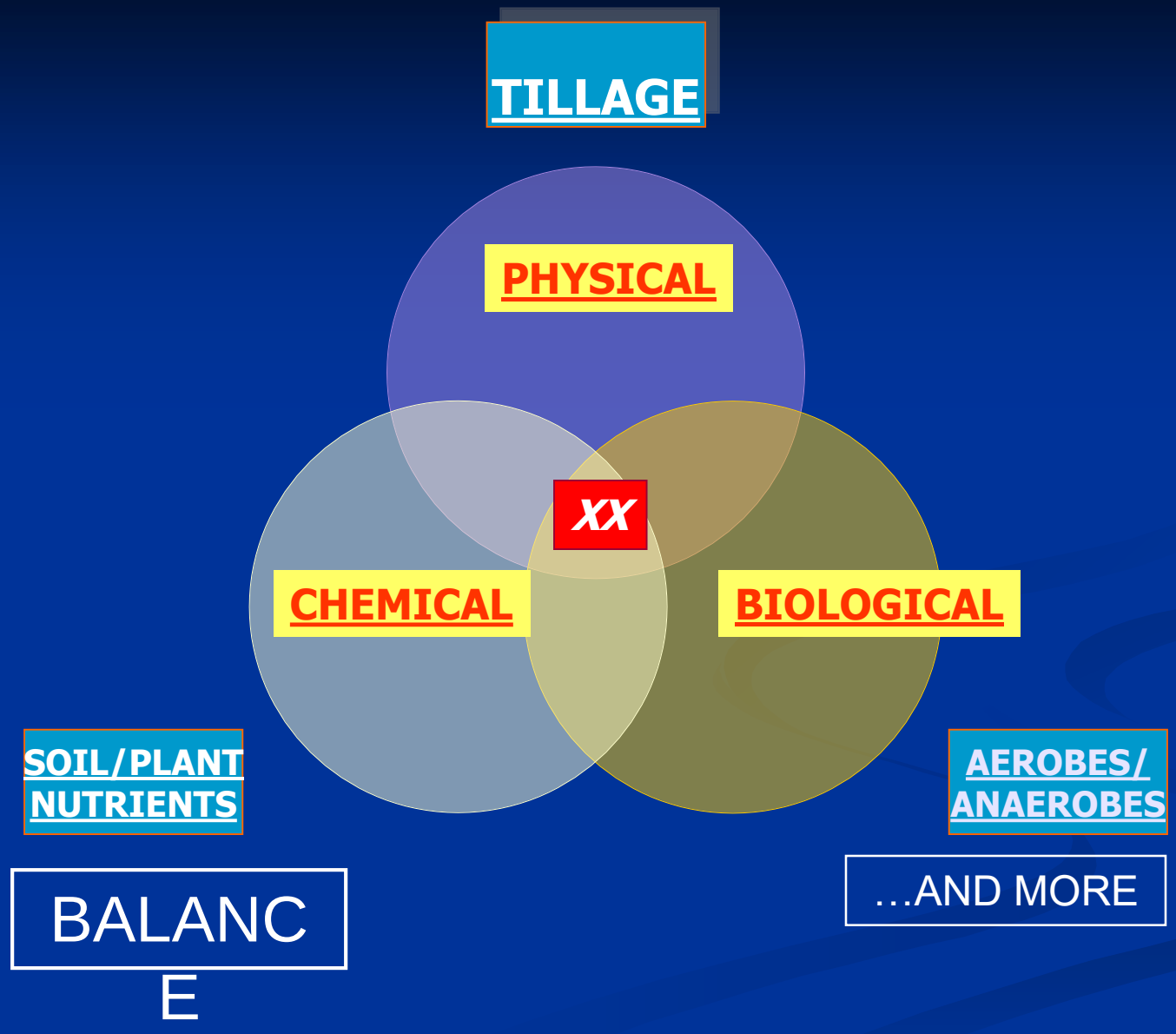
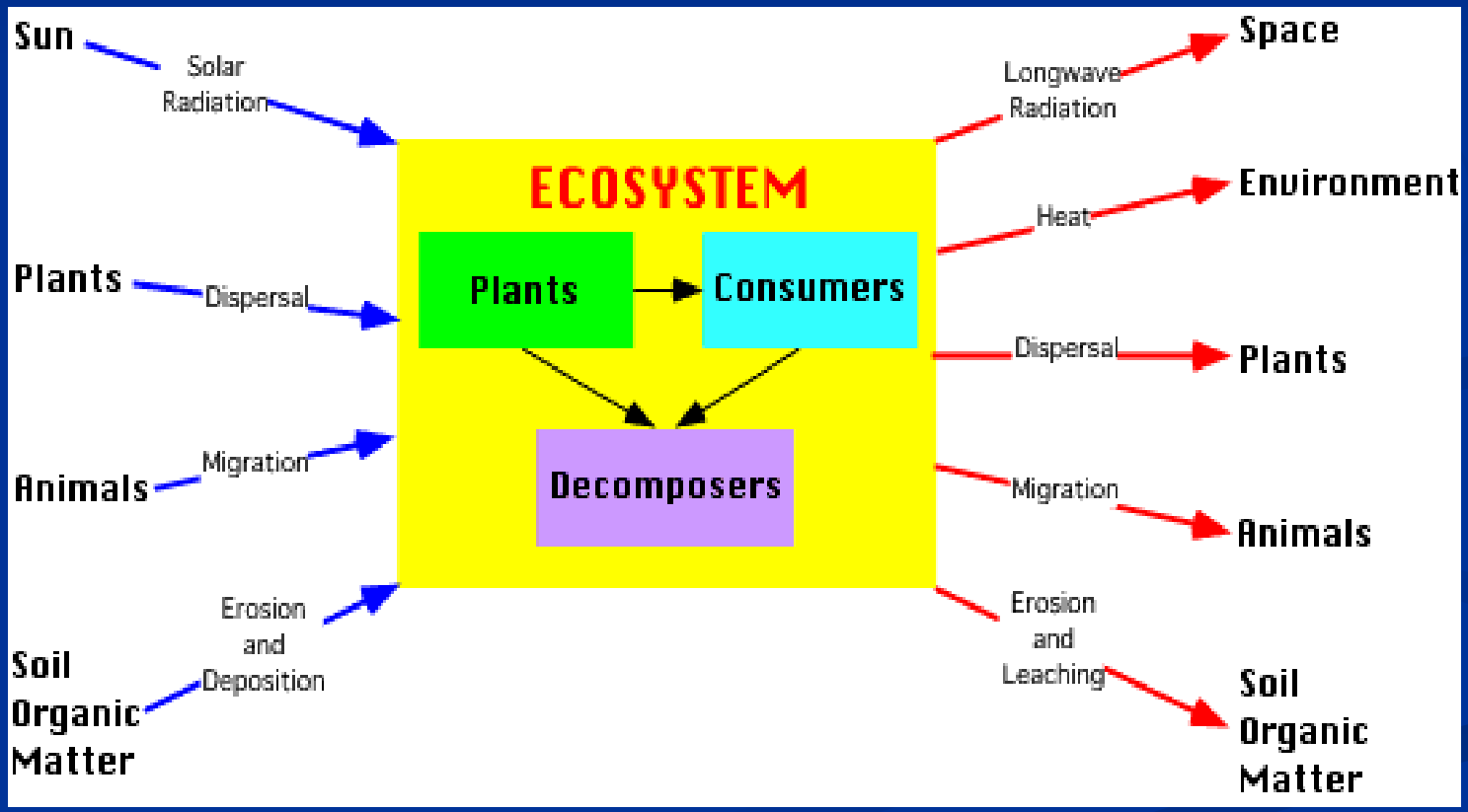
Big Oak Trees like this one in INDIANA have regrown roots over 200 times OR MORE

so far . . . .


TILLAGE
PHYSICAL
XX
CHEMICAL
BIOLOGICAL
SOIL/PLANT NUTRIENTS
AEROBES/ ANAEROBES
BALANCE
…AND MORE

A PRACTICAL RENDERING OF THE BIOTIC PYRAMID

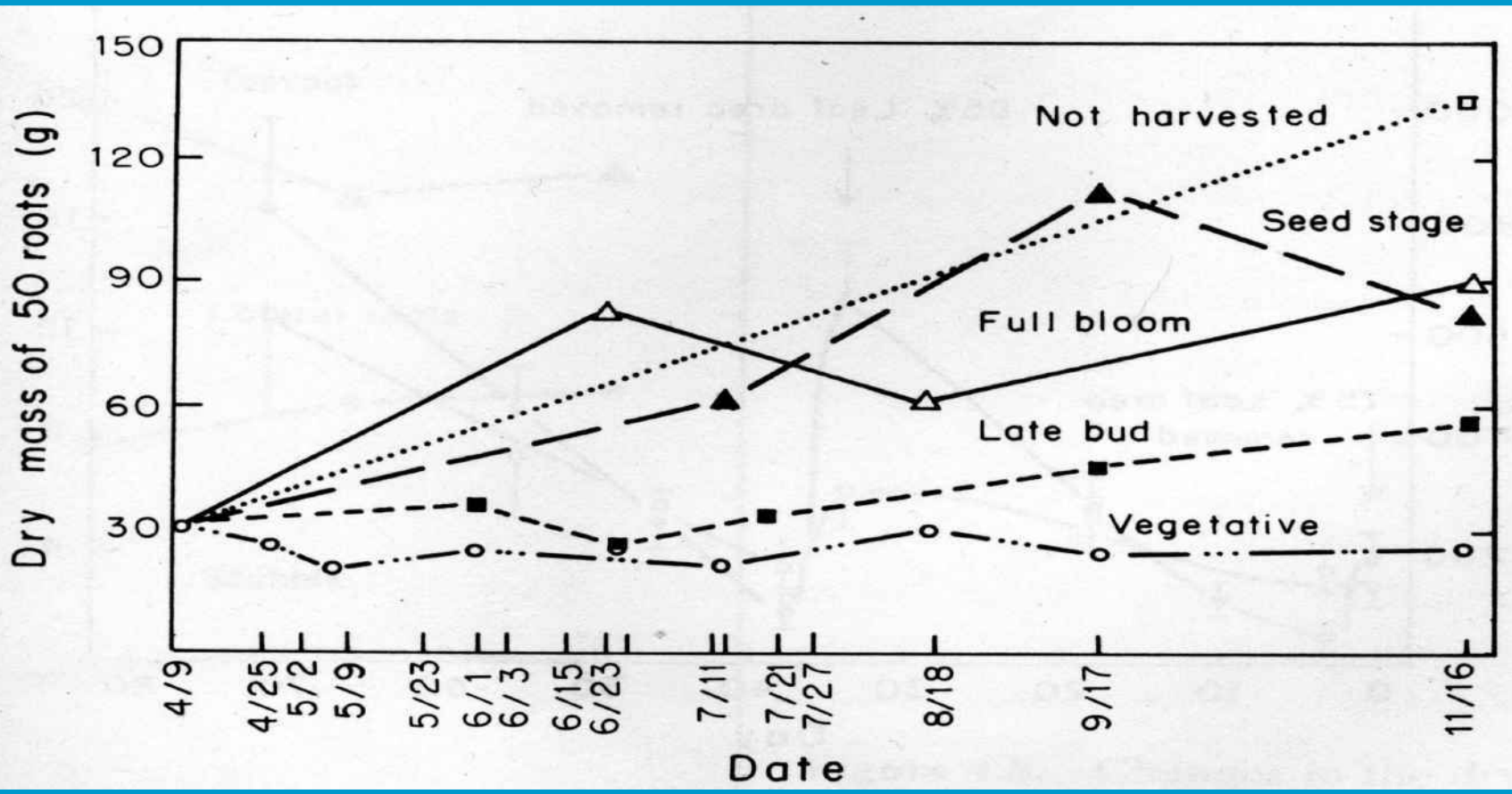



TILLAGE STRATEGY MAKES THE DIFFERENCE
3000
5000
2000
DIAGNOSING BENEFICIAL INSECT FEEDING
THE “REMAINS” AFTER 12 MONTHS

Ready for the Combine

- Suppressed with Glyphosate fall & spring
- Alfalfa aerated 1985-87
- Three alfalfa re-growths during summer
- No residual herbicide
- "Weed-free"=nutsedge w/ no seed head
  - Dandelions w/out flower

Knowing the rooting habit = critical info



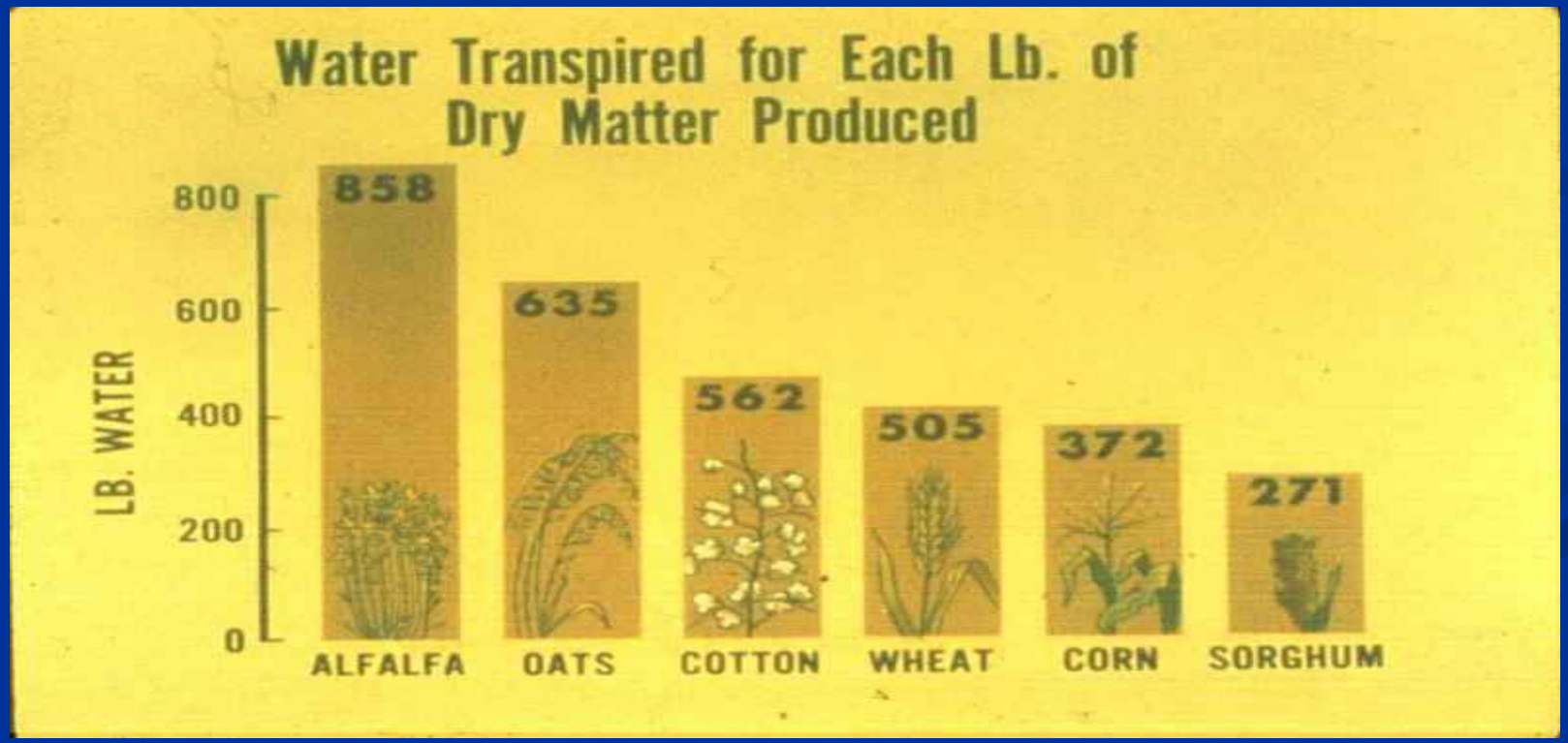
- Loosen soil before re-rooting event occurs

Looking into Second-Year Corn

- Following alfalfa a second time
- 160# N 0-7” soil test plus organic matter release = 95#
- First year yield 155 bu./ac.
- He Killed It !!!!

What about water consumption?

- Deep-well pumping alfalfa = high humidity for corn
- Alfalfa = Extra carbon dioxide for the corn



One Pass with Smart-Till Tine - corn was 5” tall

Preliminary Preparation: One pass in the Fall with Rotary Harrows attached


No tillage for 4 years

Combining the puzzle pieces…

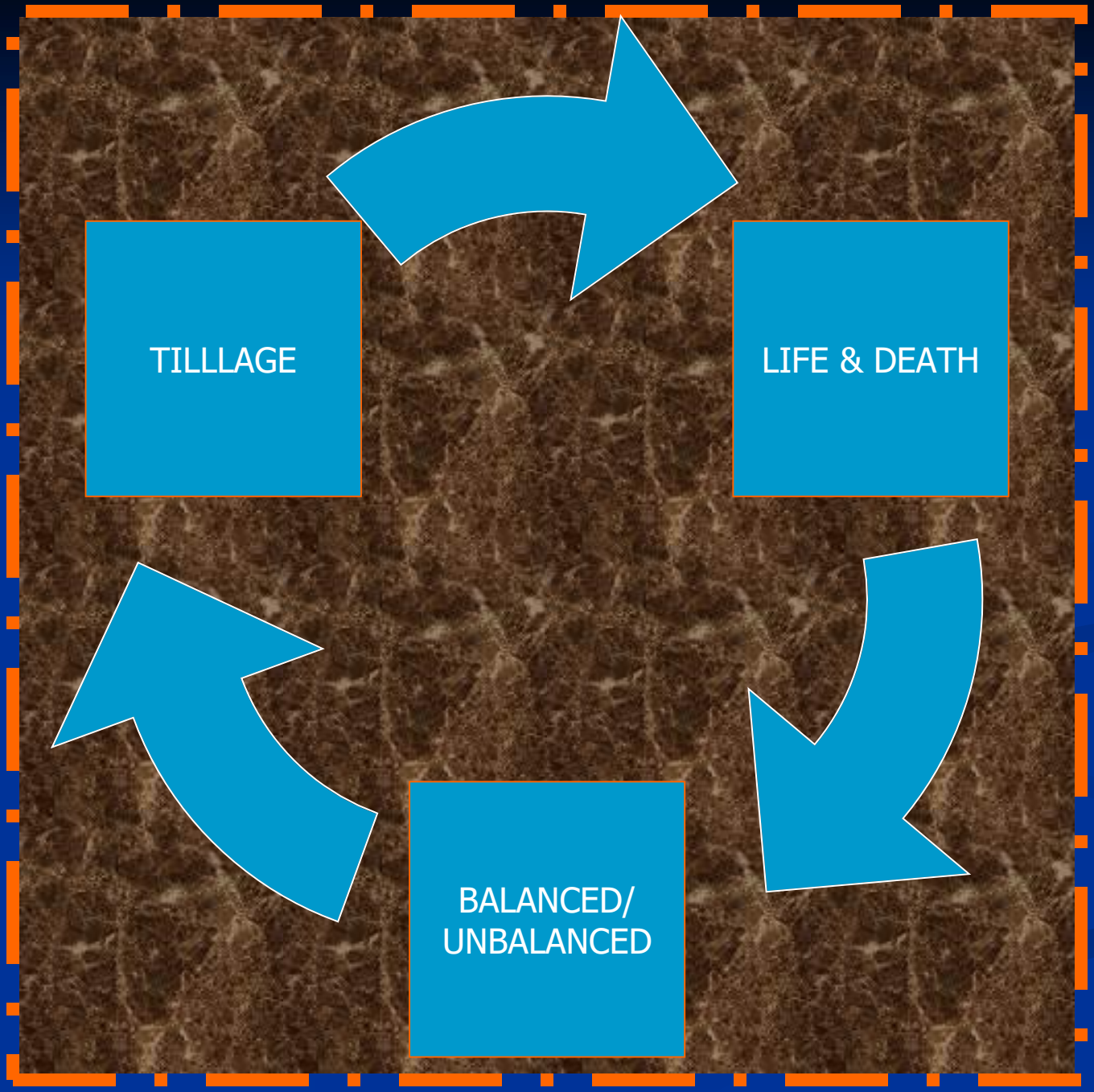
- Vigorous living mulch- alfalfa twice annual tillage, once in the fall always minimum
- Building populations with high-quality food supply and shelter (no flooded basements or nurseries)
- Creating the amino acid shift for optimal nutrition to the desired harvests by whoever
- Maintaining aerobic soil environment

Why is Tillage Important ?

God Commanded TILLAGE in

GENESIS 3:23

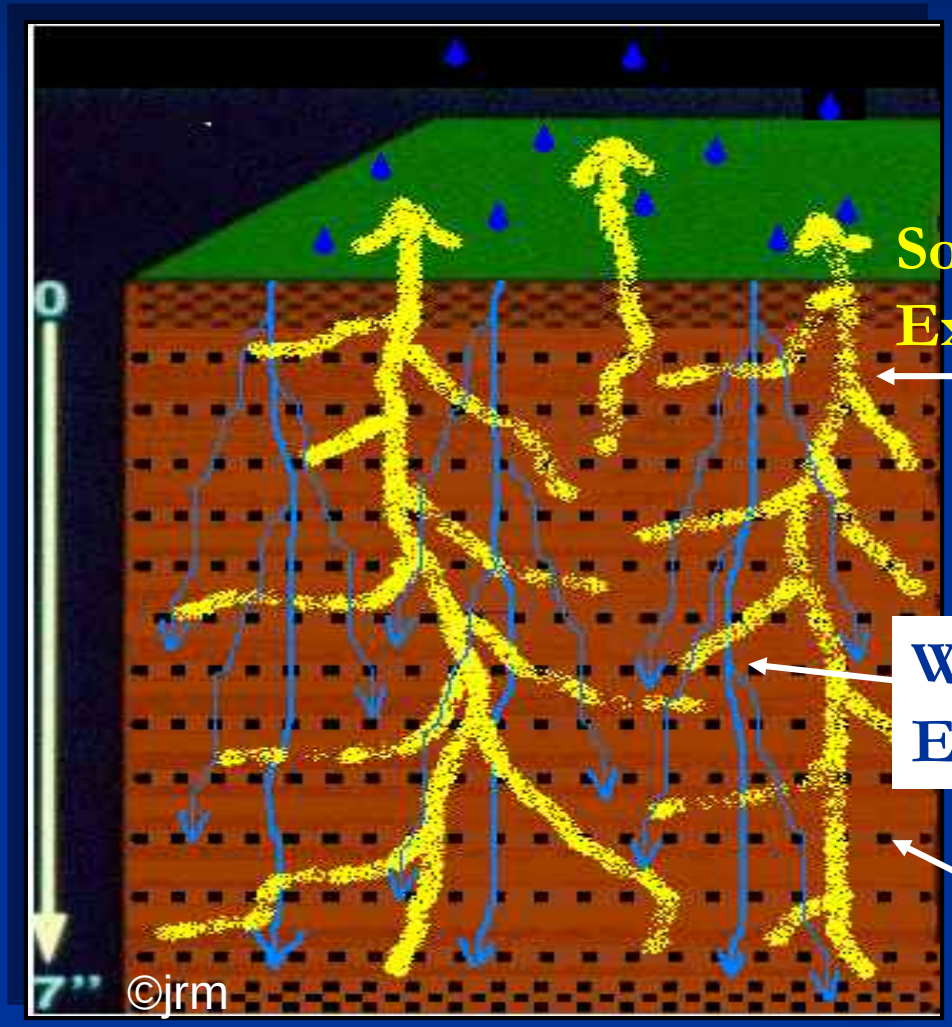
"Sent the man forth from… to till the ground from which he was taken."


TILLLAGE
LIFE & DEATH
BALANCED/
UNBALANCED

And What Does Tillage Need to DO?

- The Main Event ?
  - Restore soil physical condition for "normal" air and water exchange
    - Take off the "straight-jacket" We need to Breathe!!!

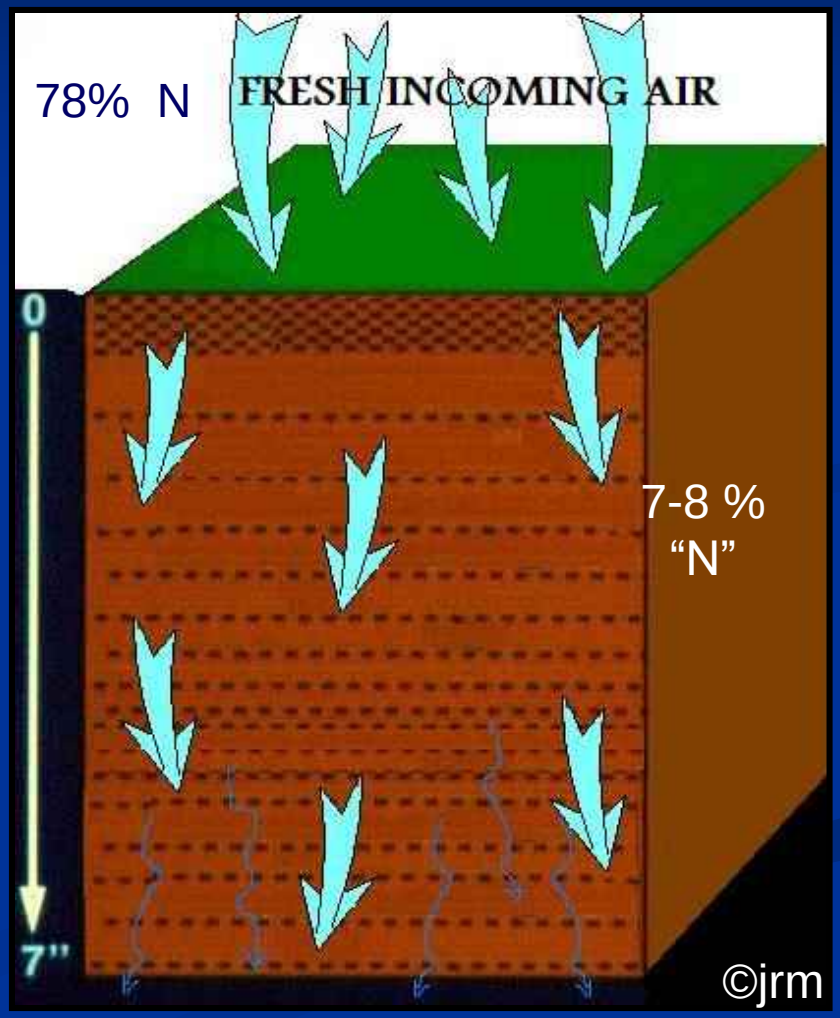
Thank God It Rains…..But When it Does, it Changes Things



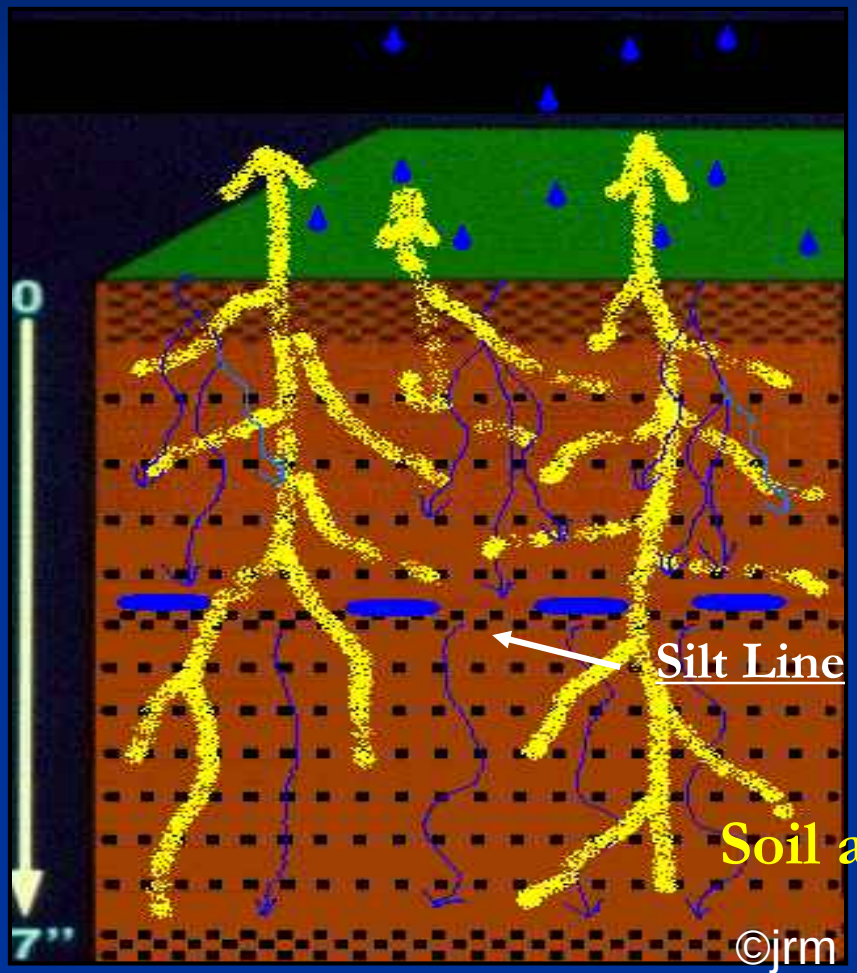
- Conventional tillage performed
- Soil silt particles evenly distributed
- Rapid diffusion of water throughout the plow-payer
- **Deep, purging of soil air**

When the Rain Stops….

- Free water continues downward- IDEALLY
- Leaves partial pressure behind or above
- Atmospheric pressure pushes “fresh air” into soil
- Brings a “Breath of Life” to all the good guys

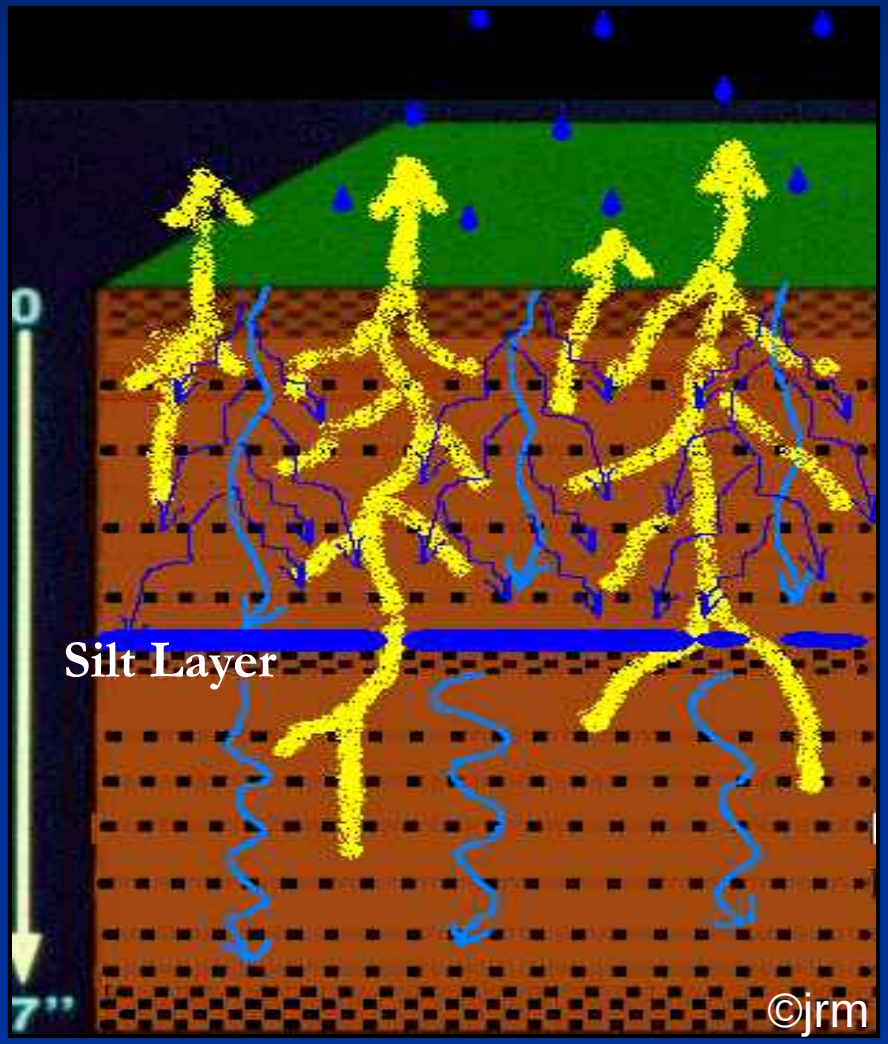


And Then it Rains Some More- We Hope



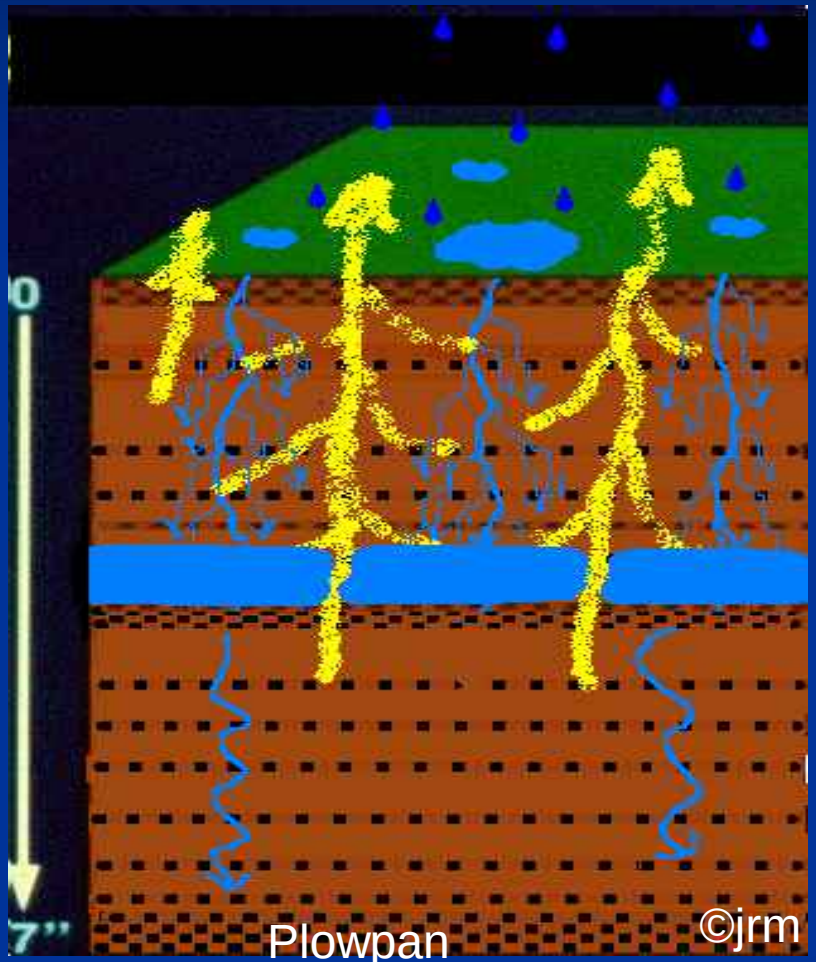
- Silt particles travel with the free-water **DOWNWARD**
- Where water speed **drops** so does the **silt**
- **Water** percolation rate through silt is reduced
- **Air** purging from below the silt line is reduced
- This **Silt Concentration** is located anywhere from in the 2nd inch to the 6th inch in most soils

Then We Hope it Doesn't Rain Too Much

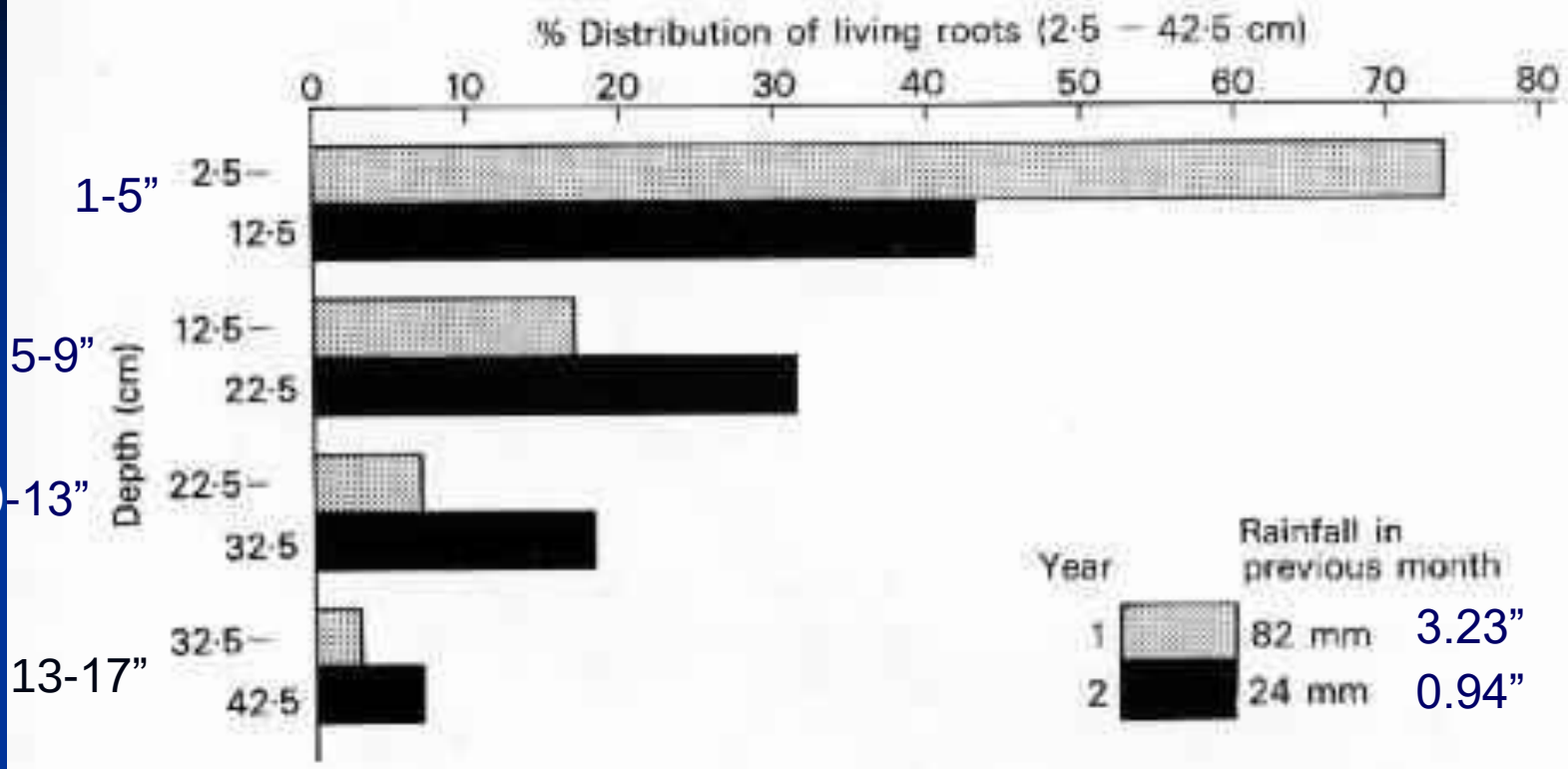


- The free-water keeps on moving more silt to the same location
- The pore spaces are getting fewer and smaller
- Less field capacity; slower percolation
- Less soil air purged
- Less incoming fresh air and slower rate of air exchange
- Straight-jacket time**

Now we start to See the Problem…



- Surface ponding appears
- Greatly restricted water percolation at silt line
- Little air exchange under silt line
- Soil spends more time anaerobic
- Field depressions become wet-holes
- The silt density layer is still only a fraction of an inch thick



1-5”

5-9”

9-13”

13-17”

3.23”

0.94”

FIG. 5.5 Contrasting distribution of living roots of spring barley grown in the same field in successive years: measurements two months after planting. In Year 2 drier conditions in the surface soil much reduced the fraction of roots in that zone.

The relationship between root density and depth was exponential in Year 1 and linear in Year 2. The percentage of the total variation accounted for on the two bases was: Exponential relationship – year 1: 98 (13), year 2: 74 (25). Linear relationship – year 1: 78 (55), year 2: 99 (7). The figures in brackets show the maximum percentage difference between the calculated values and those observed for individual horizons. (Derived from Ellis et al., *1977.)*

Taken from Plant Root Systems by R. Scott Russell, McGraw Hill (UK)

Soil Water & Air Management

- Barley root deformity caused by ethylene production in anaerobic soil (Look like no-till?)
- Note the difference in the growth habit between the arrows on each plant
- Which root system would you prefer when the rains stop ?

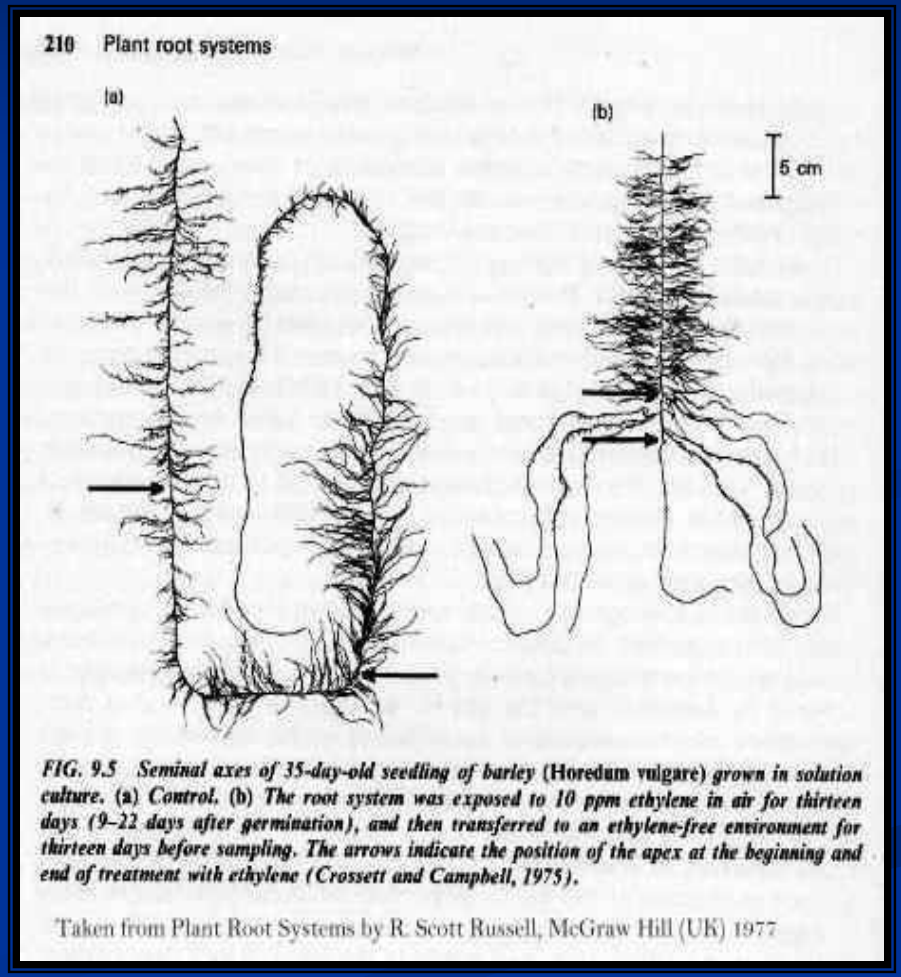


FIG. 9.5 Seminal axes of 35-day-old seedling of barley (**Horedum vulgare**) *grown in solution culture.* (a) *Control.* (b) *The root system was exposed to 10 ppm ethylene in air for thirteen days (9–22 days after germination), and then transferred to an ethylene-free environment for thirteen days before sampling. The arrows indicate the position of the apex at the beginning and end of treatment with ethylene (Crossett and Campbell, 1975).*

Taken from Plant Root Systems by R. Scott Russell, McGraw Hill (UK) 1977

Here it is in "Living" (Dying) Color--

- Visible change in water line took place in 30 minutes
- Field deep-tilled 18" and never saw disk or sweeps
- Water had stood unchanged for five days

©jrm

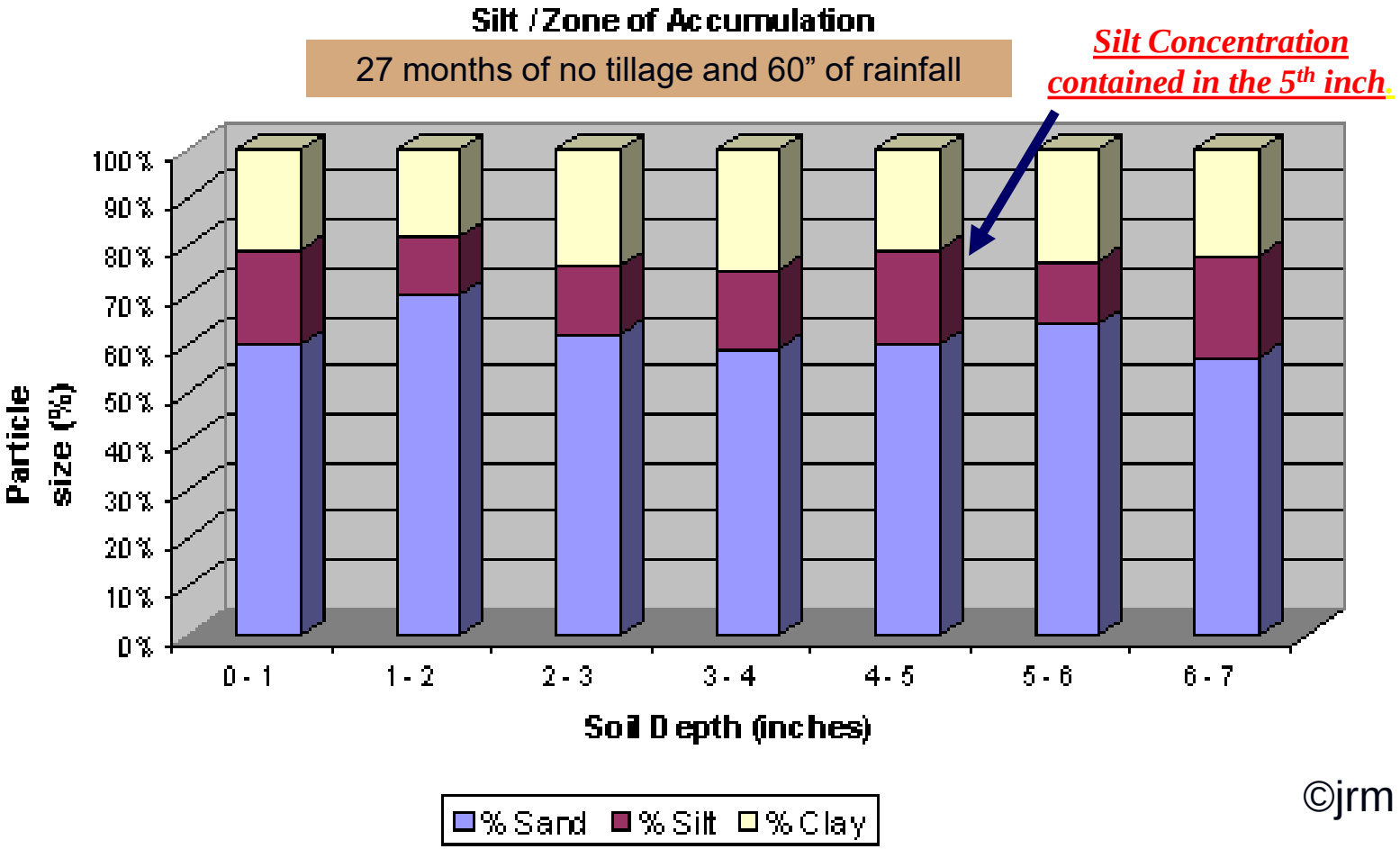
Three Hours Later– All GONE!!

- Air bubbles observed on water surface behind process
- Independently observed and recorded results shown here - Nate
- No tire ruts observed
- Aerator tine max. penetration 6 inches
- And the best part....?

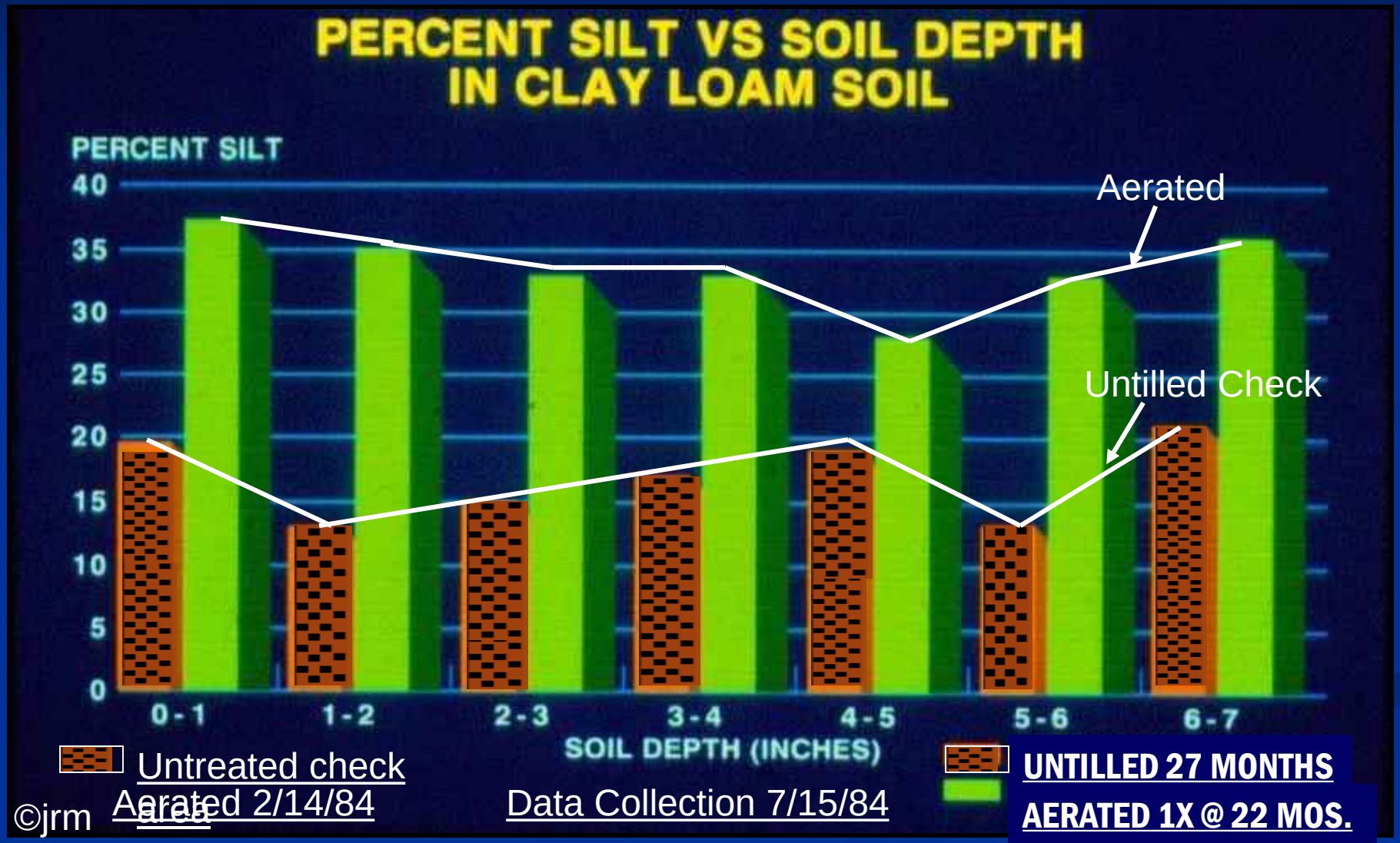
First Cutting 3rd year Alfalfa
90 days Later

Soil Depth (inches)	% Sand	% Silt	% Clay
0 - 1	60	19	21
1 - 2	70	12	18
2 - 3	62	14	24
3 - 4	59	16	25
4 - 5	60	19	21
5 - 6	64	13	23
6 - 7	57	21	22

One Way of Looking at the Evidence of What Water Does to Silt Distribution Using Mechanical Assay



FIVE MONTHS PLUS SPRINGTIME RAINFALL (8 TO 10 INCHES) CHANGED THINGS



So in Review and Summary

- Soils at rest, **DON'T** stay the same; they become less able to transport water and change air with the addition of surface water.
- Anaerobic soil conditions increase thus reducing nutrient bio-availability and increasing soil disease pathogens
- Root system development becomes more limiting to yield.

- The essence of tillage is the ability of the process to restore water movement to optimum for any given soil type.
- Water movement in soil creates soil air changes.
- IT IS NOT NECESSARY TO MECHANICALLY MIX SOIL, AND ADD AIR TO SOIL TO ACHIEVE THE BENEFITS OF TILLAGE.

Tillage Should Have a Dual-Focus

No-Till Wheat

Strip-Tilled Wheat Stubble

- We have called it…..
  - As we see it
  - As we feel it
  - As we smell it
  - By naming the tool we used
  - The way we plant it and
  - And as we harvest the results,

  But,

  LET'S CONSIDER THIS:

  DEFINING TILLAGE BY WHAT IT DOES !!!

Tillage Needs to Achieve to Purposes

Soil Production = optimal growth of humus producing elements for creating healthier soil = *NATURAL FERTILITY*

AND

Crop Production = ideal environment for emergence and plant root system performance = *OPTIMAL NUTRIENT DENSITY*

Can Tillage Achieve Both?

Do any of these tillage, including no-tillage, strategies do the job?

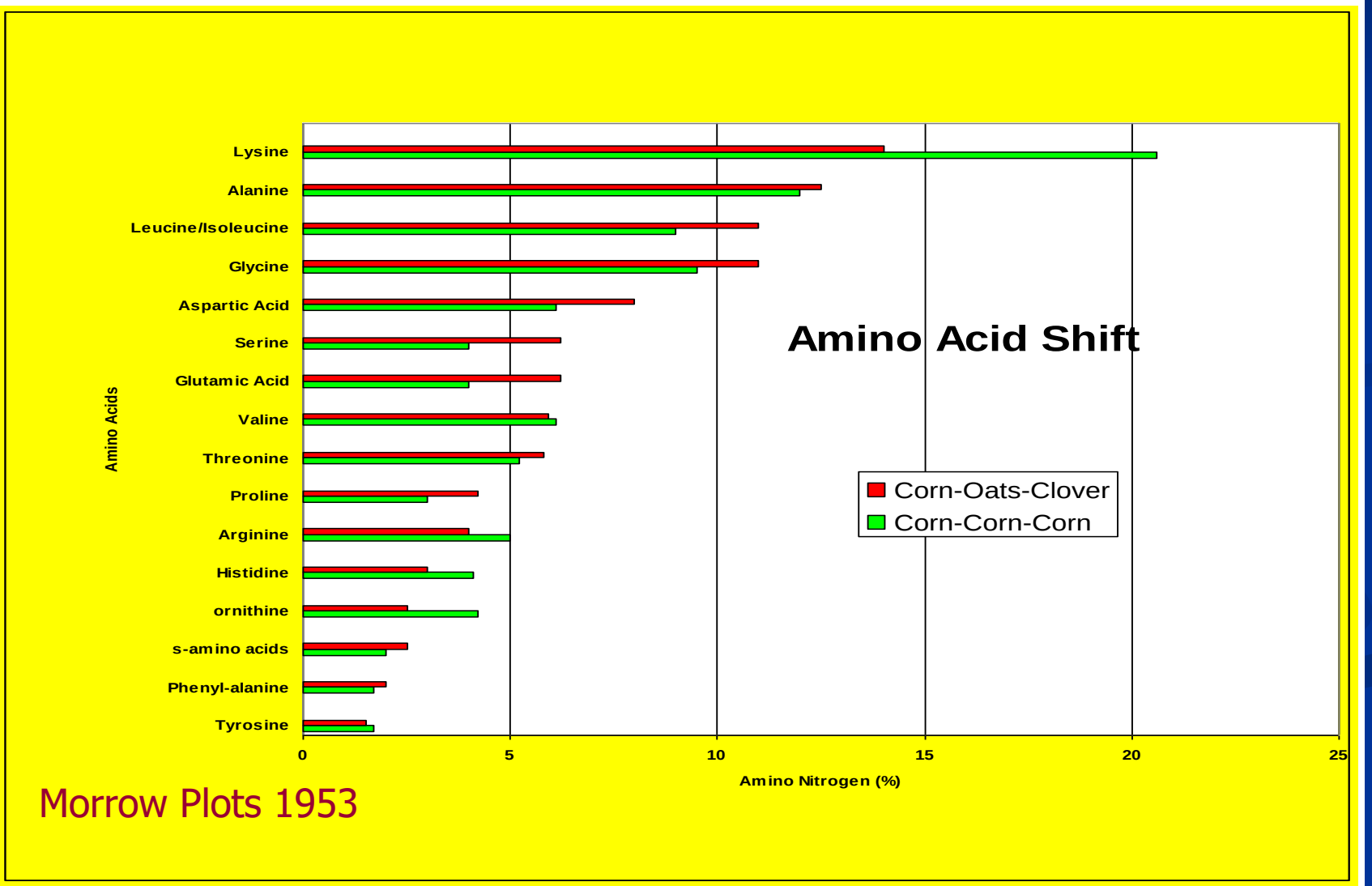
The Mason Farm Saga

- 1985 bought the machine
- 1987 tried planting corn the first time

Todd Mason, Cape Vincent, NY in August 2007

“Secret” =Where the roots grow

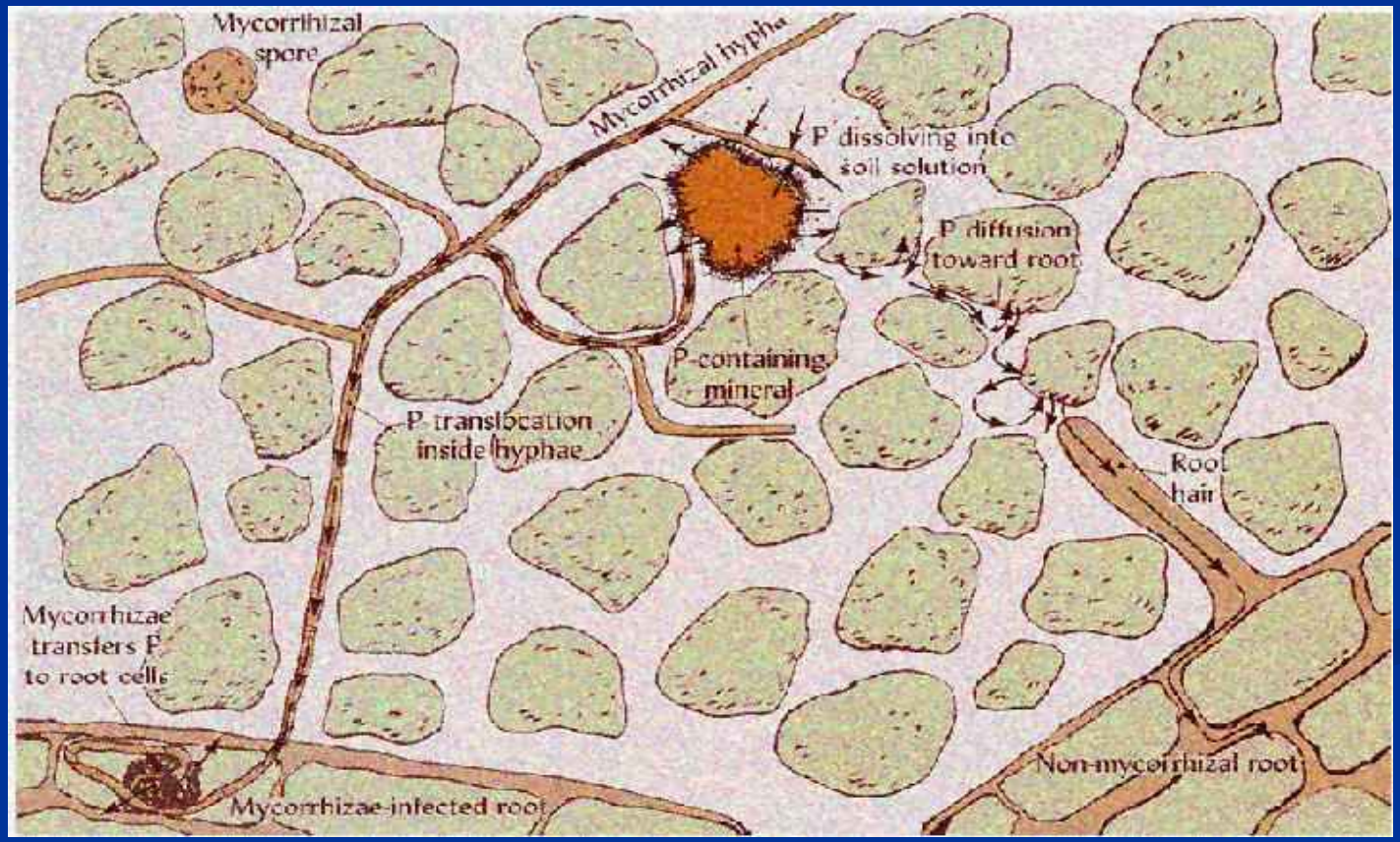
It's about amino acids from the mycorrhizae/rhizosphere



Morrow Plots 1953

SAR = Systemically Acquired Resistance

- Symbiotic bacteria and fungi co-existing in soil and plant root hair tissue



DHMO

- Odorless, Tasteless Chemical
- Lethal if Inhaled as a Liquid
- Causes Severe Burns in its Gaseous State
- A major component in Acid Rain
- Found in Contaminated Water Ways

Nurturing Plants : Nurturing Babies

Infants communicate to mother through the breast

Mother identifies pathogen

Mother creates antibody

Infant receives anti-body in the milk

Pathogen is destroyed

If --- Mom is healthy so is the Infant !!!

Max Grow on Silage Corn

Max Grow corn produced 42 Tons per acre at a height of 14’9”. With starter on seed and in band beside row in CA

Increase of 3.19 tons/acre.

Reduced N rate by 20%

Without MG With MG

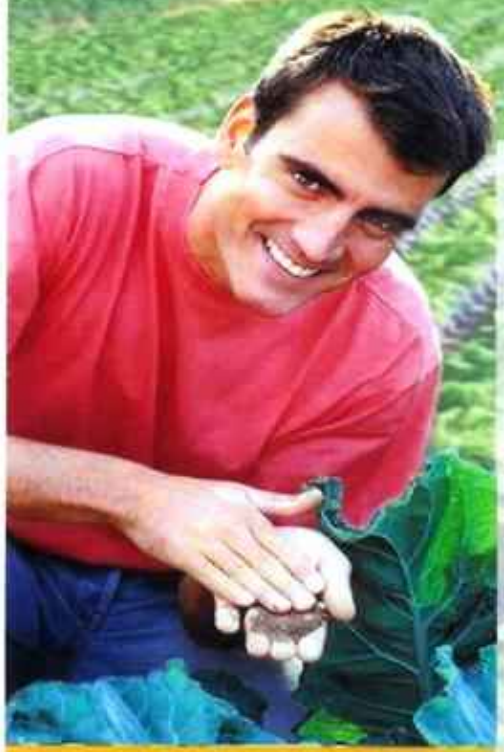
Without MG With MG

ORGANIC OIA APPROVED

There's now a natural solution to healtier crops, and larger yeilds.

MaxGrow™

Bio Accelerant



THIS ALL NATURAL PRODUCT IS DERIVED FROM MILK MINERAL EXTRACT FROM BACTERIOCIN FERMENTED WHEY PROCESS AND POTASSIUM SULFATE.

STORAGE AND HANDLING:
Store in a sealed container in a cool dry place, out of direct sunlight. Store at temperatures above 40 F and below 95 F. Product must be used within 15 days after opening for maximum efficacy. Use within 36 hours of mixing.

PRECAUTION:
If spilled, the surface will become slippery. Non-hazardous to humans, fish, or animals. No protected clothing is required. Gloves, waterproof shoes, and eye shields should be worn as precaution. In case of spill, contain, absorb and dilute with water to place in sewer system if allowed by local or state regulation. Can be cleaned with soap and water.

DIRECTIONS FOR USE:
Use 12.8oz to 25 oz. per acre, methods of application, water run (flood or sprinkler), spray air or ground (to bare ground), inject into fertigation system, shank in with or with out nutrient. Compatible with most pesticides and nutrients, jar test is recommended, or consult your technical representative. Shake well before using.

Made in the U.S.A. by SummitGold / Midwest Distributing, Inc.

SUGGESTED APPLICATION:

Small Grains: 12.8 oz/acre soil applied at planting or near dormancy break to increase microbial activity and up to 25 oz/acre foliar to assist with plant health.

Row Crops - Corn, Soybeans and Sunflowers etc.: 12.8 oz/acre soil applied at or near planting on surface, in furrow or sided banded. May also be used with side-dressed plant food. Crop may benefit from 6-8 oz/acre rates foliar applied every 30-days.

Alfalfa: 12.8 oz/acre soil applied at or near dormancy break. May also apply in 8 oz /acre rates 7-10 days after each cutting throughout the season.

Vegetable Crops: 12.8 oz/acre soil applied at or near planting. Follow with 4-6 oz/acre rates foliar applied on 30 day intervals.

Nut Tree Crops: 25 oz/acre soil applied post harvest or early spring.

Vines and Canes: 25 oz/acre soil applied in fall and early spring.

Citrus: 25 oz/acre twice a year surface applied or through drip irrigation.

Turf: 12.8 oz/acre per acre soil applied at planting followed by 12.8 oz/acre rates every 35 - 40 days.

Conditions of Sale and Warranty

1.Seller warrants that this material conforms to the description on the label and reasonably fit for use as directed hereon. Seller neither makes nor authorizes any agent or representative to make any other warranty of fitness or of merchantability, guarantee or representation, express or implied, concerning this material. 2. Critical and unforeseeable factors beyond seller's control prevent it from eliminating all risks in connection with the use of chemicals. Such risks include, but are not limited to, damage to plants and crops to which the material is applied, lack of complete control, and damage caused by drift to other plants or crops. Such risks occur even though the product is reasonably fit for the uses stated hereon, and even though label directions are followed. Buyer and user acknowledge and assume all risks and liability (except those assumed by seller under 1. above) resulting from handling, storage and use of the material.

NET WEIGHT: 8.68 lbs. /gallon

SummitGold™

Bio-Accelerant/Stimulant

- Enzymes (proteins)
- Organic Acids
- Vitamins (esp. B-1; Thiamin)
- Minerals (plus Sea-Agri-90)
- Carbon Source (galactose)

Improves Soil Nutrition

- Delivers Soluble Minerals
  - 1% Calcium
- Delivers Vitamins
  - Vitamin A, Beta Carotene, Retinol, Thiamine (B-1), Pyridoxine (B-6), Folic Acid (B-9), Cyanocobalamin (B-12), Ascorbic Acid (C), Cphytonadione (K), Vitamin D, Vitamin E

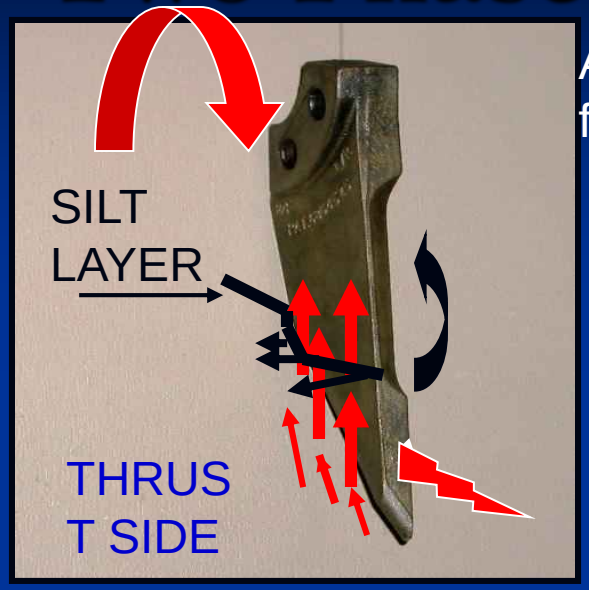
- Organic Lactic Acid
  - Functionally a Humic Acid
- Bacteria Mineralizes Nutrient Bound in the Soil
- Lowers pH

MaxGrow™
Bio Accelerant

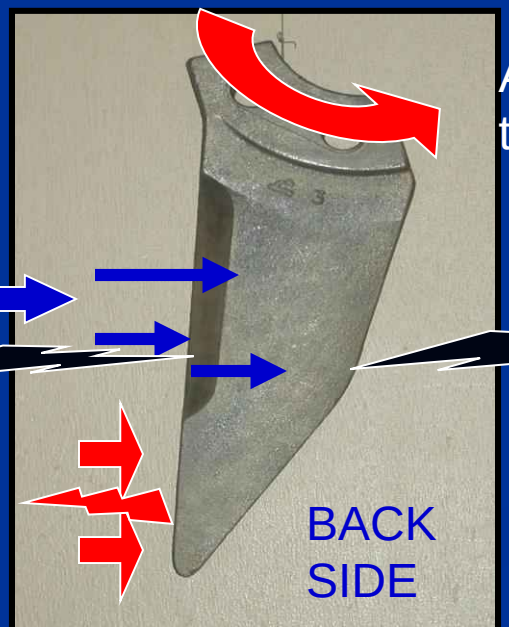
This doesn't look like a plow share!

- Built using the finest alloying for austempered ductile iron – RESISTING BREAKAGE AND WEAR
- Producing maximum vertical and lateral fracture forces BY DESIGN
- Leaving **no residual <u>horizontal</u> compaction–** ***ANYWHERE !!!!!***

Two Phases of Tine Action



Action from the front view

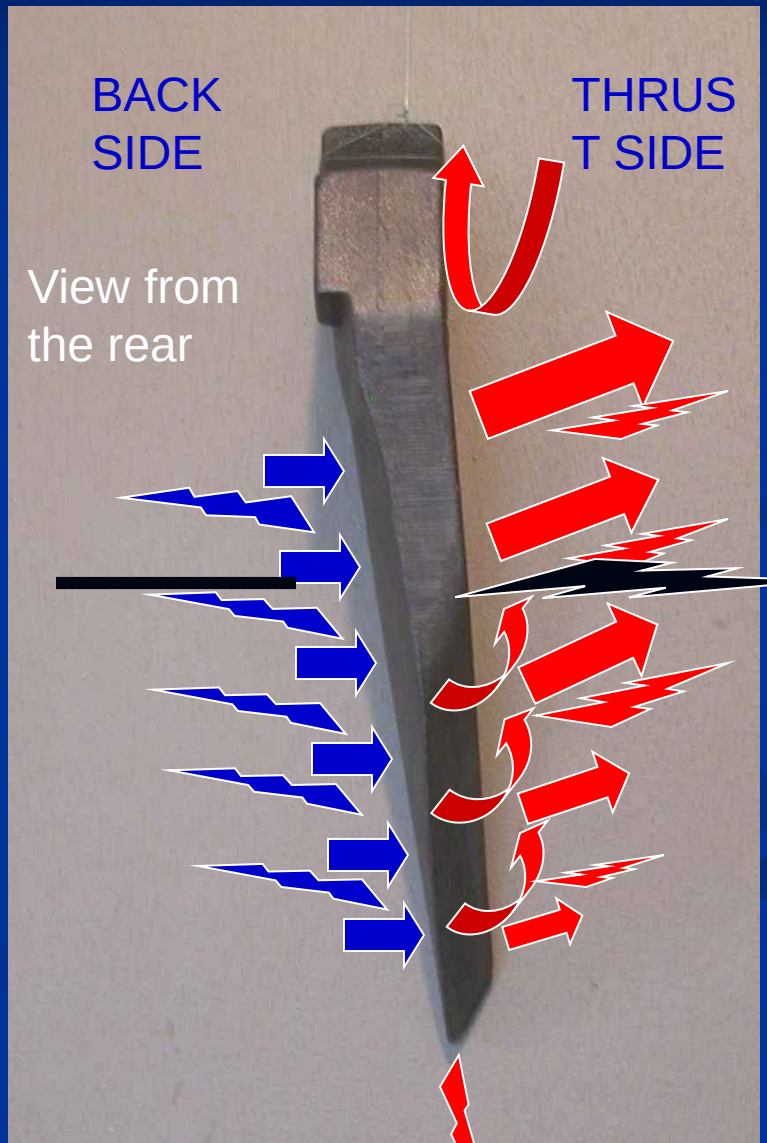


Action from the side view

- **Entry Phase**
  - Soil displaced to **thrust side** of entering tine blade
    - Soil parting line adds soil volume to thrust side of tine
    - Optimal angle of penetration of silt density layer with tine tip
    - Disruption of **SILT LAYER**
    - No smearing action on the back side of the tine blade
    - Soil shearing action reduces shaft turning torque

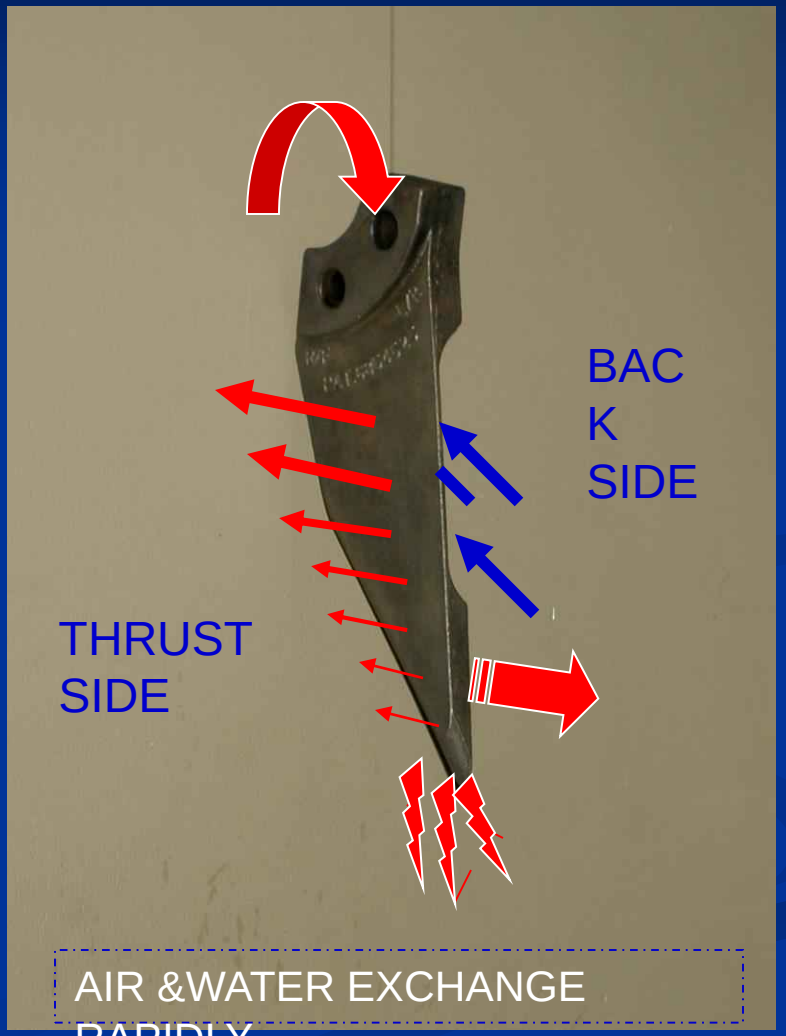
Phase Two– Fracture Force Applied

- Reduction of shaft speed produces exaggerated fracture forces by extending duration of tine contact time with the soil
- Soil fracturing visible from the front of the machine
- Beveled entry edge sharpens as it begins exit upward
- ALL Tillage is completed in 1st 90° of tine rotation in soil



The Net Effect is a Mini-Ripper !

- The secret is in controlling the speed of the tine & roller shaft
- Turning torque produced by the tines is inadequate….so
- Reduced shaft speed causes the tine tip to drag through the bottom of the insertion
- The **Density Layer** is partially destroyed so bye, bye water
- Plenty of Oxygen & Nitrogen and CO^2 exchange next rainfall
- Aerobes, beneficials & root systems love the result




Authorized Licensee of the NZ Original
HCC, Inc. Mendota, IL

KMC Basket Tooling Rotary Harrow

HCC Smart-Till ST-151

Visit us at www.genesistillage.org

How Roots Develop- Annuals

- Expanding Phase
  - Seminal roots
  - 3 day increments
  - ~90 degree window

  30-40 days- primordia grows
  - Establishment Phase
  - Filling in the blanks
  - Turning on the zein to fill
  - Root growth ends at pollination

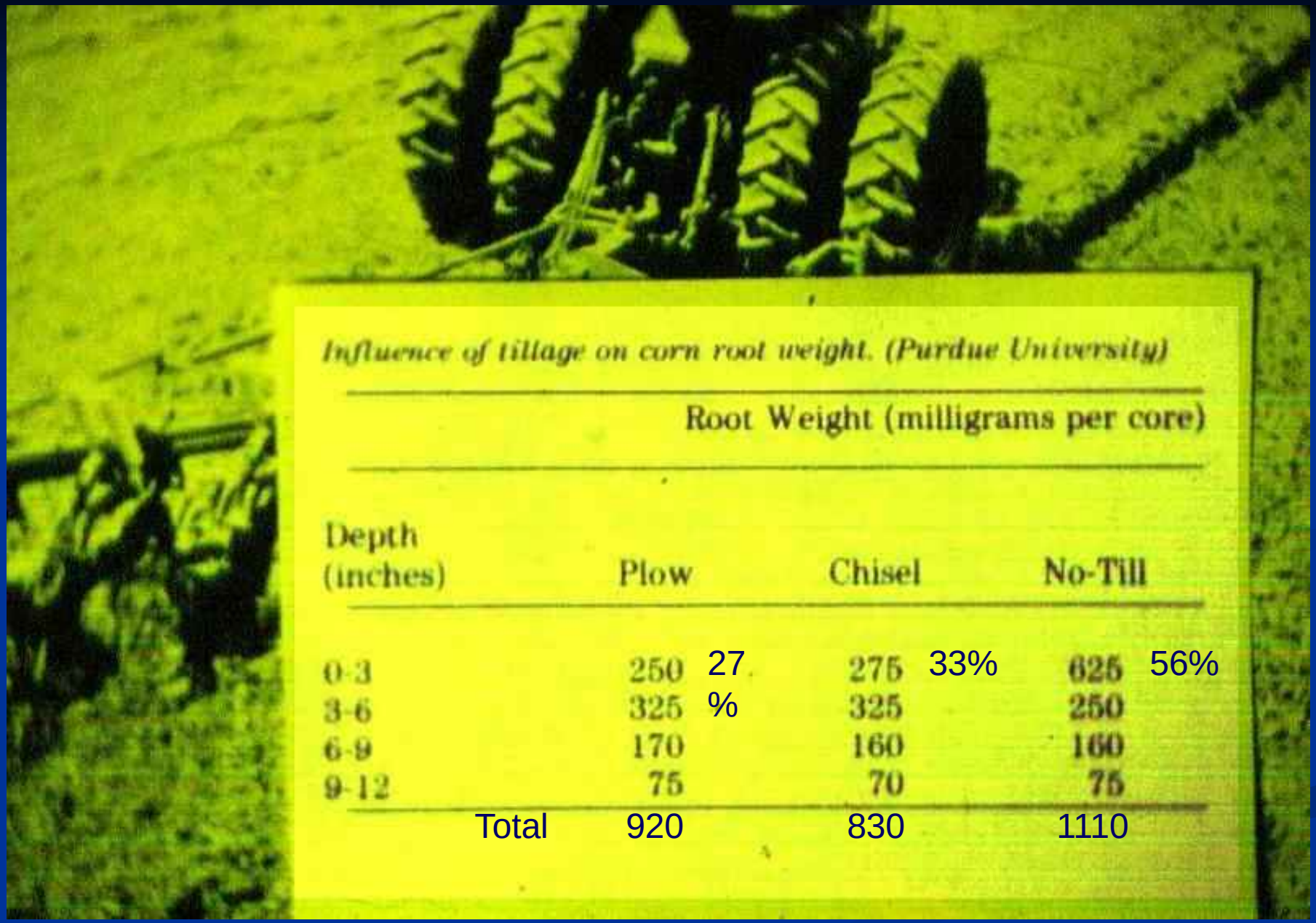
Picture is courtesy Al Trouse, retired USDA Auburn

Root Systems Tell Their Story

- Roots grow on a 72-hour time-limit clock so every minute counts
- Any delays, chemical, biological or physical that limit total depth and breadth, limit yield
- Store the water, change the air and then access it

21 Years Using Smart-Till Tine Technology

Produce Over a 6” Aerobic Zone



Influence of tillage on corn root weight. (Purdue University)

Depth (inches)	Plow		Chisel		No-Till	
			Root Weight (milligrams per core)			
0-3	250	27 %	275	33%	625	56%
3-6	325		325		250	
6-9	170		160		160	
9-12	75		70		75	
Total	920		830		1110	

Ethylene Production is the culprit in No-Till Root Design Problems

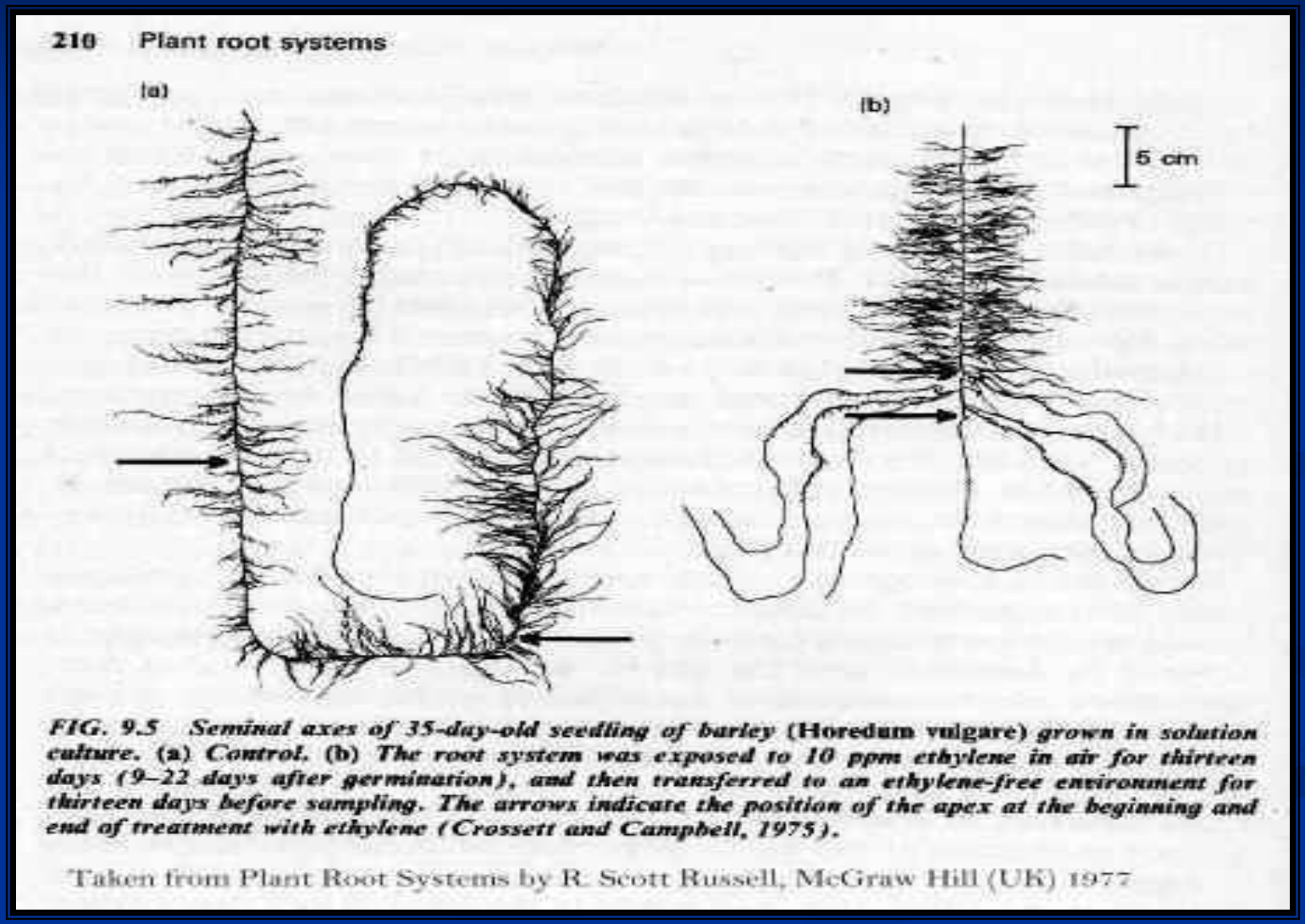
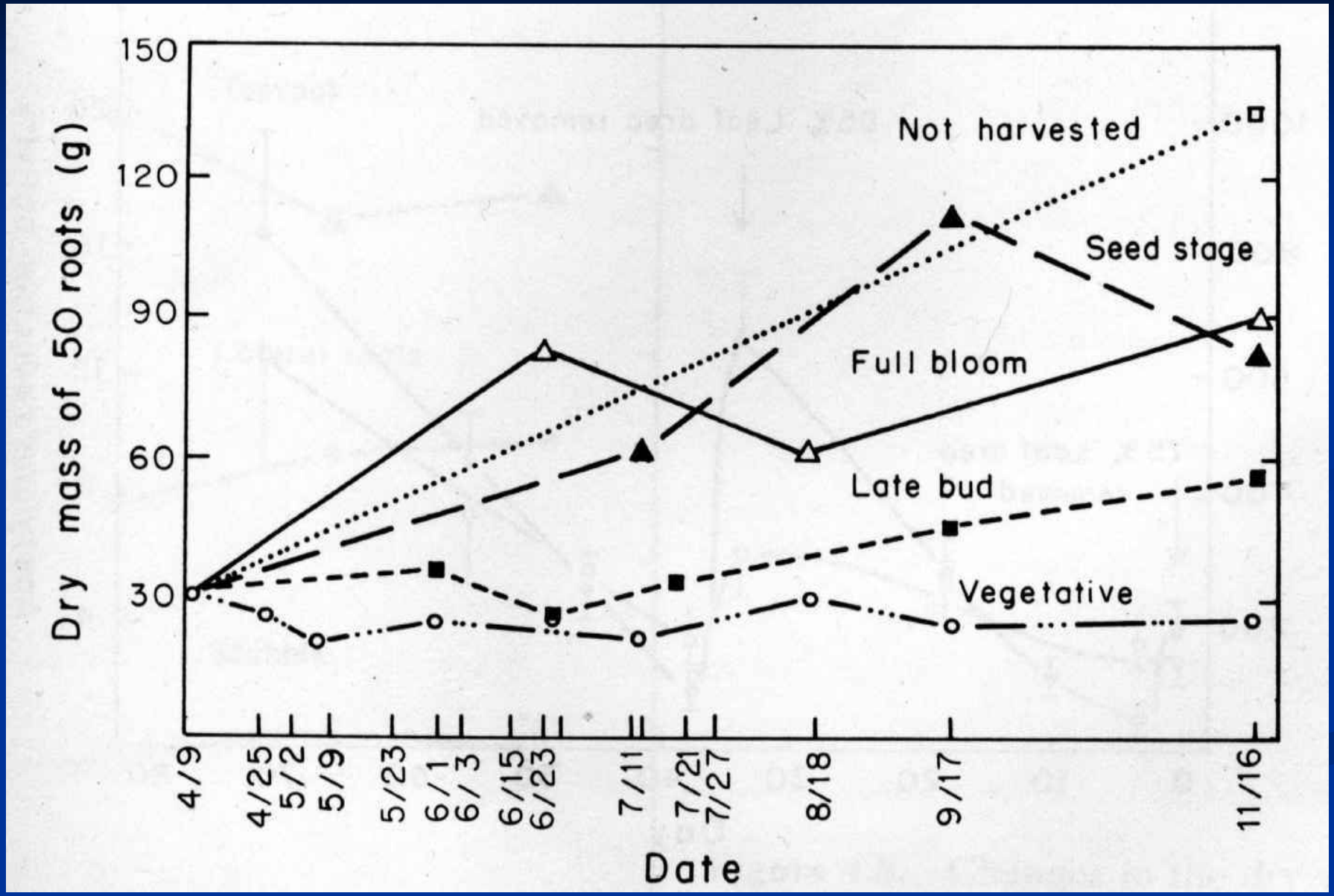


FIG. 9.5 Seminal axes of 35-day-old seedling of barley (**Horedum vulgare**) *grown in solution culture.* (a) *Control.* (b) *The root system was exposed to 10 ppm ethylene in air for thirteen days (9–22 days after germination), and then transferred to an ethylene-free environment for thirteen days before sampling. The arrows indicate the position of the apex at the beginning and end of treatment with ethylene (Crossett and Campbell, 1975).*

Taken from Plant Root Systems by R. Scott Russell, McGraw Hill (UK) 1977

ALFALFA ROOTING HABIT



Univ. of Wisconsin- 1957


I sure wish there was some way out of this wheeltrack.
Mm, Mmm!
He expects too much with roots like mine.
There's got to be a better better way...
B
S
K20
P
Ca
Mg
Loosen that compacted soil
THE "TRACK"-RECORD IN ALFALFA

Tillage can be a Management Tool

- What should it do? In the more OBVIOUS
  - Move precipitation in quickly and uniformly across the whole acreage to store the maximum amount
    - Strip-till ??
  - Evenly distribute residue on the soil surface
  - Prevent wind and water erosion
  - Leave root systems where they grew while creating new places for more new roots to develop
  - Remove shallow weeds
    - Rotary harrow
  - Make a planter or seeder work well
    - Capillary water movement to seed and/or timing it right

Dealing with Animal Waste

- One-pass fracturing soils over 8” deep plus Phillips Rotary Harrow mixing action results in no volatile or leaching losses by keeping soil biology and manure resources together near the top.

Thinking the Water Issue Through

- How many gallons of water per acre inch?
  - ~27,000

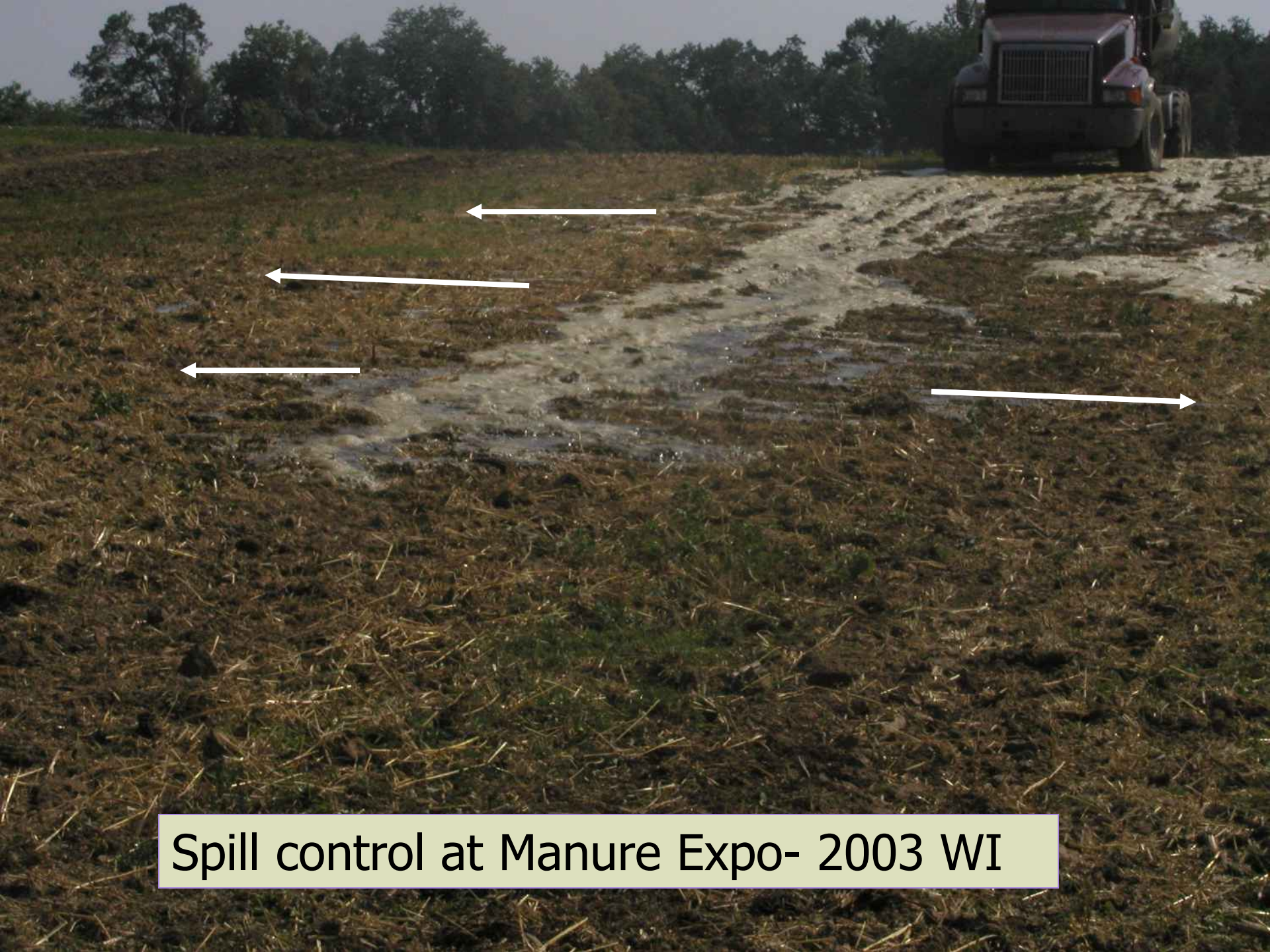
  How many gallons in Manure application?

  ~ 8,000

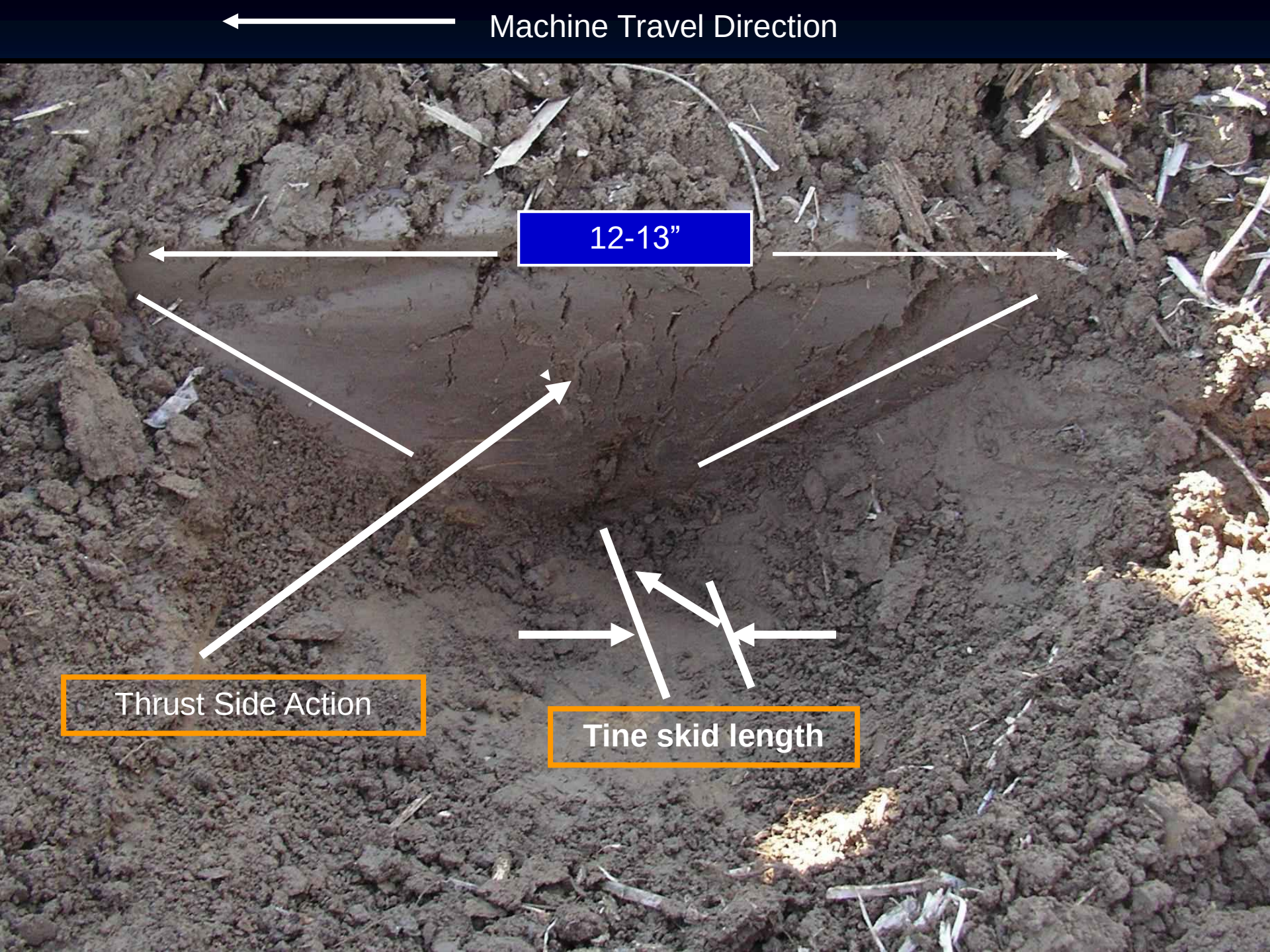
  At 25% of soil volume to hold the water how deep should manure be in your field?

  A little over 3 Inches ?

  In an 8" hole ? Not in Iowa you won't! ????



Spill control at Manure Expo- 2003 WI


Machine Travel Direction
12-13”
Thrust Side Action
Tine skid length

Machine Travel Direction

AERWAY “Shatter Tine” ???????????

Here's the Result

- The "pocket" approach.
- Firmed going in.
- Smeared and lifted out.
- "Leak-proofed" bottom.

- **IN SUMMARY**
- Localized anaerobic zone.
- Soluble nutrient headstart for groundwater.
- 8-10K increased field capacity for water=1/3" in the holes.

Technology that Makes More & Better Grass

- Sorghum-sudan hybrid seeded after spring oats with a broadcaster, & Smart-Till with Phillips Rotary Harrow

4th year With Smart-Till Technology

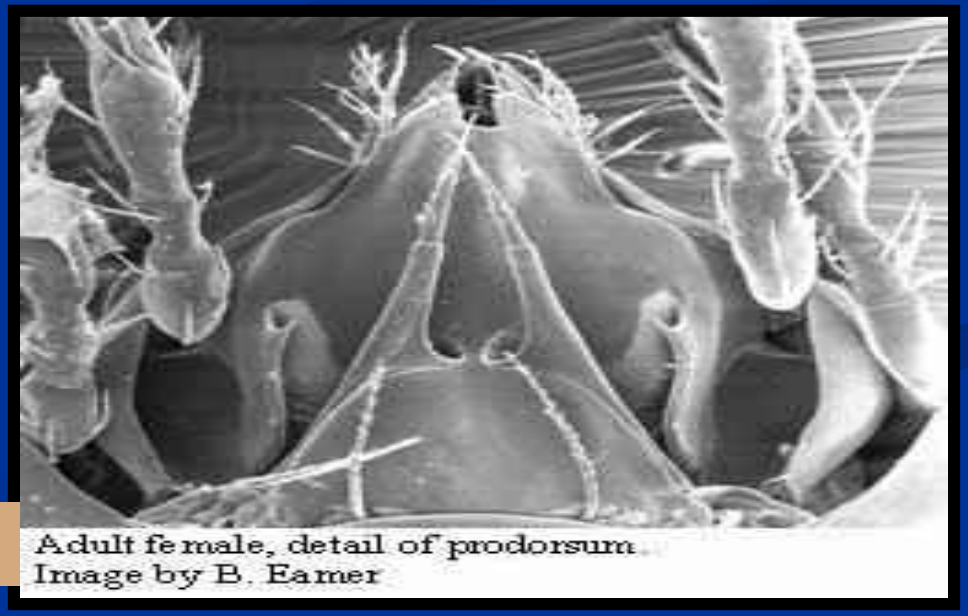
- N-West PA Twin-Row Corn
- 38,000 final pop.
- 7000 gpa dairy manure
- 120-15-70-40S from all sources
- Over 28 Ton silage on 500 acres non-irrigated

In the NOT SO Obvious?

- Change soil atmosphere… gradually but positively
- Move nutrients off the surface & into the plow-layer but NOT let them leach
- Maintain bio-sphere differentiation through strata
  - Nitrogen fixers
    - Azotobacter, nitrosomonas, blue-green algae
    - Iowa State Tillage/Soil Life Study
  - Promote beneficial insect **repopulation**
- Build humus compounds
  - e.g. glomalin- contains over 27% of total carbon

Requirements for Sustainability of the Soil Eco-System

- Till deep enough to restore air & water exchange.
- Promote extensive root development as a non-lignified carbon source for microbes, et.al.
- Provide food and shelter above ground for beneficial insects, micro-flora & fauna.
- Accelerate aerobic microbial and beneficial fungal reproduction. SAR ****



Micro-arthropod

21 Years

-Never turned

-Manured

-Lots of sulfur

-Chlorides too

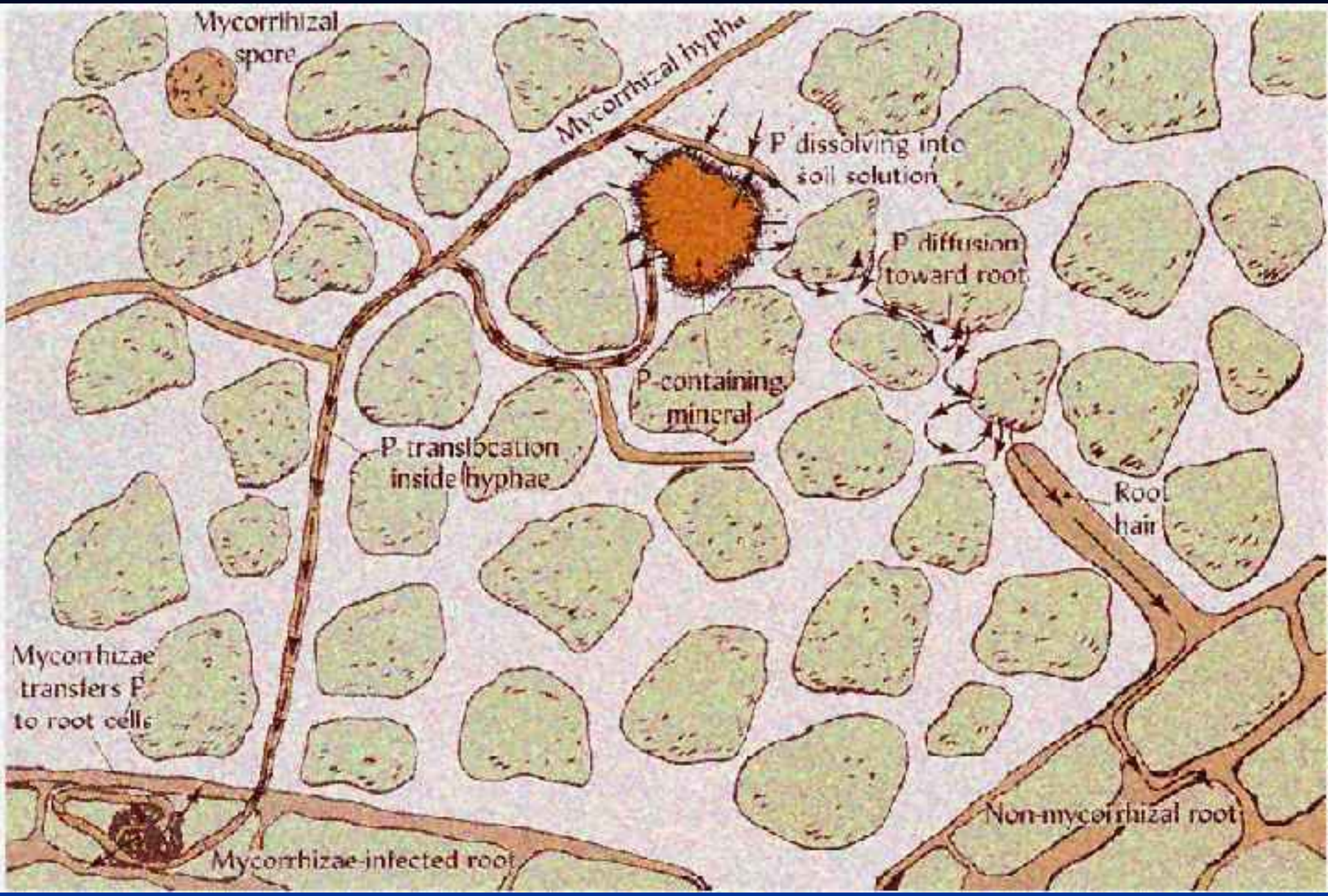
-Sodium and K salts

-Too tight to tile

-Every fall except one

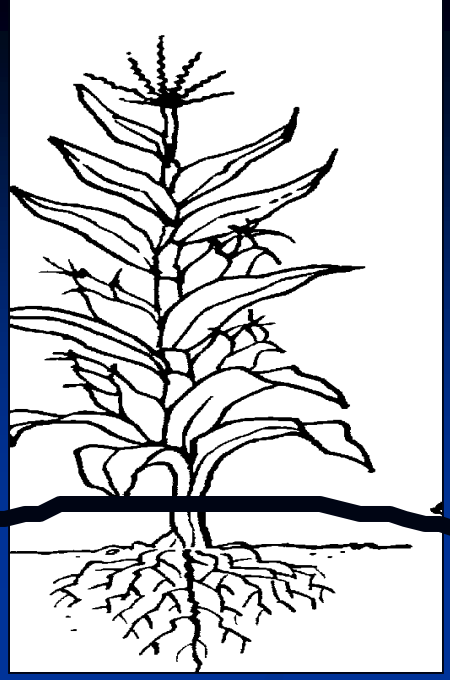
- >50% silt
- <5% sand
- The rest clay
- No “biologicals”


Cropping in Synergy


Mycorrhizal spore
Mycorrhizal hypha
P dissolving into soil solution
P diffusion toward root
P-containing mineral
P translocation inside hyphae
Root hair
Mycorrhizae transfers P to root cells
Mycorrhizae-infected root
Non-mycorrhizal root

Add a biostimulant to an organically challenged soil or a well balanced soil

Overall quality & nutrition in plant is improved dramatically



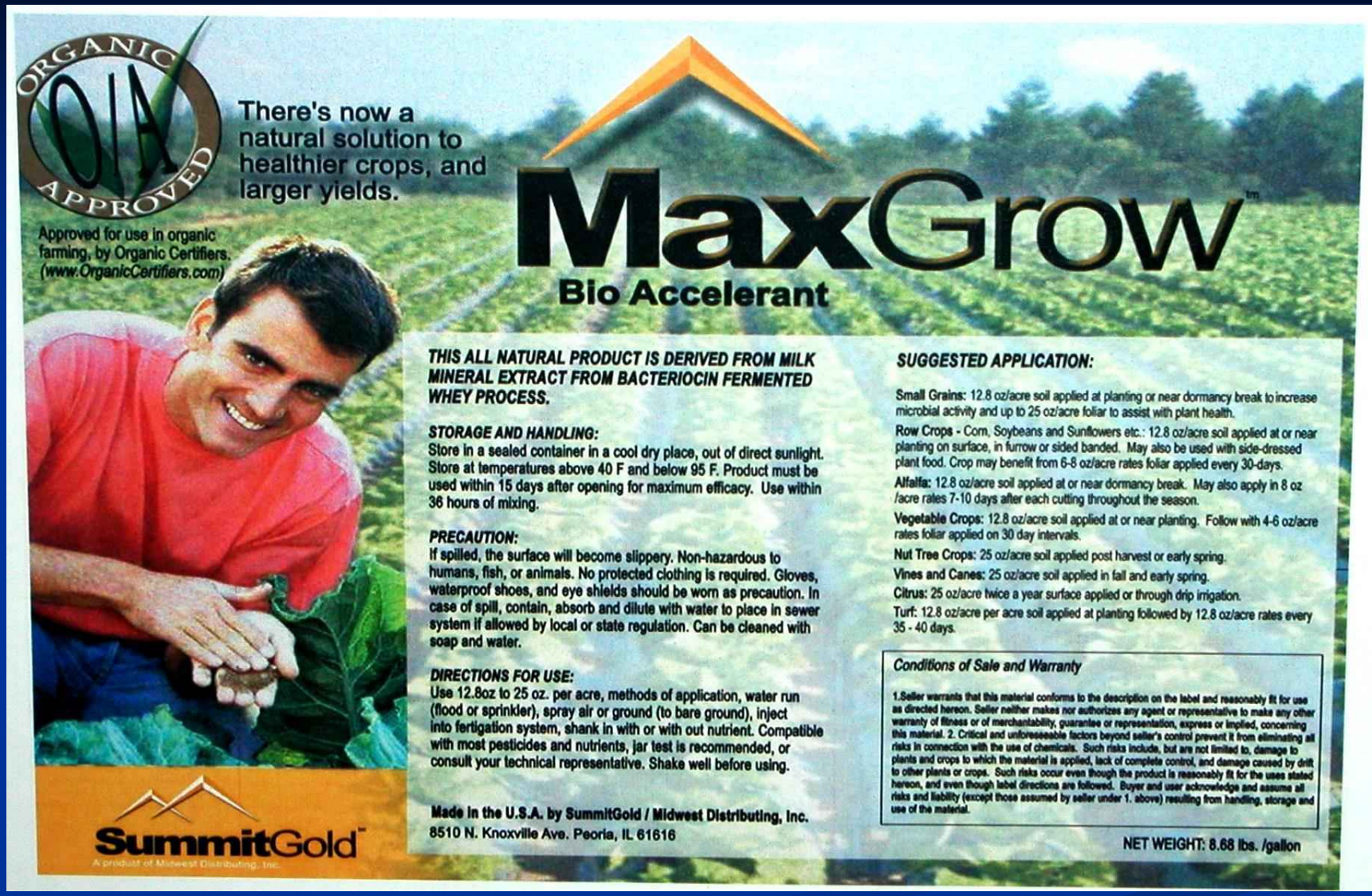
Microbes have food source to grow populations.

Plant uptake is enhanced

Microbes digest organic matter releasing fertility and organic acids

Organic acids lead to soil mineralization

Available fertility, especially Nitrogen increases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PRECAUTION:
If spilled, the surface will become slippery. Non-hazardous to humans, fish, or animals. No protected clothing is required. Gloves, waterproof shoes, and eye shields should be worn as precaution. In case of spill, contain, absorb and dilute with water to place in sewer system if allowed by local or state regulation. Can be cleaned with soap and water.
DIRECTIONS FOR USE:
Use 12.8oz to 25 oz. per acre, methods of application, water run (flood or sprinkler), spray air or ground (to bare ground), inject into fertigation system, shank in with or with out nutrient. Compatible with most pesticides and nutrients, jar test is recommended, or consult your technical representative. Shake well before using.
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SUGGESTED APPLICATION:
Small Grains: 12.8 oz/acre soil applied at planting or near dormancy break to increase microbial activity and up to 25 oz/acre foliar to assist with plant health.
Row Crops - Corn, Soybeans and Sunflowers etc.: 12.8 oz/acre soil applied at or near planting on surface, in furrow or sided banded. May also be used with side-dressed plant food. Crop may benefit from 6-8 oz/acre rates foliar applied every 30-days.
Alfalfa: 12.8 oz/acre soil applied at or near dormancy break. May also apply in 8 oz /acre rates 7-10 days after each cutting throughout the season.
Vegetable Crops: 12.8 oz/acre soil applied at or near planting. Follow with 4-6 oz/acre rates foliar applied on 30 day intervals.
Nut Tree Crops: 25 oz/acre soil applied post harvest or early spring.
Vines and Canes: 25 oz/acre soil applied in fall and early spring.
Citrus: 25 oz/acre twice a year surface applied or through drip irrigation.
Turf: 12.8 oz/acre per acre soil applied at planting followed by 12.8 oz/acre rates every 35 - 40 days.
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1.Seller warrants that this material conforms to the description on the label and reasonably fit for use as directed hereon. Seller neither makes nor authorizes any agent or representative to make any other warranty of fitness or of merchantability, guarantee or representation, express or implied, concerning this material. 2. Critical and unforeseeable factors beyond seller's control prevent it from eliminating all risks in connection with the use of chemicals. Such risks include, but are not limited to, damage to plants and crops to which the material is applied, lack of complete control, and damage caused by drift to other plants or crops. Such risks occur even though the product is reasonably fit for the uses stated hereon, and even though label directions are followed. Buyer and user acknowledge and assume all risks and liability (except those assumed by seller under 1. above) resulting from handling, storage and use of the material.
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There is a Blessing in God's Earth- The Curse Remains but is Reversed-- Isaiah 65

- Pathogens succumb.
- Humus forms.
- Topsoil is produced faster than it is washed away.
- The streams run clean.
- Natural fertility is released.
- Is. 28:21- A Rebuke