interpretation Guide
Oregon State University. Revised 2011

Soil tests indicate how much of a nutrient is likely to be available to plants



Dolomite 100 score	Lime 100 score	Gypsum	Elemental Sulfur	Nitrogen N	Phosphate P_2O_5	Potash K_2O	Magnesium Mg	Sulfur SO_4-S	Zinc Zn	Manganese Mn	Iron Fe	Copper Cu	Boron B	
	9000			90	40			20	10	10			1.0	

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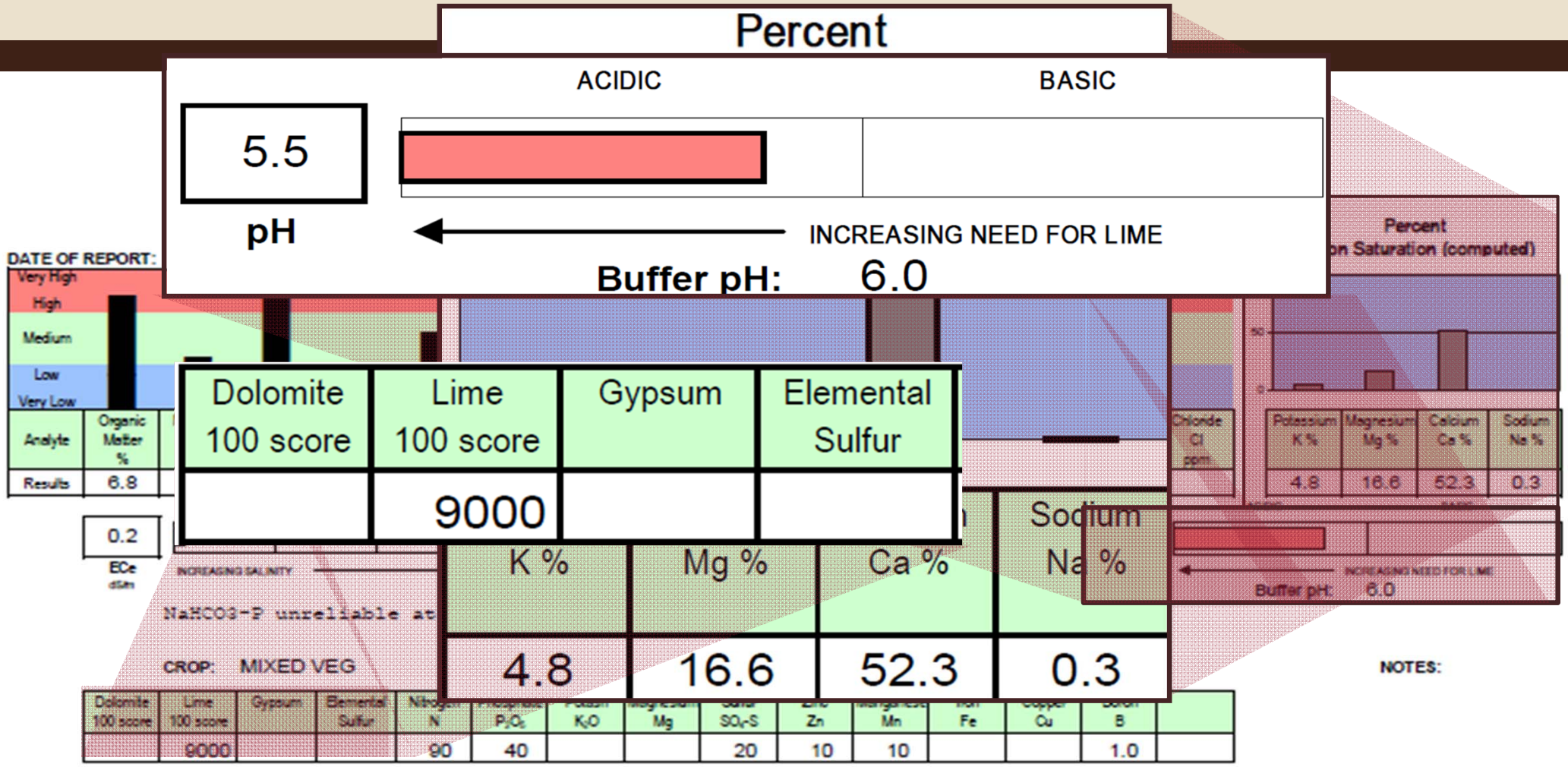
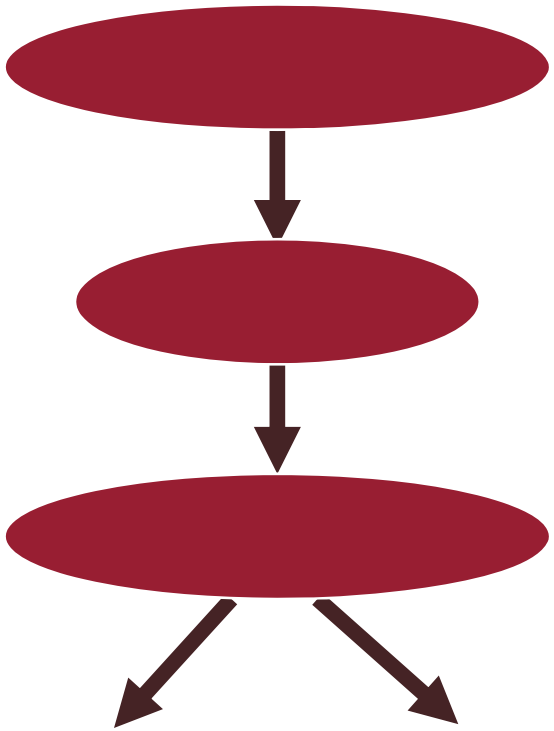


One-Minute Drill



Leaching

Gases → Atmosphere

- What are the three most common forms of nitrogen in soils and soil amendments?
- Which of these forms are available to plants?

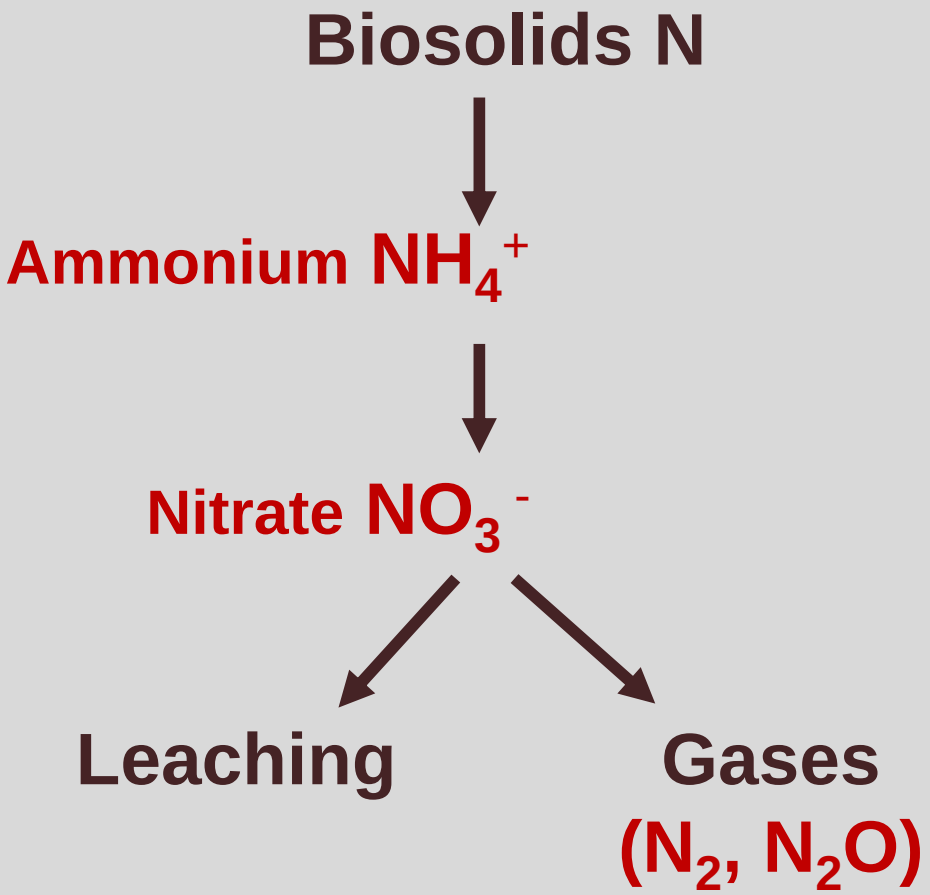
Interpreting Soil Tests

- Nutrient status
  Low, medium, high
- Fertilizer recommendation
- Reference:
  EC 1478. Soil Test Interpretation Guide

Soil Sampling and Interpretation Information

http://www.soils1.org

Click on "*Soils and Soil Testing*" for information on soil sampling and soil test interpretation.



How much N is available from biosolids?

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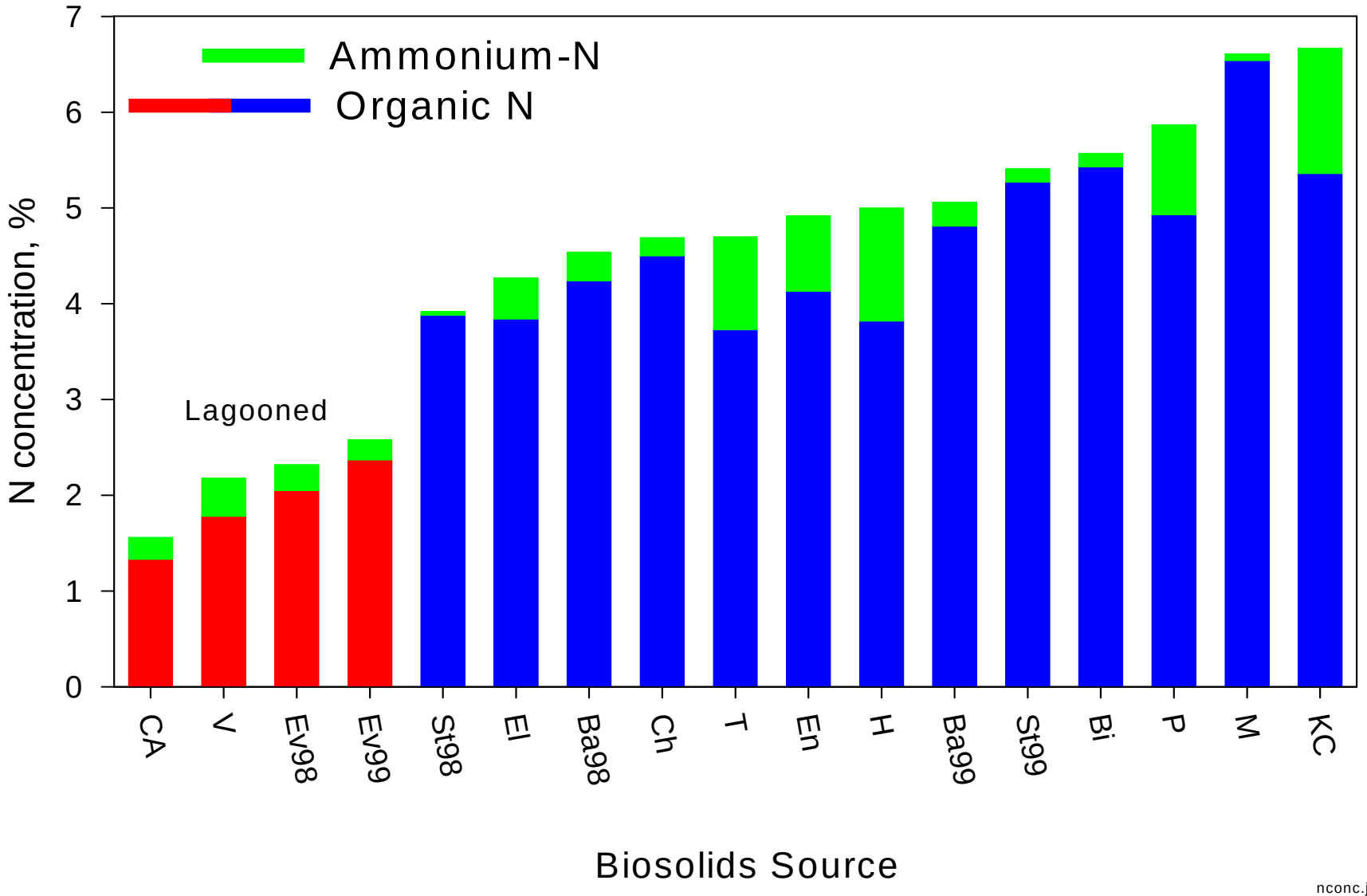
Field Experiment

Biosolids applied to surface at predetermined rates

Grass harvested at 30-45 day intervals during growing season

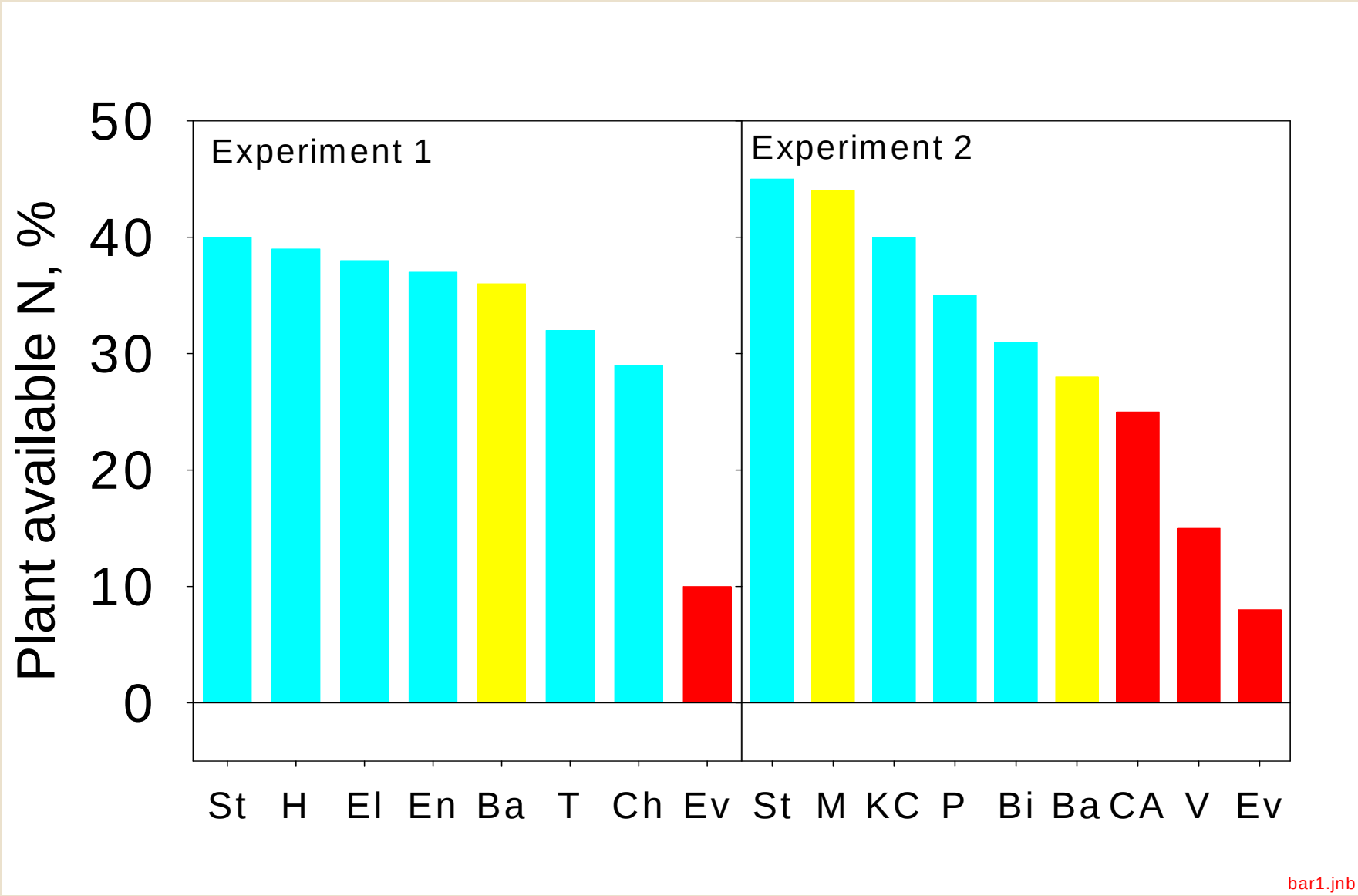
Forage yield, N concentration and N uptake measured. Plant available N calculated

Nitrogen concentration of biosolids



nconc.jnb

Biosolids PAN as % total N. Year 1



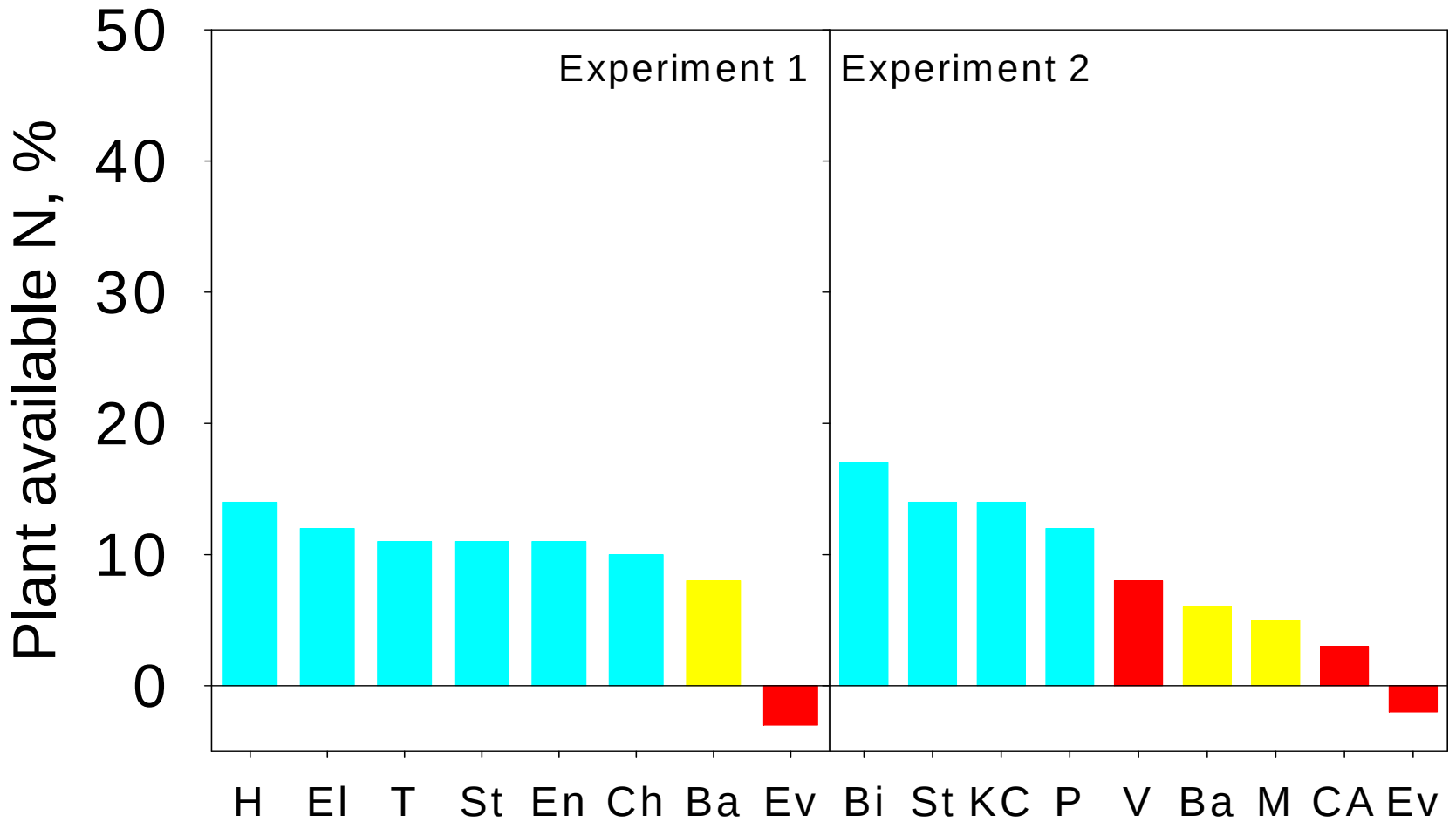
Summary of Year 1

N availability was similar across a range of biosolids treatments:

Year 1 = 37 ± 5% total N

N availability was much lower from lagoon biosolids

Biosolids PAN as % total N. Year 2



Summary, Year 2

Heat dried biosolids had lower PAN than other biosolids in Year 2

Dewatered, air-dried	13 ± 2%
Heat dried	5 to 8 %

Most Year 2 biosolids N was available by April