Hoop House Issues

PFI 2023
Allen Philo

Typical HH Experience

- Years 1-5, Great!
- Years 5-8, Some issues, declining production compared with years 1-5
- Years 8-11, More and more issues, give up.

What is happening?

- Disease
- Insect Pressure
- Compaction and other physical soil issues
- Fertility
- Soil Chemistry

Disease

- Reduced early blight, septoria, etc.
- Root diseases brought in on seedlings
- Molds diseases-
  - Grey Mold-Botrytis
    - Poor air circulation
    - Improper pH/low Ca
    - Sanitation
  - Tomato White Mold-Scletrotonia
    - Remove effected plants and soil around infected plants
  - Leaf Mold
    - Poor air circulation

http://articles.extension.org/pages/18337/managing-diseases-of-organic-tomatoes-in-greenhouses-and-high-tunnels

Pest Pressure

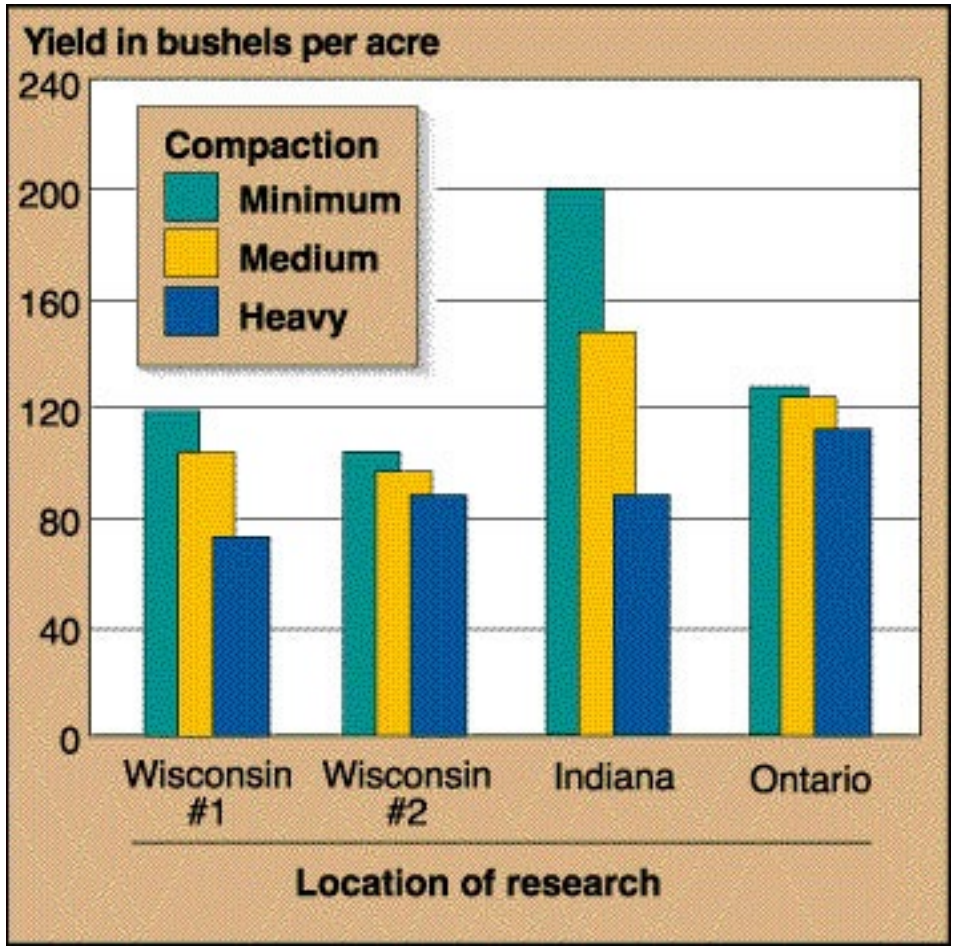
- Takes a year to find it
- What is around the house?
- Regular Control with Organic Pesticides
- Rotation
- Introduce predators
- Screening
  - Can reduce air movement

Physical Soil Issues

- Issues
  - Frequent Foot Traffic
  - Hard to till deeply
  - Soil is sometimes walked on when wet
- Solutions
  - Permanent walkways and beds
  - Build tall enough for a tractor
  - Elevated walkways
    - Can attract slugs

Physical Soil Issues

- Foot Traffic
  - Average human foot exerts 16psi
  - Same as a tractor
  - Exacerbated when wet
- Yield Depression
  - Dependent on soil type
  - Can cut yields in half
- Spread out Weight
  - Tracked tractor exerts 4-7psi
  - Snowshoed human exerts 1psi



https://extension.missouri.edu/publications/g1630

What is happening?

- Disease
- Insect Pressure
- Compaction and other physical soil issues
- Fertility

Fertility - Starting Out

- Balance pH
- Bring K and P levels up to an optimal amount
  - 150ppm K minimum, or between 3-5% base saturation
  - 50ppm Bray 1 Phosphorous Test
- Subsoil

Fertility - Yearly

- How are you addressing N?
  - Compost
  - Fertilizer
  - Fertigation
- Replace P and K
  - Soil Test Yearly
  - Mass balance

Fertility – Issues and Solutions

- Overuse of Compost and Chicken Litter
  - Provides N
  - Too much P and K
  - Can lead to groundwater pollution through excess nitrate leaching
- Solutions
  - Use low P fertilizers
    - Feathermeal 13-0-0
    - Potassium Sulfate 0-0-50
    - K-Mag 0-0-22-11Mg
  - Use liquid forms of N

Fertility – Bulk Applications

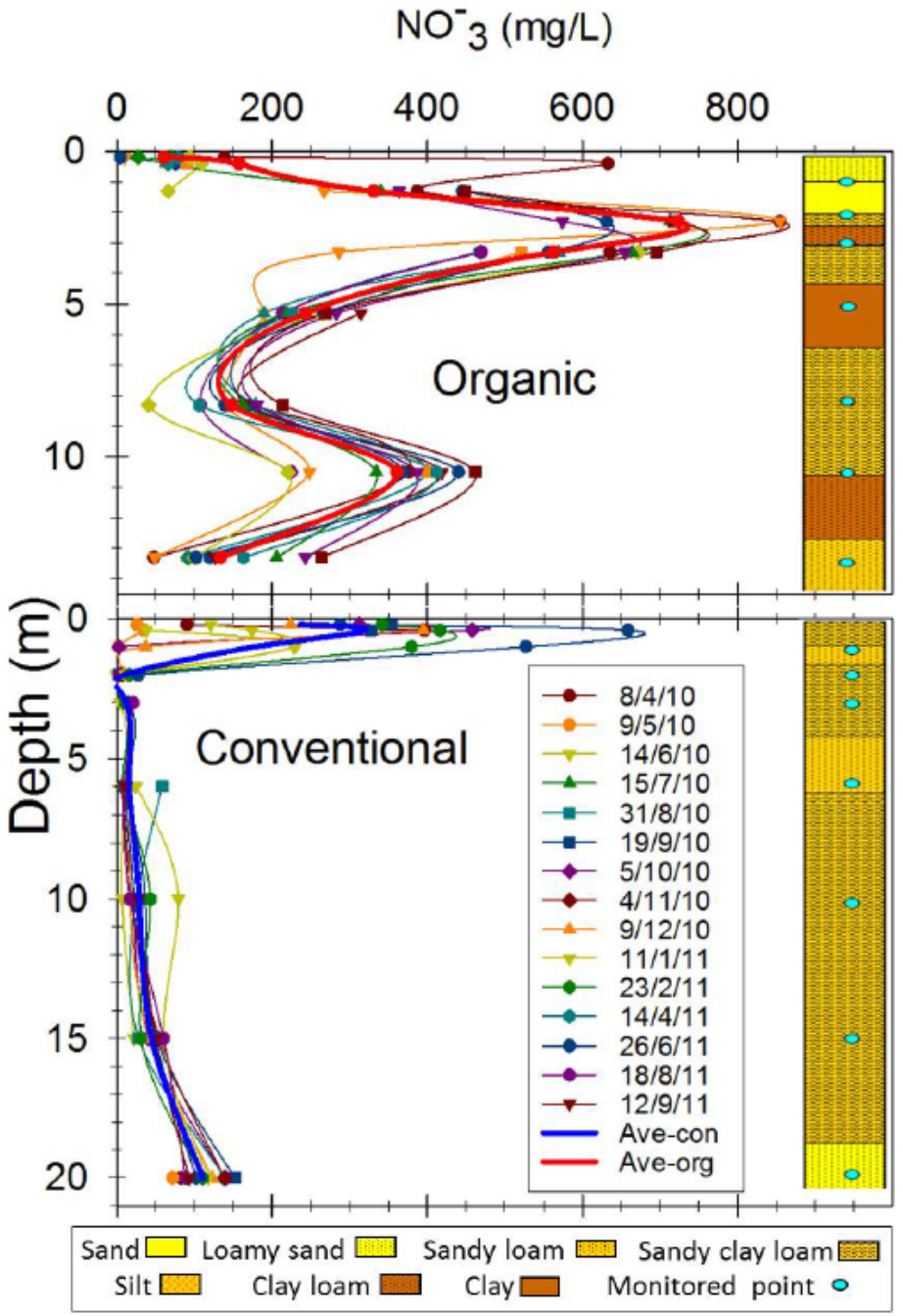
- Compost
  - 1-1-1
  - 10 Ton application
  - Will lead to P buildup
    - Can shut down Zn, Fe and other micros
    - Can lead to P runoff when tunnel is decommissioned
  - Doesn’t supply enough K for Solanaceous crops
    - Apply another 100 lbs of K in another form.

Fertility – Bulk Applications

- Chicken Litter
  - 5-3-2
  - 2 Ton application
  - Will lead to P buildup, but slower than compost
    - Can shut down Zn, Fe and other micros
    - Can lead to P runoff when tunnel is decommissioned
  - Doesn’t supply enough K for Solanaceous crops
    - Apply another 220 lbs of K in another form.

Fertility – Leaching

- Bulk application vs Liquid Fertigation 870lbs N/Acre/Yr
- Organic vs. Conventional
  - Organic 98% of N was supplied by compost or compost guano mix
  - Conventional 45% of N was supplied as compost (in early years) then switched to liquid
- Monitoring
- Water Regime
- Results



Nitrate leaching from intensive organic farms to groundwater
O Dahan, A Babad, N Lazarovitch… - Hydrology and Earth …, 2014 - hess.copernicus.org

Fertility – Leaching

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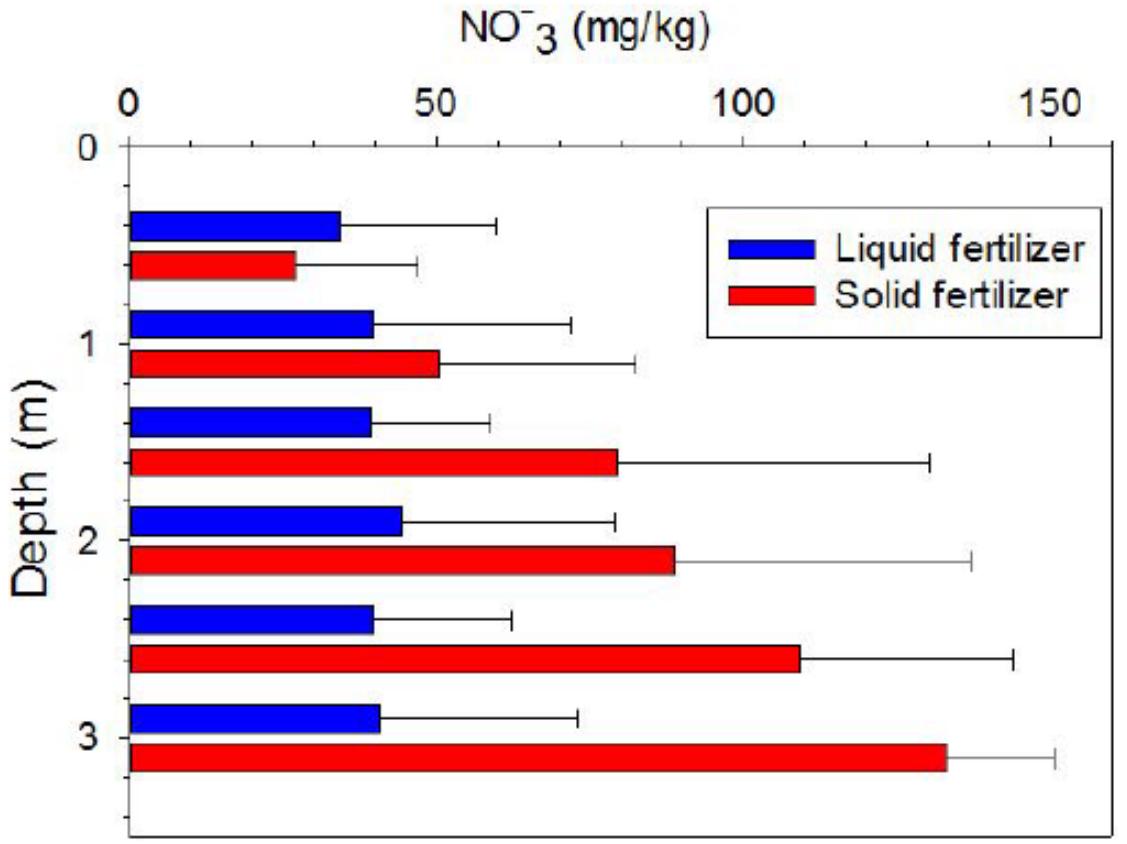


Fig. 8. Nitrate concentrations in the vadose zone underlying greenhouses fertilized by solid fertilizers as compost and guano and liquid fertilizers.

Nitrate leaching from intensive organic farms to groundwa…
O Dahan, A Babad, N Lazarovitch… - Hydrology and Earth …, 2014 - hess.copernicus.org

Fertility –Solutions

- Balance house and build fertility using bulk applications
- Match fertility application to plant needs
- Use a combination of bulk and liquid for N
  - Bulk can help provide micronutrients
  - Food for microbiology

Typical HH Experience

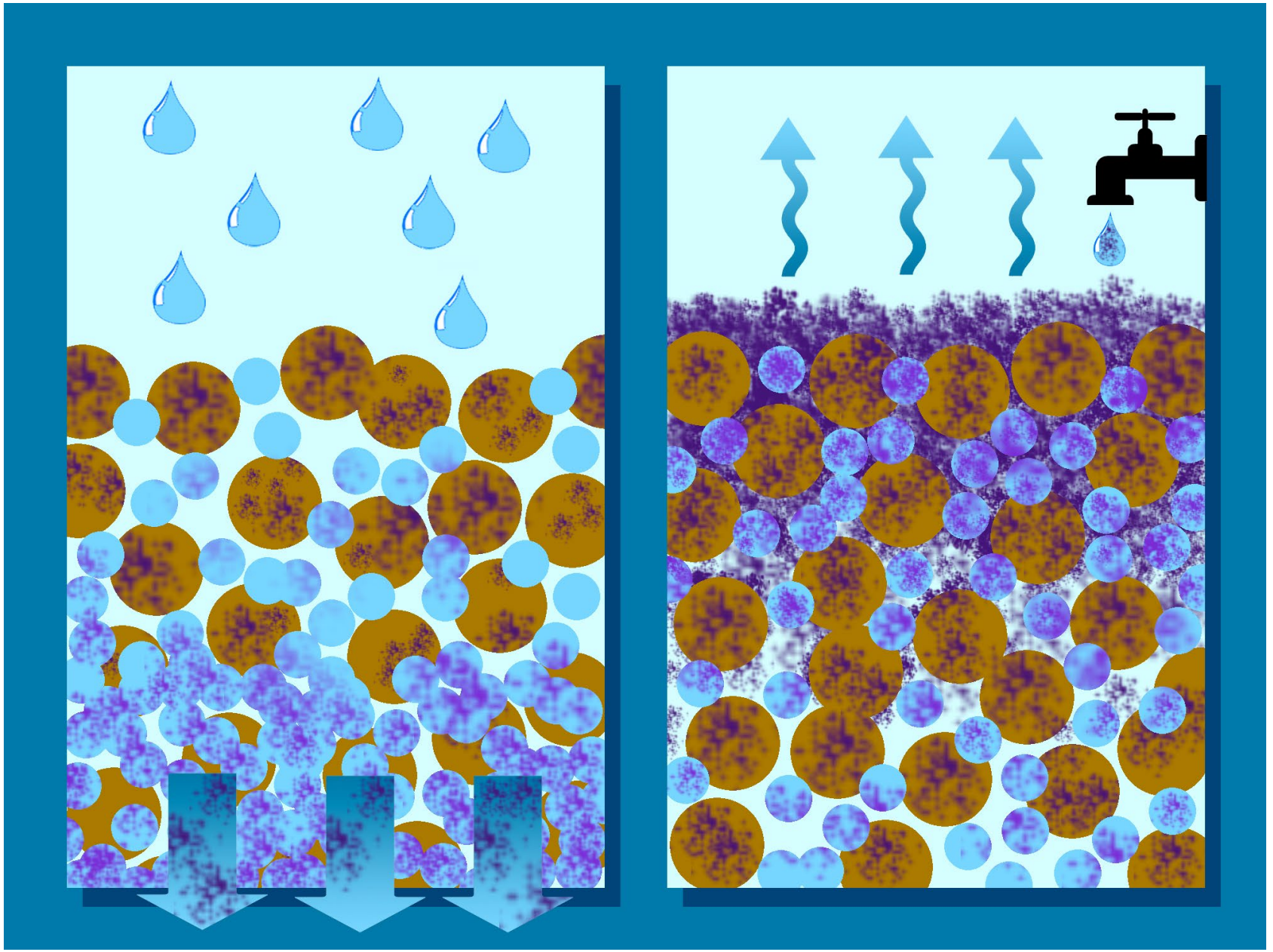
- Years 1-5, Great!
- Years 5-8, Some issues, declining production compared with years 1-5
- Years 8-11, More and more issues, give up.

Now what?

- What changes when you put plastic on?
- Your water regime!
- You have moved to the desert.

Field

Hoop House (Desert)

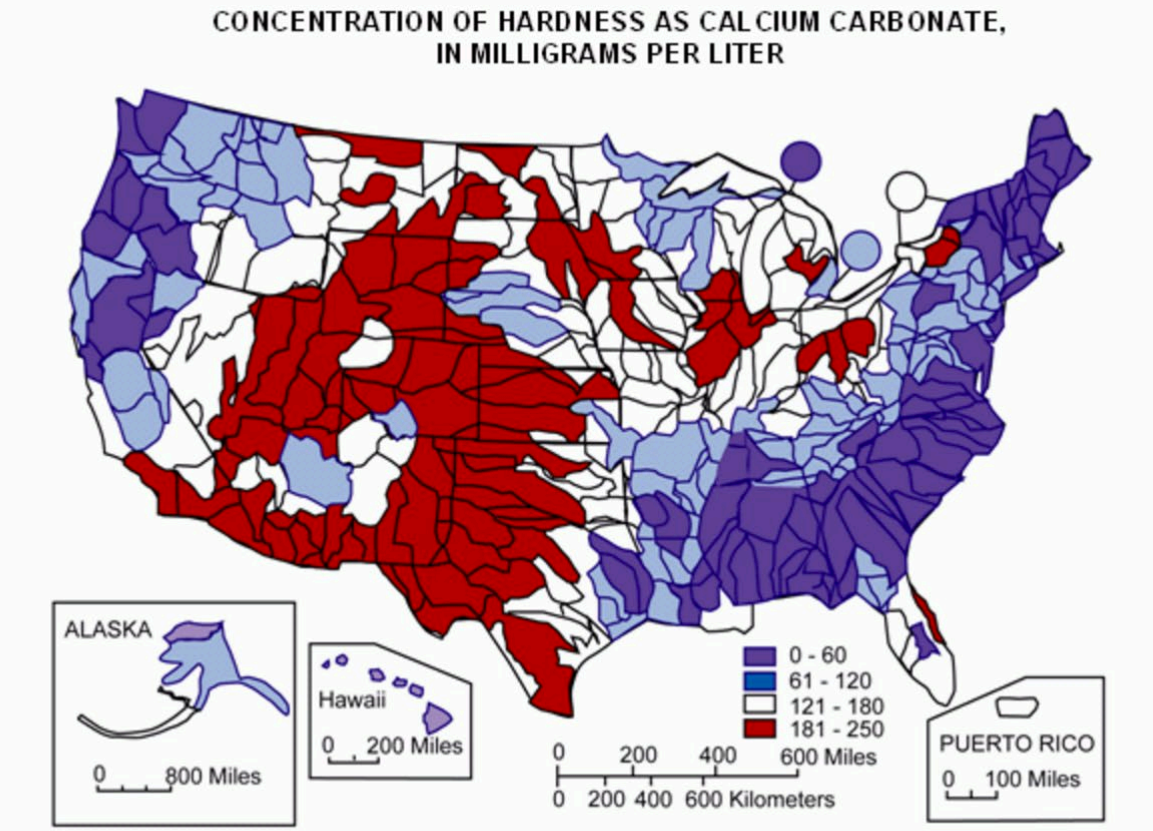


Graphic by Sarah Maxwell

Bicarbonate

Water hardness in the United States

- Many Midwest farms are over a form of limestone
- Rain is naturally acidic (5.6 pH)
- Rain dissolves limestoneto form bicarbonate and enters the groundwater
- When you water with groundwater the water evaporates it leaves behind the bicarbonate which reforms into Calcium Carbonate (Lime)

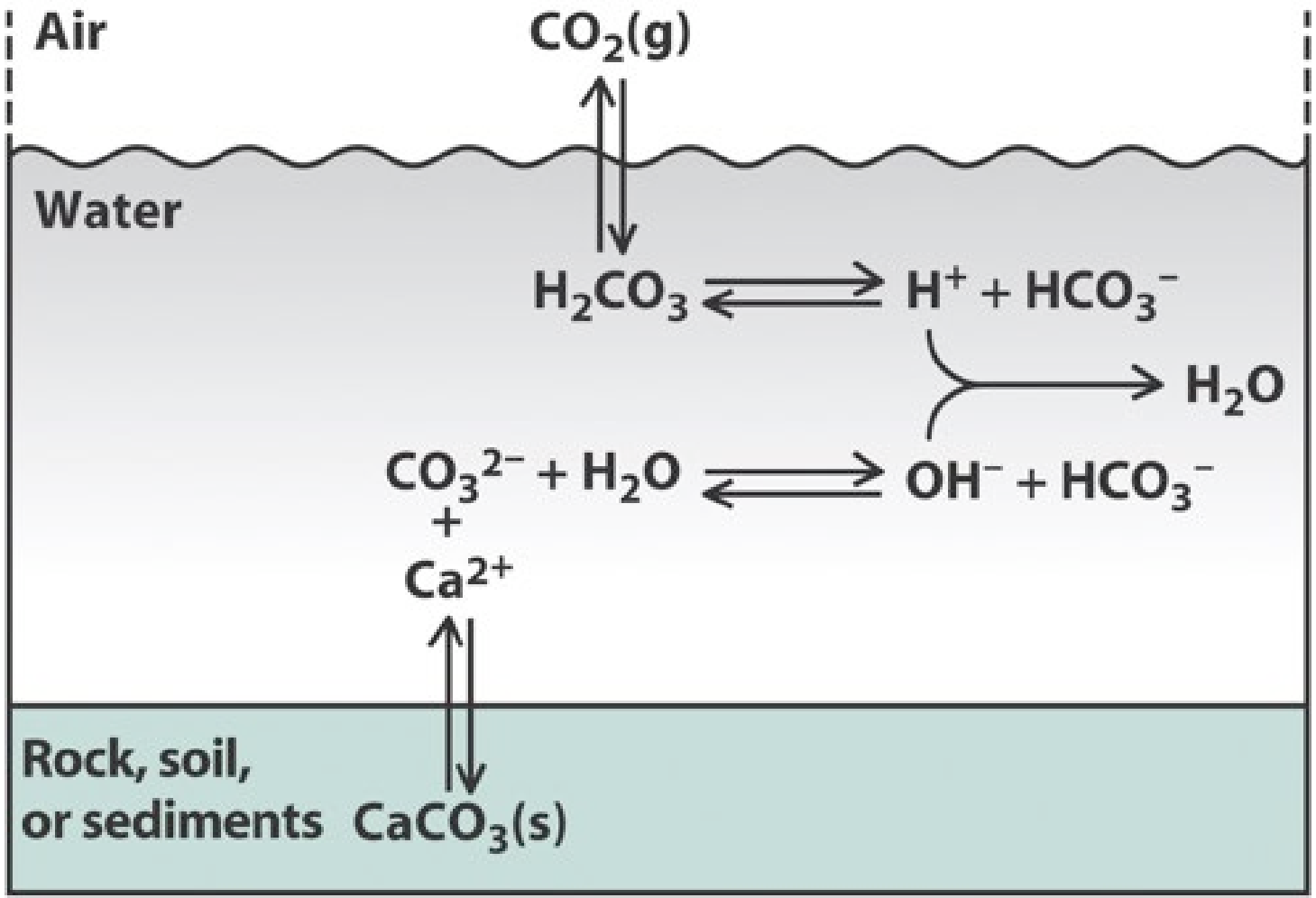


Mean hardness as calcium carbonate at NASQAN water-monitoring sites during 1975 water year.

Colors represent site data representing streamflow from the hydrologic-unit rea.

(Map edited by USEPA, 2005)

Chemical Reactions



Test Your Water

LIVESTOCK WATER REPORT

DAIRYLAND LABORATORIES, INC.
217 E. Main Street
Arcadia, WI 54612

SAMPLE 1
217 E Main St
Arcadia, WI 54612

REPORT DATE..... 2/ 2/2017

SAMPLED FOR: Sample

SAMPLE #: 9204
DESCRIPTION: milkhouse tap
DATE SAMPLED: 1/31/2017 TIME SAMPLED:

		YOUR LEVELS	POSSIBLE PROBLEMS
NITRATE-N		1.11 ppm	> 50.00 ppm
pH		6.32	< 5.5 or > 8.3
CALCIUM		9.166 ppm	> 200.000 ppm
MAGNESIUM		3.096 ppm	> 80.000 ppm
PHOSPHORUS		0.128 ppm	> 0.700 ppm
POTASSIUM		0.597 ppm	> 20.000 ppm
COPPER	<	0.001 ppm	> 0.500 ppm
IRON		0.197 ppm	> 0.300 ppm
ZINC		0.215 ppm	> 25.000 ppm
SODIUM		12.691 ppm	> 150.000 ppm
MANGANESE		0.015 ppm	> 0.050 ppm
CHLORIDE		14.000 ppm	> 200.000 ppm
SULFATES		4.890 ppm	> 300.000 ppm
TOTAL DISSOLVED SOLIDS		50.000 ppm	> 1000.000 ppm
WATER HARDNESS		36 ppm (VERY SOFT WATER)	
		2 gpg (Grains Per Gallon)	

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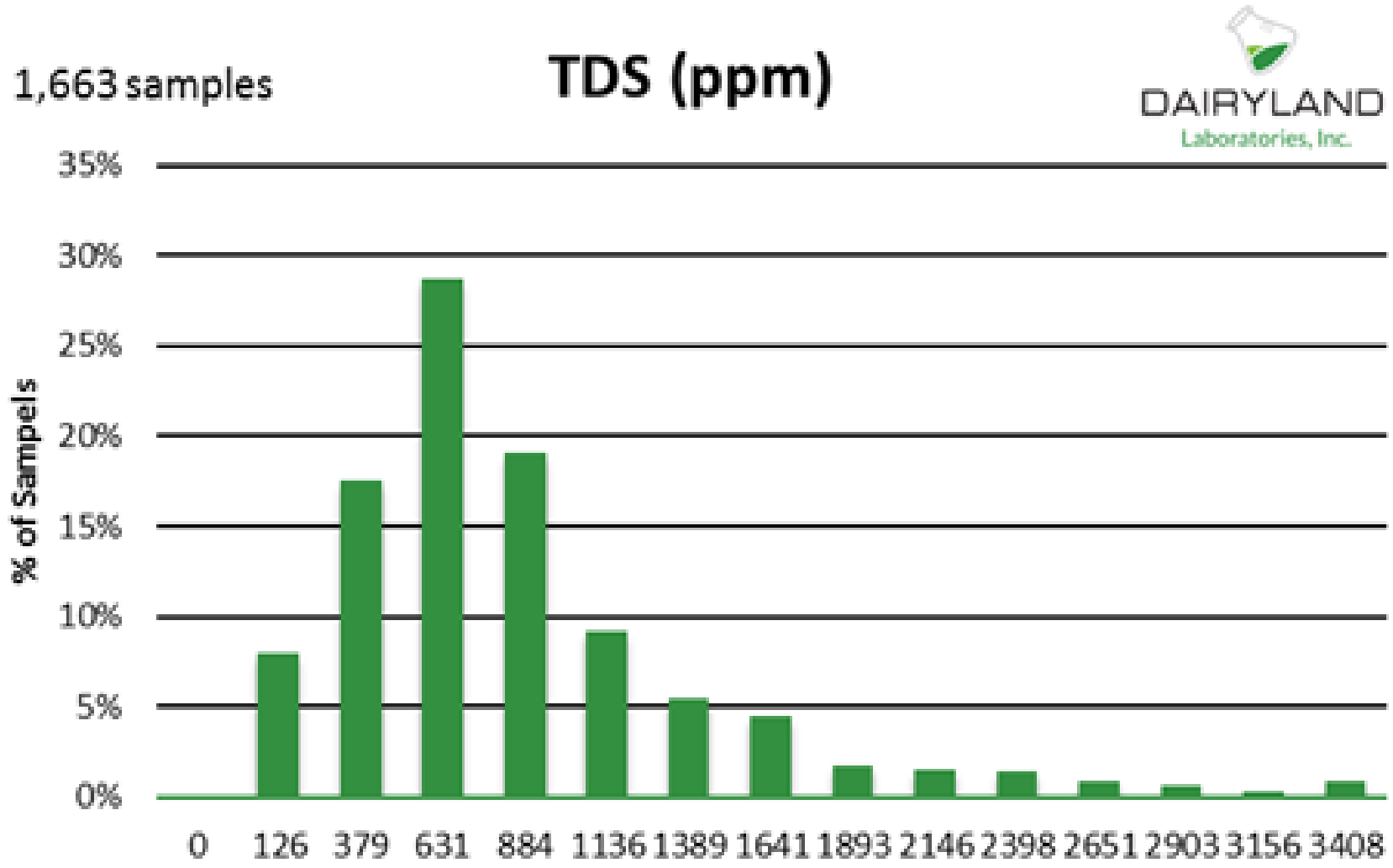
SAMPLE #: 9212
DESCRIPTION: milkhouse tap
DATE SAMPLED: 1/31/2017 TIME SAMPLED:

	YOUR LEVELS	POSSIBLE PROBLEMS
NITRATE-N	2.67 ppm	> 50.00 ppm
pH	7.66	< 5.5 or > 8.3
CALCIUM	143.358 ppm	> 200.000 ppm
MAGNESIUM	34.823 ppm	> 80.000 ppm
PHOSPHORUS	0.098 ppm	> 0.700 ppm
POTASSIUM	4.297 ppm	> 20.000 ppm
COPPER	< 0.001 ppm	> 0.500 ppm
IRON	0.241 ppm	> 0.300 ppm
ZINC	0.065 ppm	> 25.000 ppm
SODIUM	888.652 ppm*	> 150.000 ppm
MANGANESE	0.011 ppm	> 0.050 ppm
CHLORIDE	52.000 ppm	> 200.000 ppm
SULFATES	2241.456 ppm*	> 300.000 ppm
TOTAL DISSOLVED SOLIDS	3600.000 ppm*	> 1000.000 ppm
WATER HARDNESS	501 ppm (EXTREMELY HARD WATER)	
	29 gpg (Grains Per Gallon)	

* Levels exceed the guidelines. Caution is advised as possible problems or reduced performance may occur.

What's in your water?



What this means

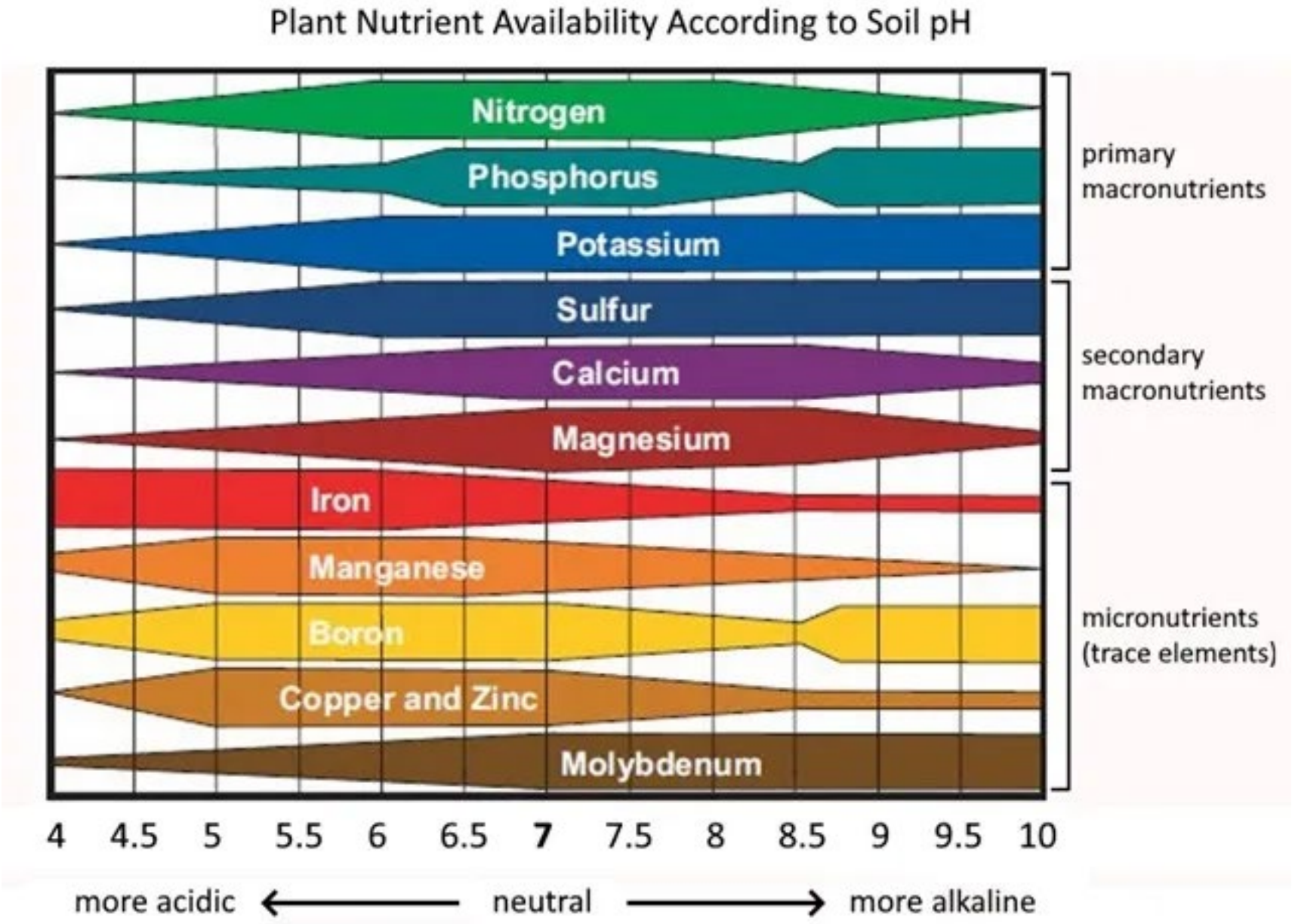
- 290 ppm $CaCO_3$
- Water 30 inches per year
- Equivalent of ~1 ton of Lime

Sample ID	Analysis Date	Organic Matter %	Cation Exchange Capacity CEC meq/100g	Percent Base Saturation (Computed)					Soil pH
				% K (+)	% Mg (+)	% Ca (+)	% H (+)	% Na (+)	
T1	03-25-15	3.9	19.3	2.8	25.3	70.3		1.6	7.9
Desired Level				3-5	12-16	70-75			6.8
T2	03-25-15	3.8	20.6	2.7	23.9	72.0		1.4	7.9
Desired Level				3-5	12-16	70-75			6.8
T3	03-25-15	3.4	16.3	6.0	26.6	65.3		2.1	7.7
Desired Level				3-5	12-16	70-75			6.8
T4	03-25-15	4.2	19.4	4.9	29.4	63.7		2.0	7.7
Desired Level				3-5	12-16	70-75			6.8
T5	03-25-15	2.2	15.4	7.3	26.1	64.1		2.5	7.6
Desired Level				3-5	12-16	70-75			6.8
T6	03-25-15	2.0	11.6	3.2	27.5	66.9		2.4	7.8
Desired Level				3-5	12-16	70-75			6.8
HOME FARM	03-25-15	1.5	12.4	2.9	25.9	70.1		1.1	7.5
Desired Level				3-5	12-16	70-75			6.8
SECT A/E	03-25-15	1.5	9.1	3.7	26.6	69.0		0.7	7.3
Desired Level				3-5	12-16	70-75			6.8

Sample ID	Analysis Date	Organic Matter %	Cation Exchange Capacity CEC meq/100g	Percent Base Saturation (Computed)					Soil pH
				% K (+)	% Mg (+)	% Ca (+)	% H (+)	% Na (+)	
SECT BCD	03-25-15	1.9	10.9	3.0	26.5	69.9		0.6	7.3
Desired Level				3-5	12-16	70-75			6.8
SECT GF3	03-25-15	3.1	12.8	2.0	28.4	68.9		0.7	7.3
Desired Level				3-5	12-16	70-75			6.8
CORNER	03-25-15	5.8	22.8	1.1	24.6	73.7		0.6	7.7
Desired Level				3-5	12-16	70-75			6.8
HILL	03-25-15	1.0	7.0	2.6	26.7	64.3	5.5	0.9	6.6
Desired Level				3-5	12-16	70-75			6.8

Consequence

- Nutrient Availability Decreases
- Plants less vigorous
- More troubles with disease and pests
- Decreased biological activity in HH makes this harder to combat



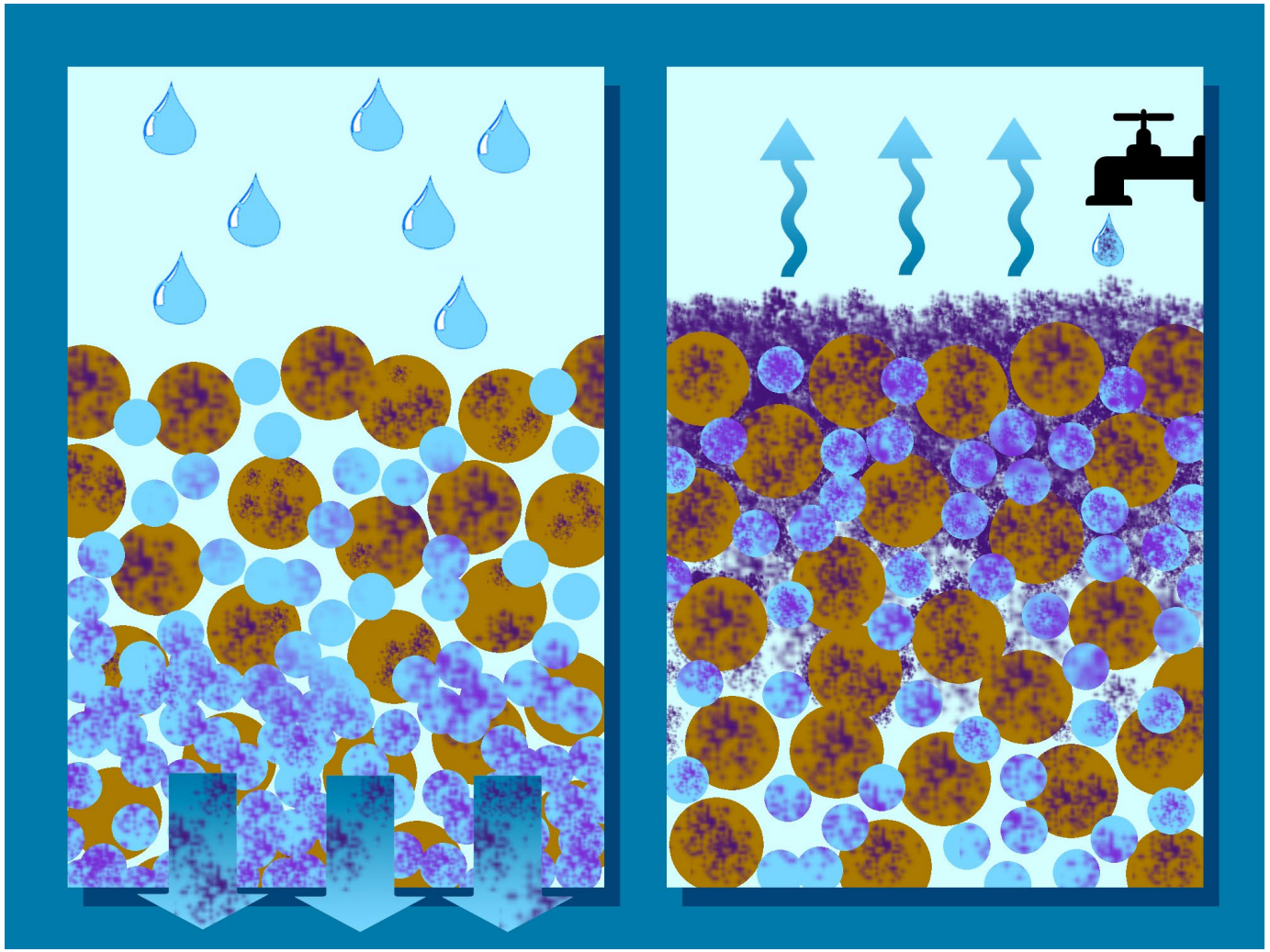
Solutions

- Movable House

- Standard House
  - Build two of them, and only use one at a time on a three year rotation
  - Remove Plastic for a season
  - Flush House
  - Acid Injection System

Solutions

- Remove Plastic
- Flush House
- Trying to move water through the soil profile
  - Have to 6 Inches total at minimum
  - 1 inch a day for two weeks



Acid Injection

- Citric Acid
- Reacts with Bicarbonate and turn it into CO_2
  - $3Ca(HCO_3)_2 + 2C_6H_8O_7 \rightarrow 3Ca + 2C_6H_5O_7 + 6H_20 + 6CO_2$
- Free Ca and the Mg to be taken up by plants
- Choose your pH
  - Prevent future problems
  - Eat up alkalinity in the soil

What this means

- 580 ppm $CaCO_3$
- Water 30 inches per year
- Equivalent of ~2 ton of Lime
- Over 5 years ~10 tons of Lime

Reserve Alkalinity and Free Lime Test

- Reserve Alkalinity
  - No matter how much lime pH will read 8.0
  - If it only took 5 tons/Acre to reach pH of 8.0 there are 5 hidden tons/Acre
  - How do I know how much?

- Free Lime Test
  - Available from most soil testing labs, especially those in the west.
  - Will let you know how much elemental sulfur to use to help bring this down.

Acid Injection Calculator

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Acid Injection Calculator

Water hardness in mg/L	501
Water Hardness or Alkanlity in meq/L	16.7
Ounces of CA/1000 Gallons of Water to Adjust Straight	1.835165

Conclusion

- Disease
- Insect Pressure
- Compaction and other physical soil issues
- Fertility
  - Create a balanced plan
- Soil Chemistry
  - Water Alkalinity
    - Acid Injection
  - Free Lime
    - Elemental Sulfur