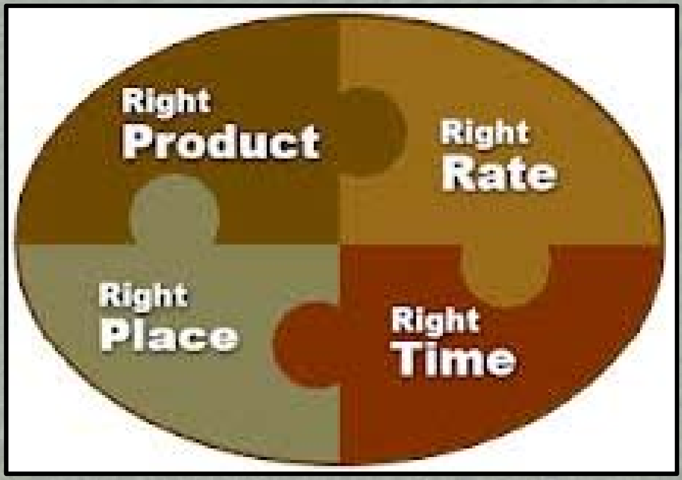
IPNI
International
Plant Nutrition
Institute

Emerging FREP Resources

Rob Mikkelsen, Western Director

4R Nutrient Stewardship — applying the **right** nutrient source, at the **right** rate, **right** time, and **right** place — is an essential tool in the development of sustainable agricultural systems.

4R PLANT NUTRITION



Best practices are dynamic

- Evolve along with science and technology and …
- as practical experience reveals what works locally

Nutrient management practices are nested within cropping systems

- Nutrient effectiveness is greatly influenced by other system management and site factors

- System factors interact with plant nutrition

Decision support tools:

- Help integrate numerous site factors influencing 4R nutrient stewardship
- Should consider short-term and long-term consequence
- Increase in importance as demand for efficiency and productivity increases

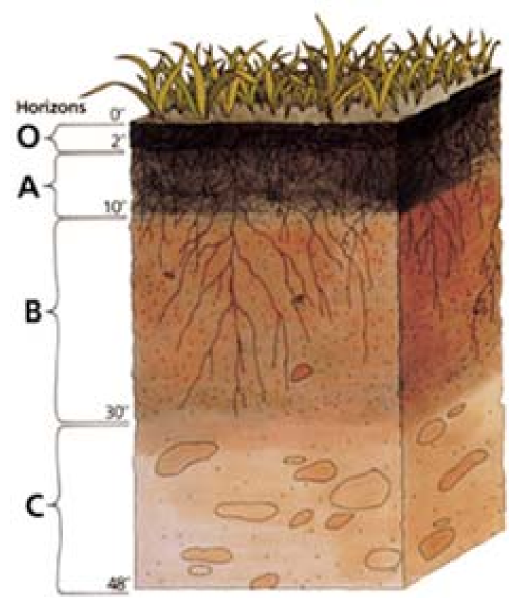
Nutrient demand is related to yield target

- Setting realistic yield targets
- Potential yield
- Maximum attainable yield
- Attainable yield in an average season
- 10% above 3 to 5-year average yield?
- Yield goal is not yield limit
- What is the nutrient need?

Factors affecting nutrient availability	N	P	K	S	Ca and Mg	Micros
Soil pH	x	x	x	x	x	x
Moisture	x	x	x	x	x	x
Temperature	x	x	x	x	x	x
Aeration	x	x	x	x	x	x
Soil organic matter	x	x		x	x	x
Amount of clay	x	x	x	x	x	x
Type of clay		x	x		x	x
Crop residues	x	x	x	x	x	x
Soil compaction		x	x			
Nutrient status of soil		x	x		x	
Other nutrients		x	x		x	x
Crop type	x	x		x		x
Cation exchange capacity (CEC)			x		x	x
% CEC saturation					x	

Fertilizer use efficiency

- Plants cannot utilize 100% of the externally applied nutrients due to inherent sinks and loss mechanisms
- Fixation by inorganic and organic soil components
- Microbial immobilization
- Leaching
- Volatilization



Consider all available nutrient sources

Adjust rates of externally applied nutrients for:

- Native soil supply
- Organic manure
- Irrigation water
- Crop residues
- Biological N fixation

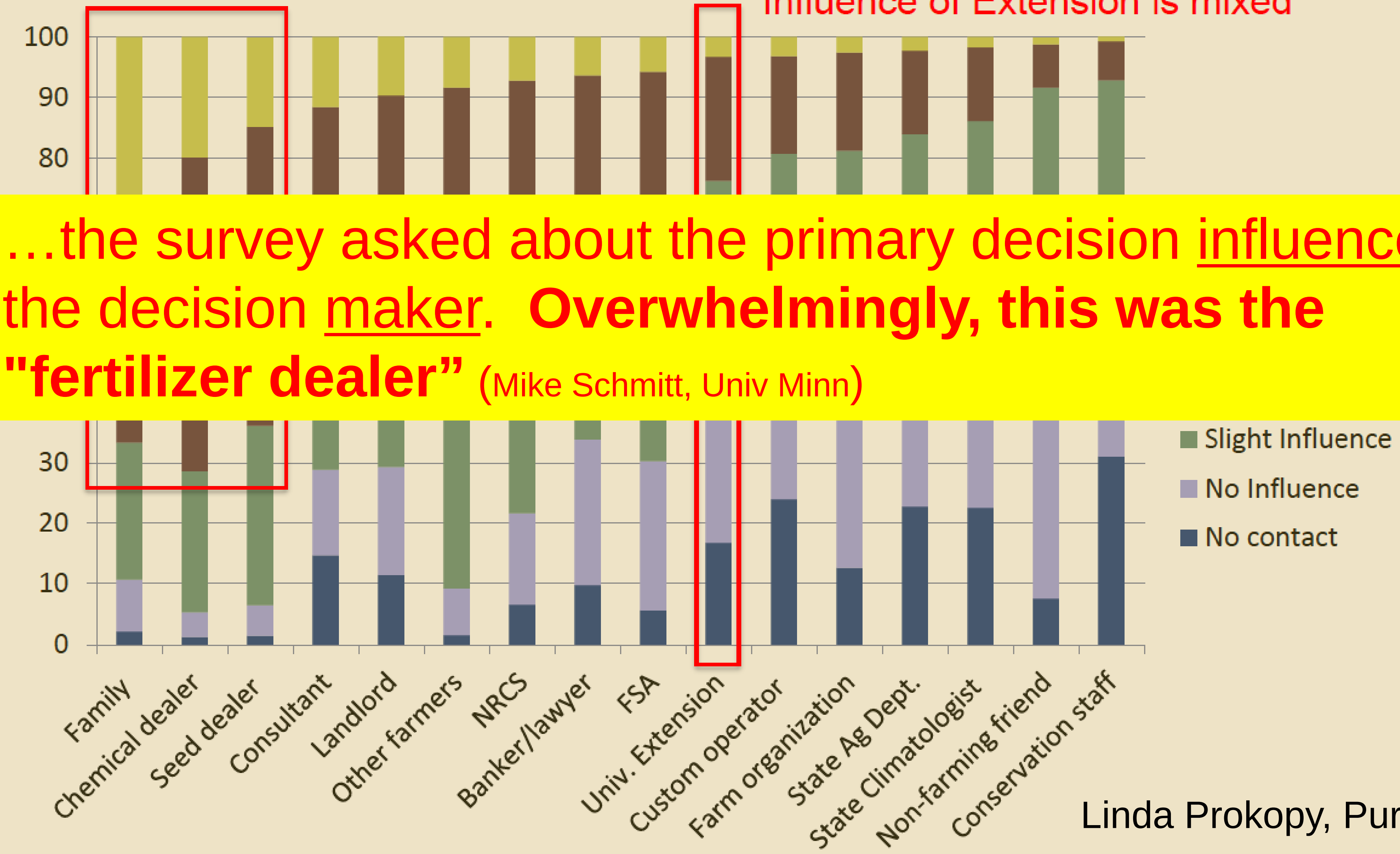
The power of CCA's

Where do farmers get their information?

Please indicate how influential the following groups and individuals are when you make decisions about agricultural practices and strategies. (16 options)

Family, chemical dealers, and seed dealers are most influential

Influence of Extension is mixed



…the survey asked about the primary decision influencer for the decision maker. **Overwhelmingly, this was the "fertilizer dealer"** (Mike Schmitt, Univ Minn)

Linda Prokopy, Purdue

Empower CCA's

Helping farmers get their information!

FREP initiative for providing information
to support nutrient stewardship

Several examples already:

- Crop Fertilization Guidelines
- CCA Nitrogen Management Training
- CropManage
- Western Fertilizer Handbook
- UC Nutrient Management for Vegetable, Fruit and Nut Crops website

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CCA's required to earn 40 hours of continuing education (CEU) every two years.

Currently, the maximum number of self study CEUs in 2-year CCA cycle is 20.

Self study limit will likely increase, more opportunities will be available

NUMBER 1

Nitrogen NOTES

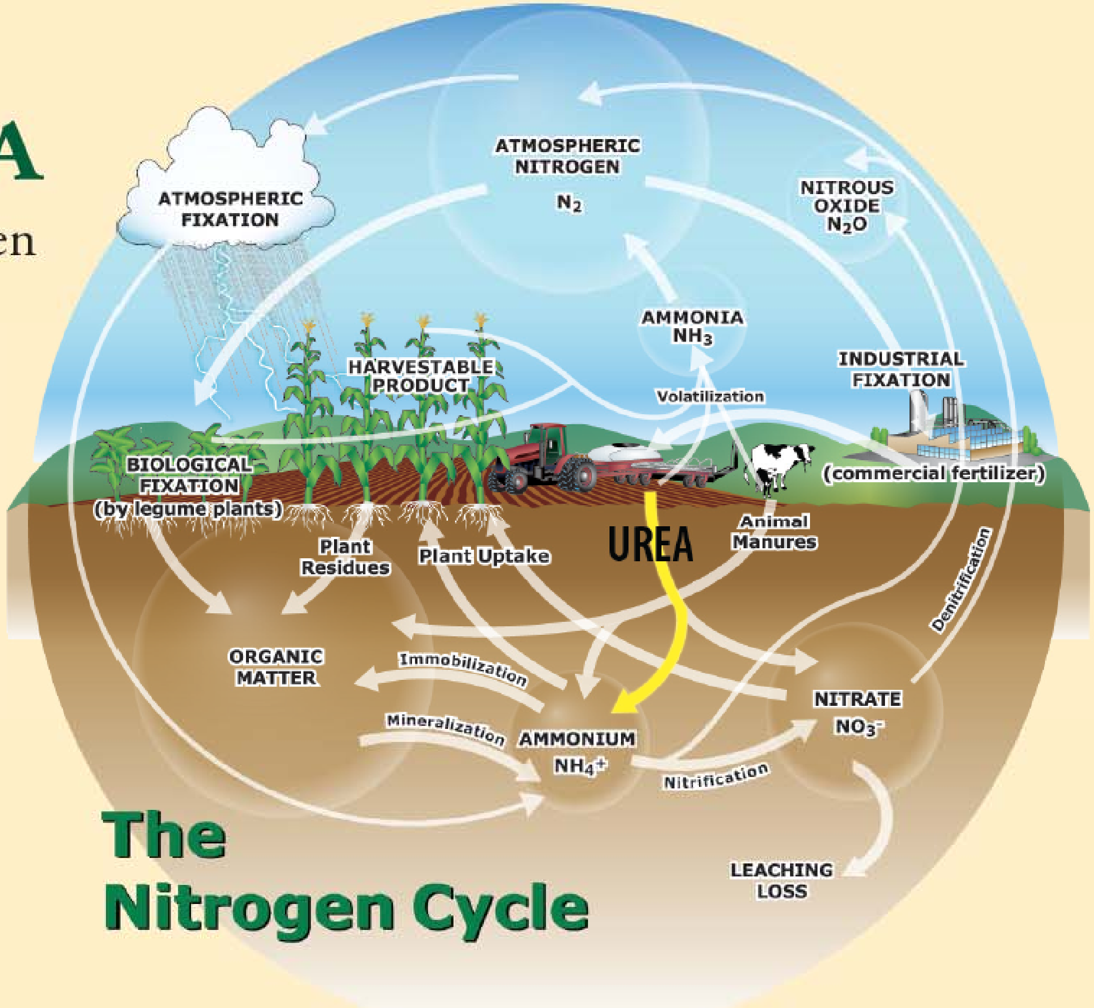
Managing Nitrogen

Examples of new educational materials to help you be successful

IPNI Nitrogen NOTES NUMBER 2

Managing Urea

Urea is the most widely used solid nitrogen (N) fertilizer in the world. Urea is also commonly found in nature since it is excreted in the urine of mammals. The high N content of urea (46% N) makes it efficient to transport to farms and apply to fields. Understanding its behavior is important for getting the maximum benefit from this important plant nutrient.

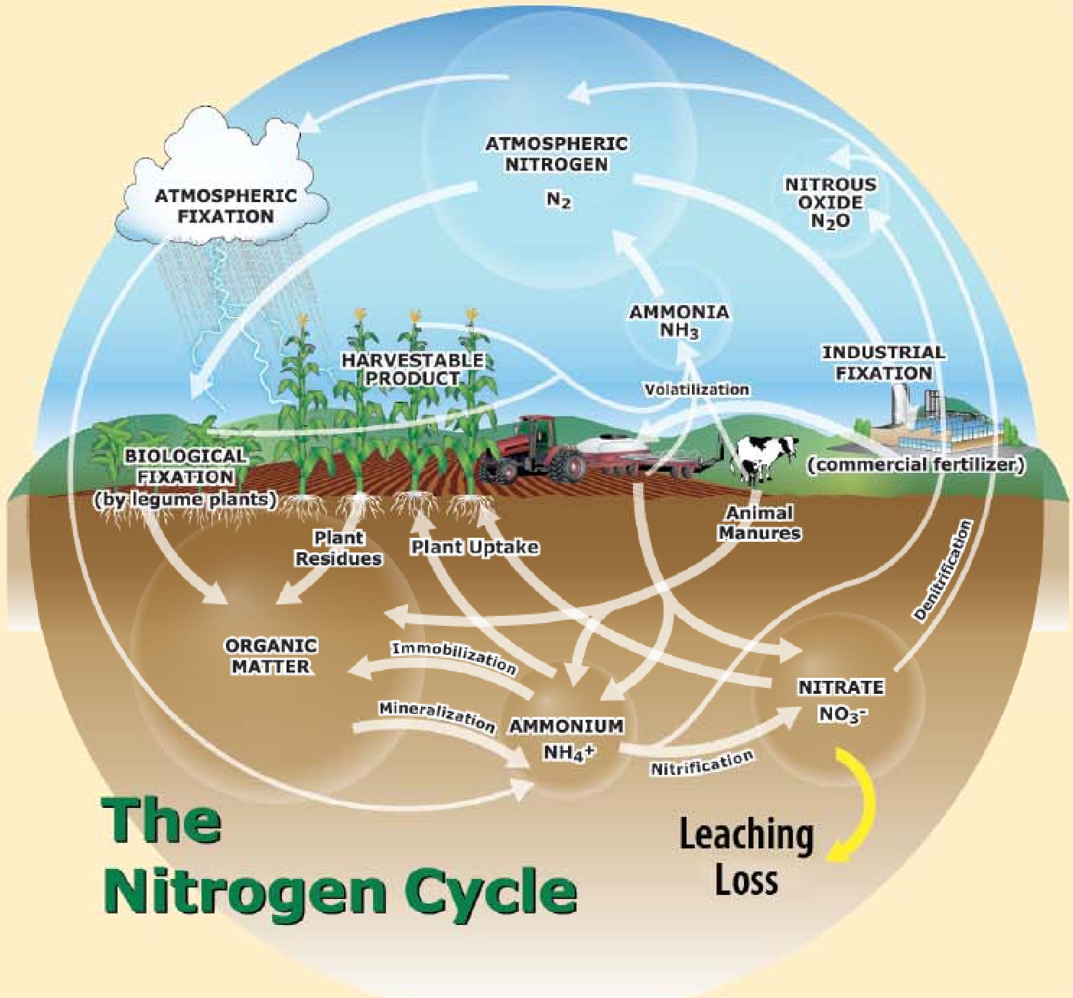


NUMBER 3

Nitrogen NOTES

Nitrate Leaching

Nitrate is critical for supporting plant growth, but it is vulnerable to leaching through soil. For nitrate leaching to occur, (1) nitrate must be present in the soil, (2) the soil must be permeable for water movement, and (3) water must be moving through the soil.

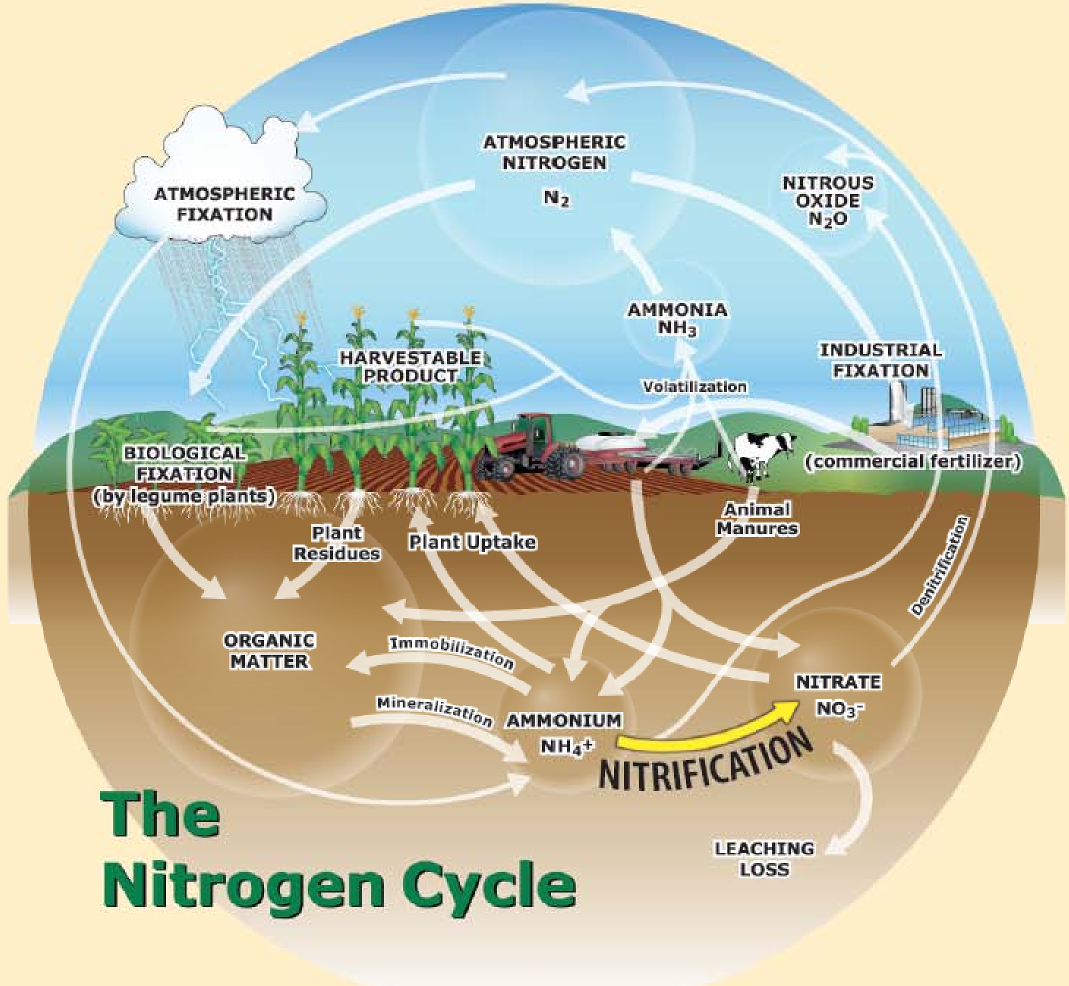


Nitrogen NOTES

NUMBER 4

NITRIFICATION

Nitrification is a two-step conversion of ammonium (NH_4^+) to nitrate (NO_3^-) by soil bacteria. In most soils, it is a fairly rapid process, generally occurring within days or weeks following application of a source of ammonium.



IPNI
Nitrogen NOTES
NUMBER 4

Ammonia Volatilization

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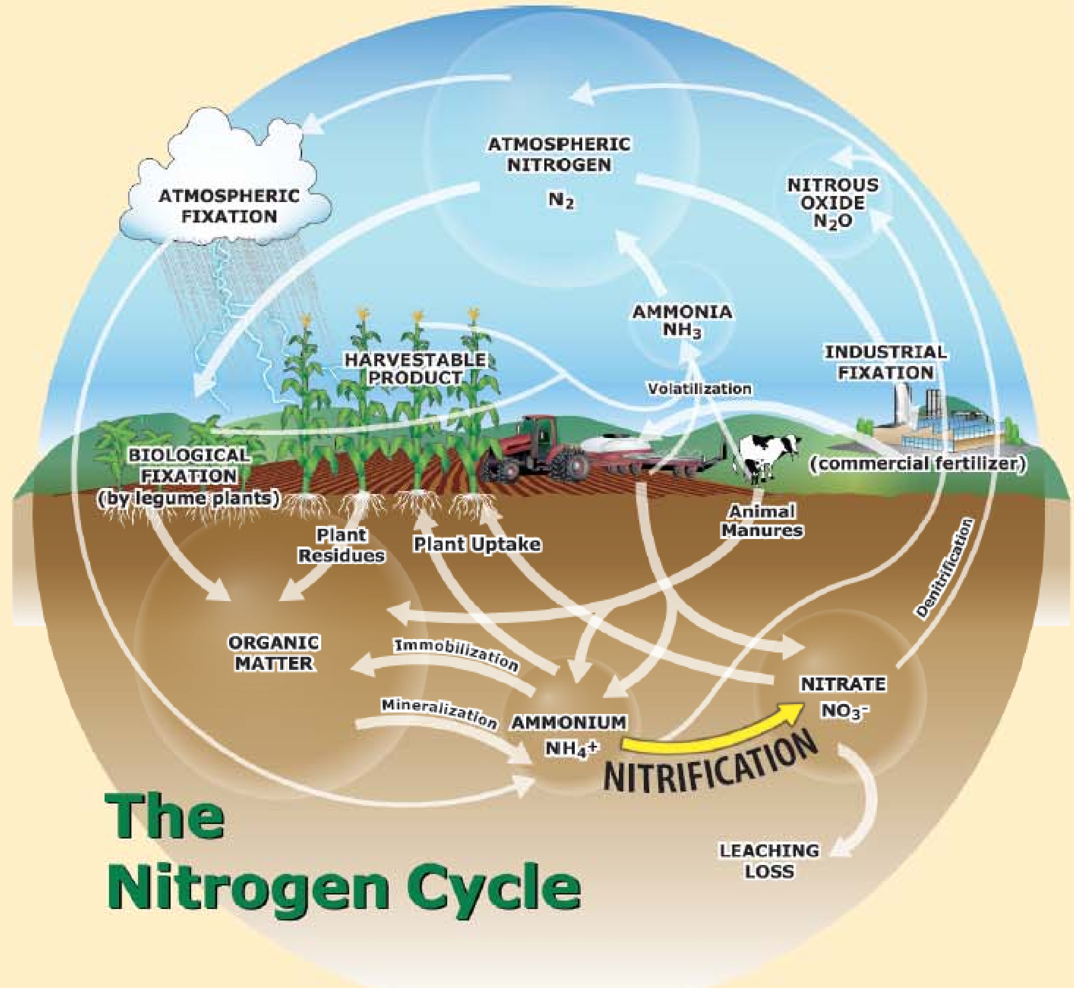

NUMBER 4

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Nitrogen NOTES

DENITRIFICATION

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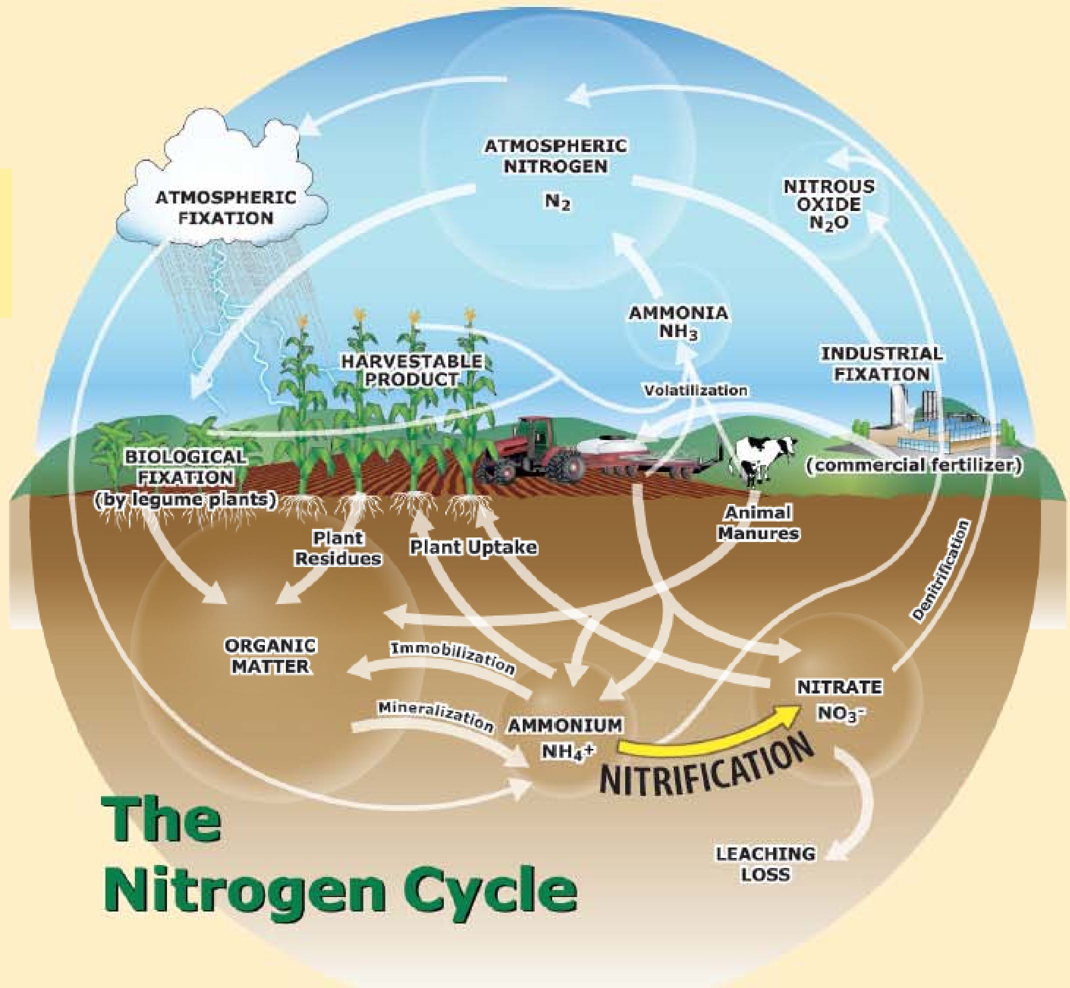

IPNI Nitrogen NOTES
NUMBER 4

MINERALIZATION

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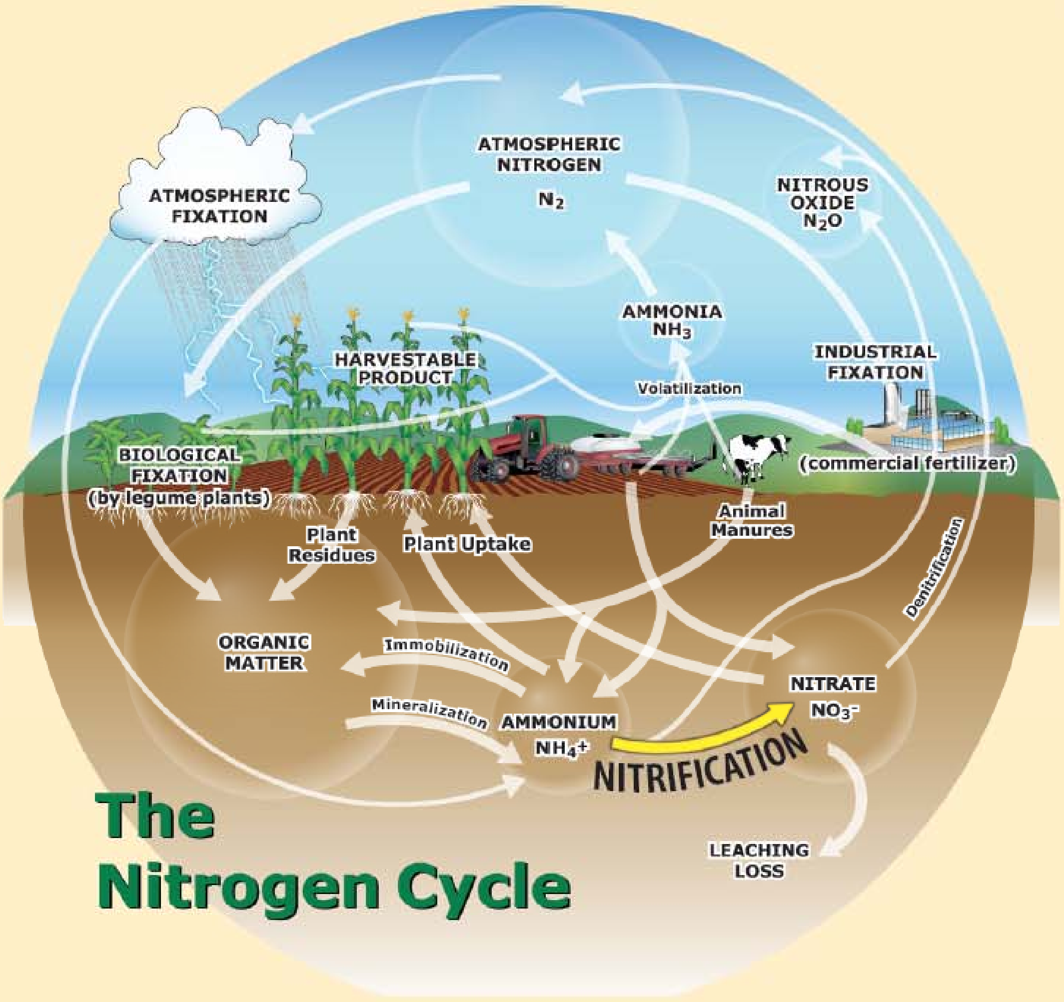

NUMBER 4

Nitrogen NOTES

IMMOBILIZATION

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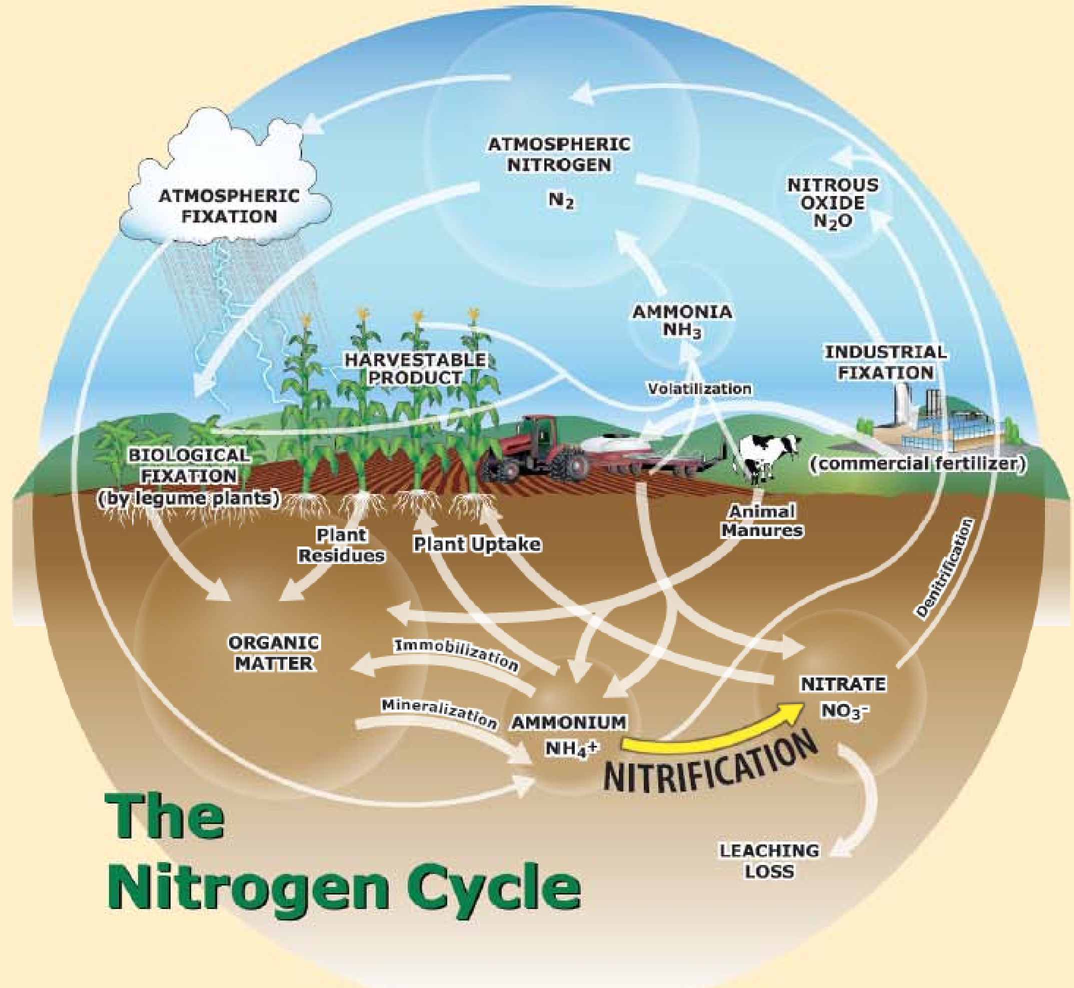

NUMBER 4

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Nitrogen NOTES

PLANT N UPTAKE DYNAMICS

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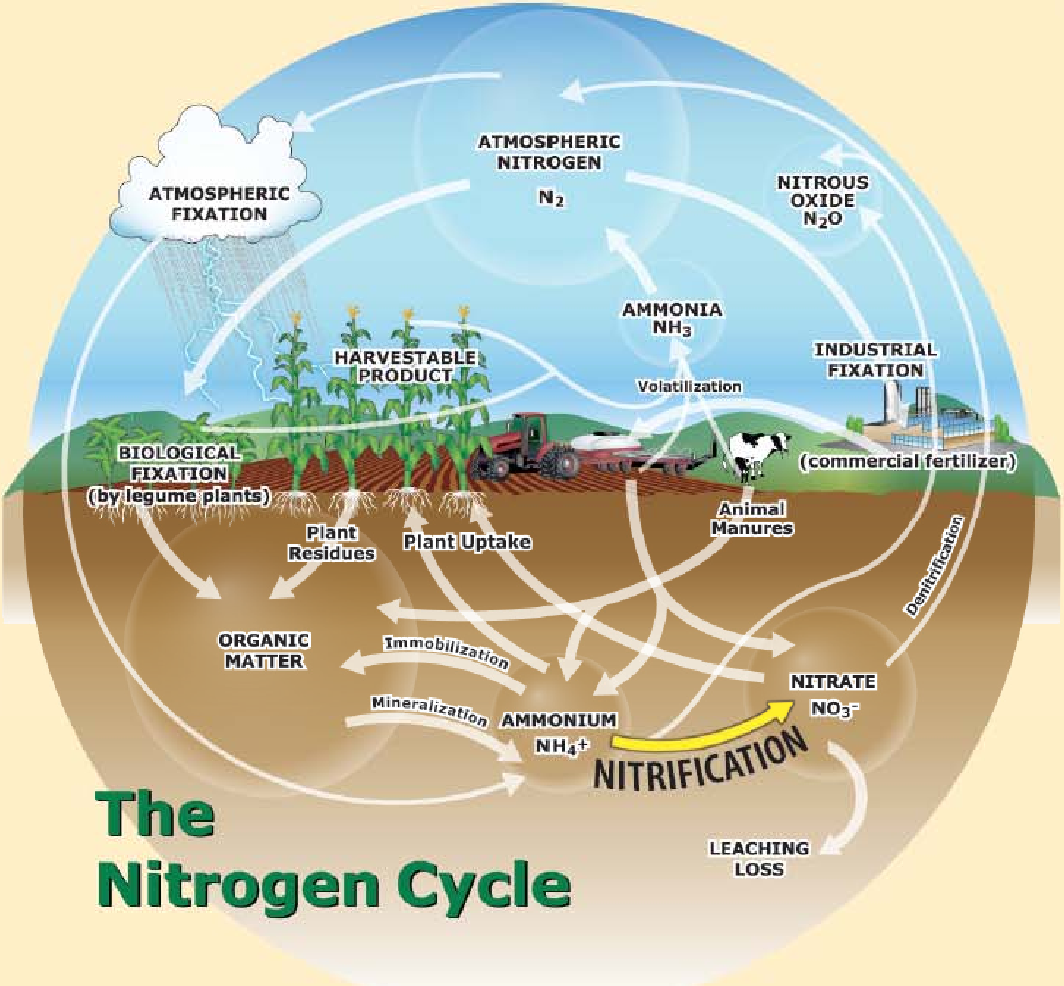

NUMBER 4

Nitrogen NOTES

Cover Crops

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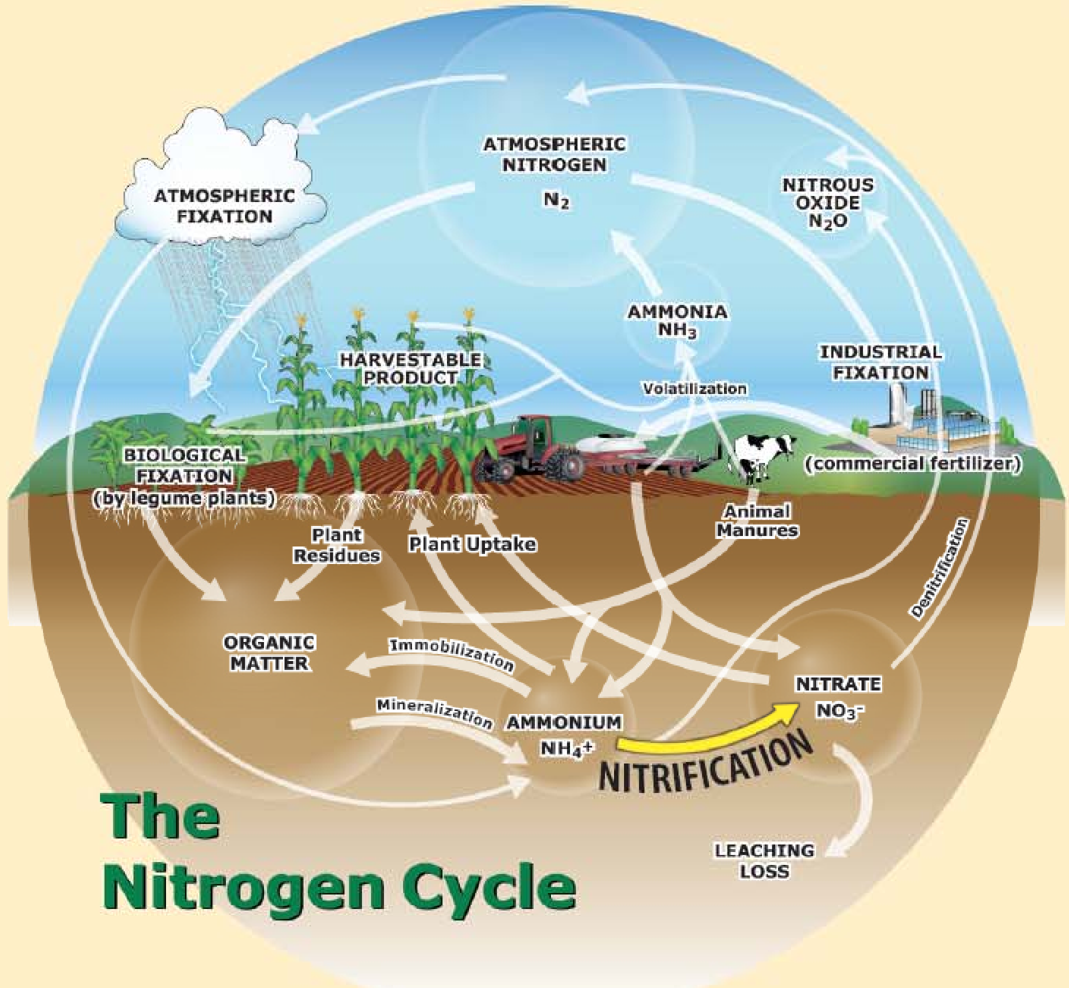

NUMBER 4

Nitrogen NOTES

Using Nitrate in Irrigation Water

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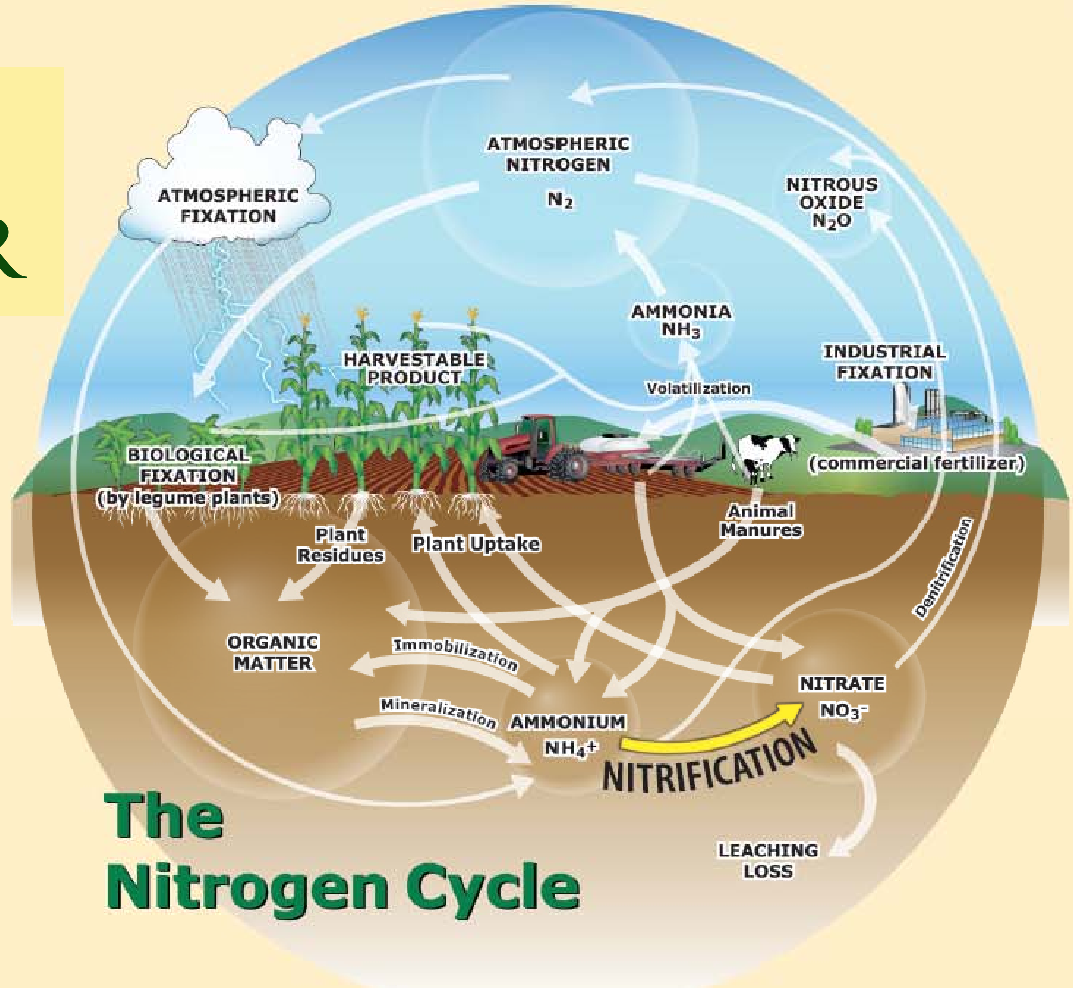

VOLUME 1

MARCH 2013

NUTRIENT MANAGEMENT RESEARCH REVIEW

Celery PROJECT HIGHLIGHTS

This project showed that in general, more frequent watering, with lower volume per application, would dramatically improve water use efficiency.

Minimizing pre-plant and topdressed N, and setting N fertigation programs to reflect actual crop N uptake pattern would improve N use efficiency. Lorem ipsum dolor sit amet, consectetur adipisicing elit, sed do eiusmod tempor incididunt ut labore et dolore magna. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum nulla pariatur.

Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

Drip Irrigation and Fertigation Scheduling for Celery Production

INTRODUCTION

Celery is one of the most heavily fertilized and irrigated vegetable crops grown in California. In recent years the acreage of celery that is produced with drip irrigation has grown substantially. While drip irrigation offers the potential of improving water and nitrogen (N) use efficiency, there has been virtually no relevant research on water or N fertility management of celery under drip irrigation. This project was undertaken to evaluate current industry practices, and to develop appropriate irrigation and N fertigation guidelines for drip-irrigated celery.

METHODS/MANAGEMENT

Field trials were conducted in nine commercial celery fields evaluating current drip irrigation and N fertigation practices employed by the industry. In each field, replicated plots of drip tapes of different flow rate were patched into the field system, some higher and some lower than the flow rate of that system. As each grower applied his standard management practices, graduated amounts of water, and fertigated N, were applied in these plots. In-line water meters and tensiometers were installed to monitor irrigation volume and soil water availability. Soil and crop N status were also monitored. At harvest mean trimmed weight and the degree of pithiness of marketable petioles (an important quality parameter) were determined.

FINDINGS

The growers differed widely in their management strategies. Seasonal water application varied from 120-340% of CIMIS reference evapotranspiration (ET0), average drip irrigation frequency from every other day to once a week. None of the growers based irrigation volume directly on real-time ET0, and at only one site was irrigation delivered throughout the season in rough proportion to historical ET0. Seasonal N fertigation varied from 50-378 lbs/acre. In 5 fields, reducing drip irrigation volume by up to 20% did not affect yield. In the other 4 fields, some level of yield reduction was observed when irrigation volume was reduced below that applied by the grower. However, in most cases yield reduction was more closely associated with transient water stress caused by infrequent irrigation rather than insufficient irrigation volume per se. Unacceptable levels of pithiness of petioles were observed in 3 fields; in 2 of those, irrigation rates above those applied by the grower reduced the problem. Here, too, the problem appeared

cdfa CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE

FREP FERTILIZER RESEARCH AND EDUCATION PROGRAM

WPHA Western Plant Health Association

Interpretative Summaries of FREP Research Projects:

…will be posted on WPHA & FREP websites

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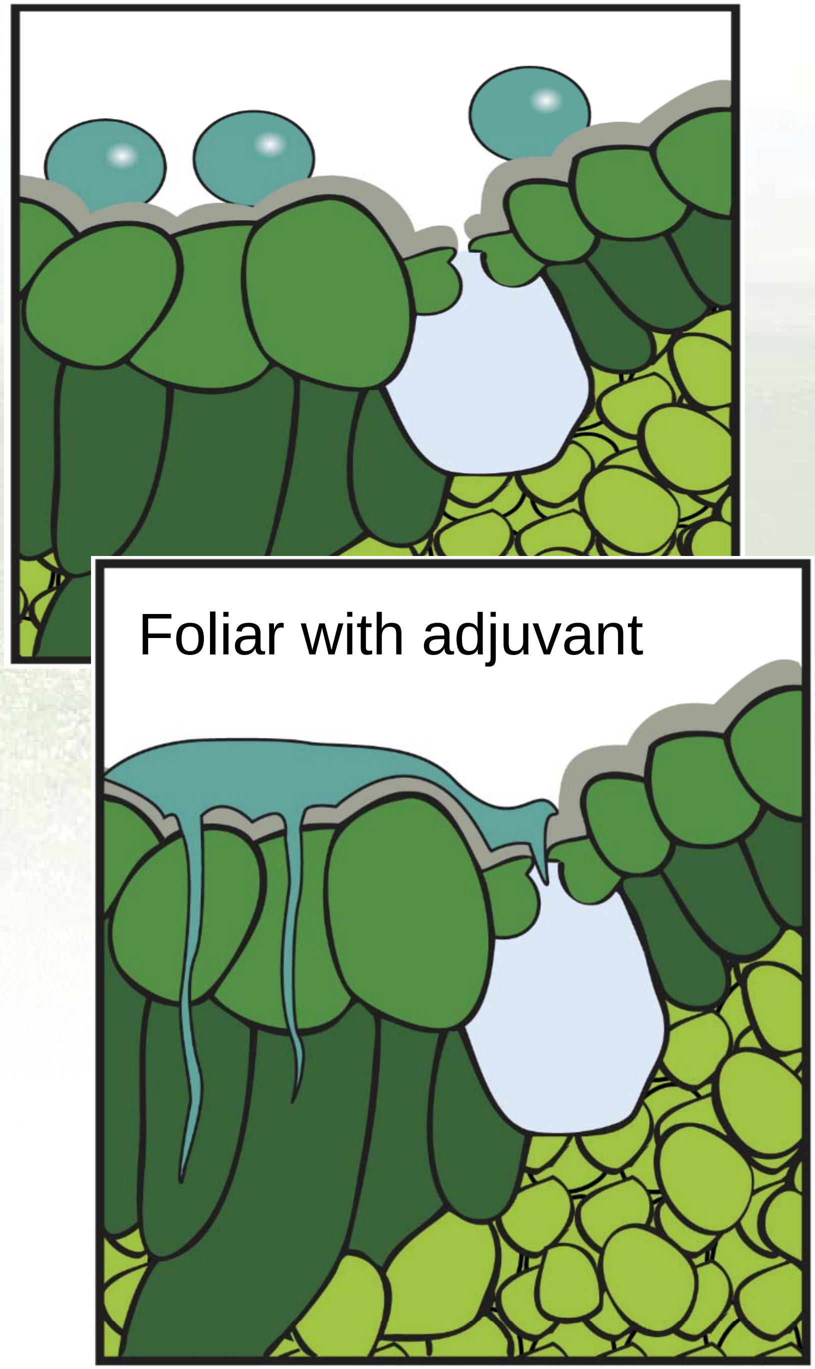
Foliar fertilization

- Nutrients in the gaseous state enter the leaves through the stomata
- Nutrients in solution enter the leaves through small pores in the epidermis of the plant leaf
- Foliar fertilization creates small, localized supplies of nutrients that have a short duration
- Effective when soil supplies are limited



Limitations of foliar fertilization

Factors limiting the effectiveness of foliar fertilization:

- Plants with thicker cuticle layers
- Runoff of fertilizer from leaves
- Washing off of fertilizer by rain
- Drying of liquid fertilizer on the leaf
- Limited translocation of some nutrients within the plant
- Leaf damage

Next in the Nitrogen Management Series:

Applying 4R principles to meet the Nitrogen Demand of Major California Crops

- Almond
- Broccoli
- Citrus
- Corn
- Lettuce
- Rice
- Tomatoes
- Walnut
- Tomatoes

IPNI International Plant Nutrition Institute

WPHA Western Plant Health Association

cdfa California Department of Food & Agriculture

FREP Fertilizer Research and Education Program

Example field information sheet

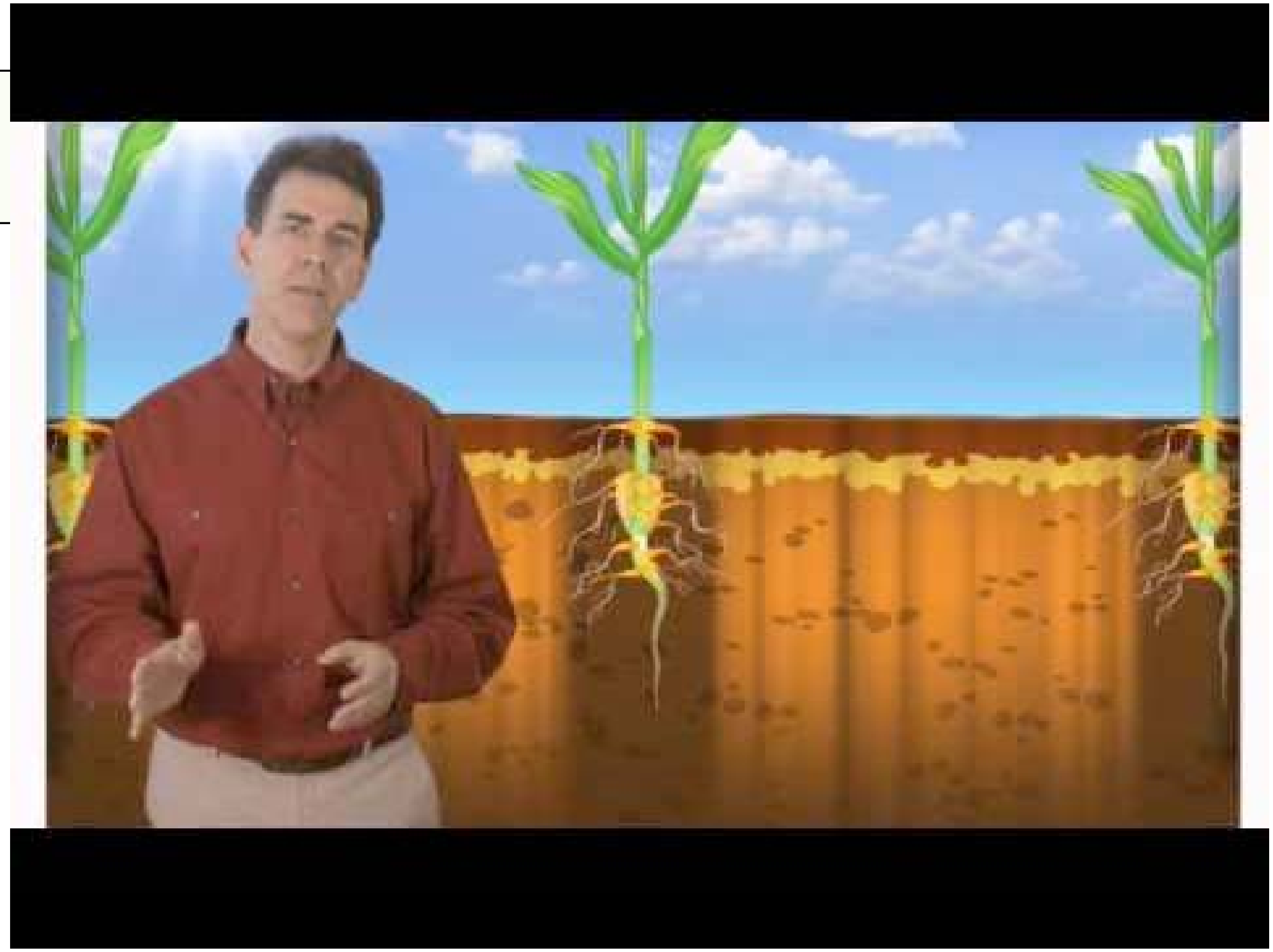
Nutrient Applications Planned (recommended)				
Application	RIGHT SOURCE (analysis)	RIGHT RATE	RIGHT TIME (date, crop growth stage)	RIGHT PLACE (depth, method)
1				
2				
Nutrient Applied				
Application	SOURCE	RATE	TIME	PLACE
1				
2				

Example field information sheet

Nutrient Balance Summary				
	N	P_2O_5	K_2O	S
Applied				
Uptake				
Removal				

Western Plant Health Association

Video outreach



CCA-targeted videos covering high-priority FREP research projects

Welcome

Introduction

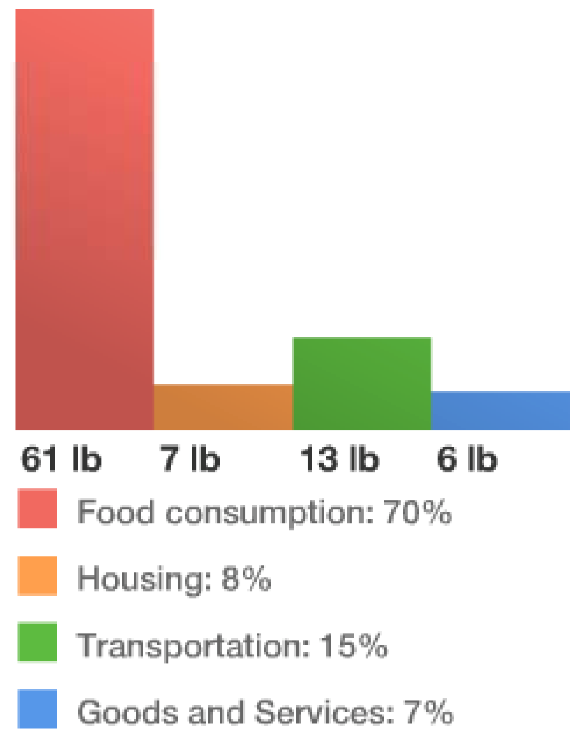
Welcome to the Nitrogen Footprint Calculator! A nitrogen footprint is a measure of the amount of reactive nitrogen* released to the environment as a result of human activities.

Most people are aware of the dangers of releasing CO2 into the environment, but did you know that it is just as dangerous to release too much nitrogen? The human use of nitrogen through agriculture, energy use, and resource consumption has profound beneficial and detrimental impacts on all people. The beneficial impacts include food produced by nitrogen fertilizer. However, in areas that already have a lot of nitrogen, excess nitrogen lost to the environment negatively impacts both people and ecosystems. Once lost to the environment, nitrogen cascades through the Earth's atmosphere, forests, grasslands, and waters. This excess nitrogen can lead to smog, acid rain, forest dieback, coastal "dead zones", biodiversity loss, stratospheric ozone depletion, and an enhanced greenhouse effect. This expansive impact makes it important to understand one's nitrogen footprint.

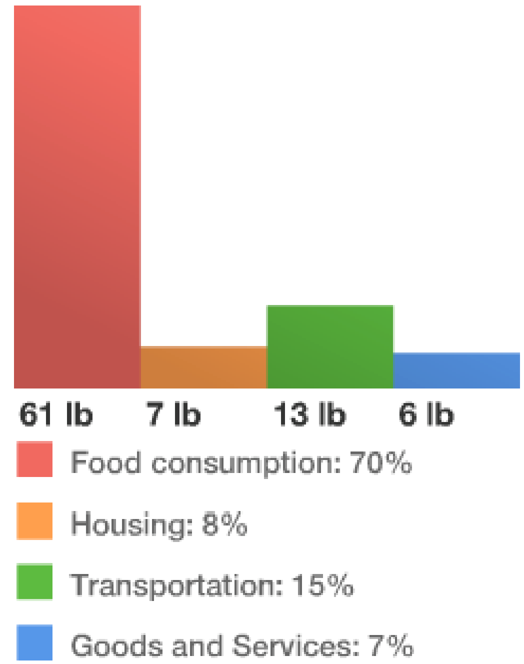
After answering the two questions below, a chart will appear on the right. This chart will initially show the average footprint of a person from the country you selected, but as you answer the different N-

Your country

This is the average footprint for your country.



steak would include the fertilizer applied to the feed crop, the animal waste, the transportation, and all of the other losses throughout the process.



In this section, you will answer questions about your average weekly food consumption. When answering these questions, try to think about the ingredients in your meals. For example, if you consume a piece of pepperoni pizza, you are eating grains (the bread), vegetables (the sauce), pork (the pepperoni), and of course cheese.

Please look at the serving size amounts to help you answer questions about your food consumption. You can also mouse over the word "times" next to the food type to see the average serving size. The default numbers below are the average for your country.

On average, how many times a week do you consume:

Poultry meat — 4 times

Pork — 2 times

Beef — 3 times

Fish and seafood — 2 times

Milk and other dairy products — 20 times

Cheese — 6 times

Wheat and other grains	14 times
Rice	1 times
Vegetables	7 times
Fruit	8 times
Beans and other legumes	0 times
Potatoes	4 times
Nuts	2 times
Cups of coffee and tea	9 cups
Alcoholic beverages	7 glasses

Housing

Your housing choices influence your nitrogen footprint because they determine how much fuel is burned to accommodate your lifestyle. Electricity use and natural gas for heating both generally require the burning of fossil fuels, which then emit reactive forms of nitrogen like nitrogen oxides (NOx) and nitrous oxide (N2O) to the atmosphere. The state that you live in also affects how much nitrogen is released because different states burn fuels with different intensities.

In this section, you will answer questions about the energy use in your home. If you do not know the utility usage in your household, then use the following general guide:

Apartment or small home:
Electricity use is about 600kWh/month, and natural gas use is about 3,531ft^3/month

Average home:
Electricity use is about 900kWh/month, and natural gas use is about 6,357ft^3/month

Large home:
Electricity use is about 1,200kWh/month, and natural gas use is about 8,829ft^3/month

On average, how many kWh of electricity does your household use each month? 990 kWh

What state do you live in? California

On average, how much natural gas does your 6500 ft^3

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Transportation

Although some exceptions like electric cars do exist, most vehicular forms of transportation require that a fuel is burned. Burning these fuels releases reactive forms of nitrogen to the atmosphere.

In this section, you will answer questions about your average transportation habits. When thinking about your average use of transportation, try to incorporate both your regular commute and any big trips you take throughout the year, such as vacations.

How many hours do you fly each year? 4 hours

On average, how far do you travel by bus or rail each week? 5 miles

How far do you travel by car each week? 250 miles

What kind of car do you drive? Truck or SUV

Go back | Continue

Goods and Services

Nitrogen is released to the environment as a result of the consumption of goods and services. Goods include clothing, furniture, household appliances, tools, recreational equipment, and other material possessions. Services include water supply, hospital services, postal services, education, and recreational services. Nitrogen is released to the environment for goods and services through fossil fuel burning. This includes the production of goods, the associated transportation, and any energy use necessary for services like electricity.

Since the purchase of goods and use of services is based largely on spending habits, the nitrogen footprint associated with goods and services in this tool is calculated based on your level of spending compared with the average. Consider both your personal income (look up the average annual income in your country here) and spending habits when answering this question.

How would you describe your personal spending on goods and services?

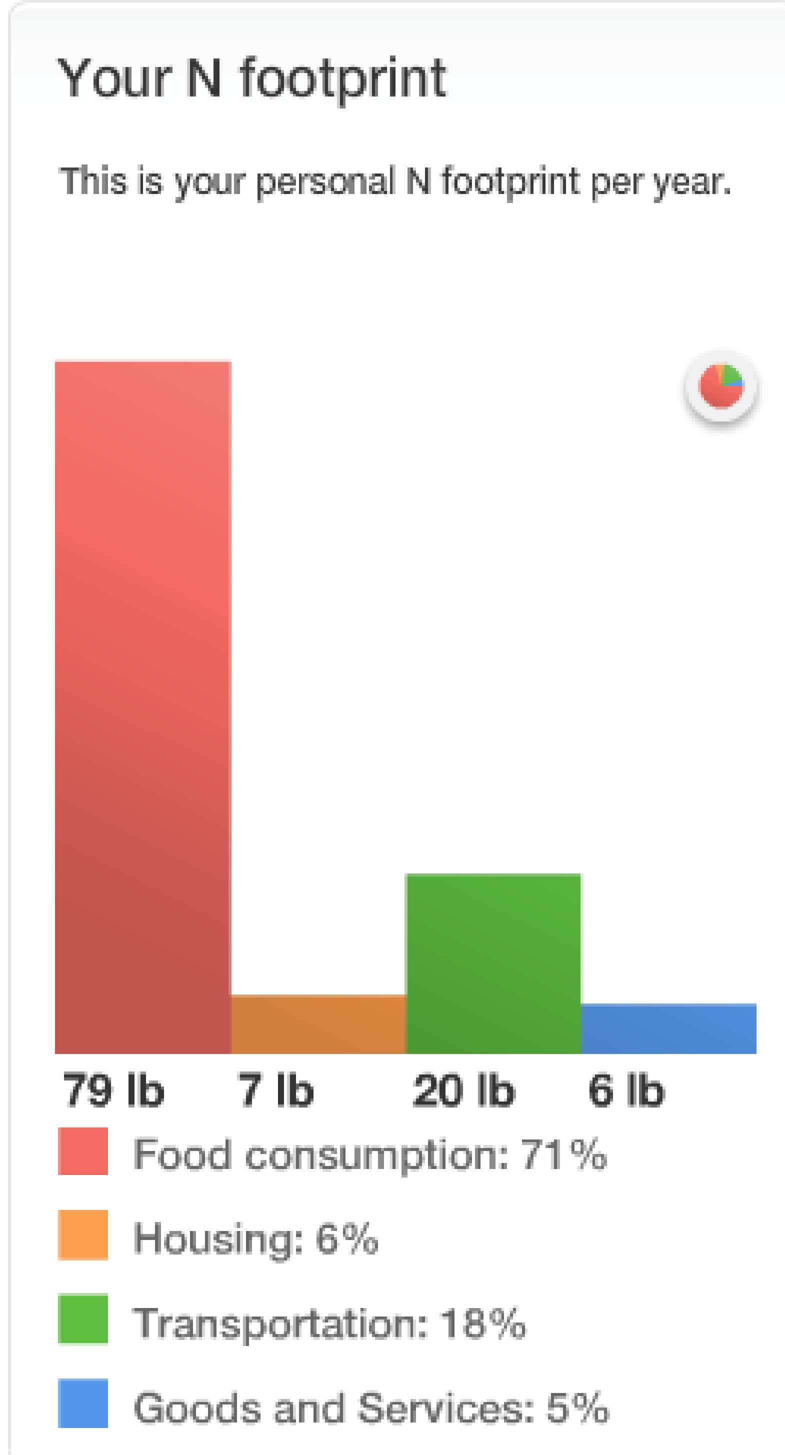
- ○ Less then average
- ● Average
- ○ More then average

Website: Nitrogen footprint

n-print.org

Result

Result	Result
Food	79 lb
Housing	7 lb
Transportation	20 lb
Goods and services	6 lb
Total	**111.27 lb**



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Questions ?

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