Some numbers

- We assume that the weight of the inorganic components of soil is $2.65 \text{ g cm}^{-3}$
- If the BD of a soil is 0.7 (assume no OM) what is the pore space?
  \[ \frac{0.7}{2.65} = 74\% \]
- $1.5? = \frac{1.5}{2.65} = 43\%$
- $1.85? = \frac{1.85}{2.65} = 30\%$

You want Macropores

- More conducive to root penetration
- More conducive to air movement
- In a fine texture soil - macropores enable plant growth

Using conventional ag

- Incorporate more air into soil
  - Break down organic matter
- Plowing can break existing aggregates
  - Decrease number of macropores
- Soil compaction
- Can lead to formation of a plow pan
  - Cemented layer as a result of compaction

Moldboard plow - lifts and turns soil

Heavy equipment especially under improper conditions
Conservation tillage - Mulchtiller
Only a portion of the soil is disturbed

No till agriculture
Conservation tiller

Crop residues

Use of organic amendments
- Manures
- Biosolids
- Crop residues
- Composts

Mark Sheppard wants all the flotation he can get. He works anywhere from 25 to 35,000 acres around Loving, Texas, where much of the soil is sandy and easily disturbed. He needs the kind of low ground contact pressure and high flotation narrow tires can't provide. With Firestone Flotation 23° Center Rib tires up front and Firestone Flotation 23° DTs in back, he's riding high.

Non agricultural
Heavy traffic

One reason trails exist
Reading the fine print

- Controlled traffic
- Wide wheels
- No till - conservation tillage
  - “Under some circumstances, less pore space has been found with conservation tillage than with conventional tillage”

Organic amendments

- Not been observed to decrease soil tilth
- I say it’s the answer

Focus on air and water

What plants need air and water for

- Respiration            Photosynthesis

What is respiration?

- Process of getting energy from food

Aerobic Respiration
Most things do this

- How we get energy from food
  \[ C_8H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O \]
- This means that we need O\textsubscript{2} to eat
- Here the we are plants, aerobic micro-organisms, larger biota (worms, nematodes, moles...)
- It also means that we produce CO\textsubscript{2} in the process
C₆H₁₂O₆ + 6O₂ → 6CO₂ + 6H₂O
(sugar)

• This means that we take C in a reduced state (C₆ valence = 0, H₁₂O₆) and release energy by oxidizing C (6C valence = +4, O₂)

• We take the electrons from the C and dump them on the O (that is why its aerobic respiration)

• 6O₂(valence = 0) → 6CO₂ + 6H₂O(valence = -2)

Photosynthesis
Only plants do this

• How plants make food
  6CO₂ + 12H₂O → C₆H₁₂O₆ + 6O₂ + 6H₂O
• Plants need water and CO₂ to photosynthesize
• CO₂ fixation takes place in the leaves
• Respiration takes place in the roots and leaves

This means

• That there is a lot of CO₂ being released in the soil
  – By all the creatures that use aerobic respiration
• Also a demand for O₂ in the soil
  – By the same creatures

And

• That the demand for CO₂ is being satisfied by the leaves above the soil
• This means you need good air exchange between soil air and the air to maintain sufficient O₂ in the soil

In addition

• Certain gases can be produced by roots that can be phytotoxic in small concentrations
  – Ethylene

• These need to move out of soil as well

Review - What air contains

• Nitrogen 78.1%
• Oxygen 21%
• Carbon dioxide 0.03%
• Argon 0.09%
Respiration

- Use $6O_2$ to give off $6CO_2$
- Oxygen 21%
- Carbon dioxide 0.03%
- Tendency to accumulate $CO_2$ in the root zone

For a soil to function well

- Need rapid air exchange
- Wind generally does not blow through the soils

Diffusion - things move to reach equilibrium

Move as a function of concentration

Macropores provide for most efficient movement

So when the soil stays waterlogged for extended periods

- The macropores are filled with water instead of air
- Plants start to die - they can’t breathe
For forests and fields, this is how things work

- However, there are specialized plants that have developed ways to grow in waterlogged soil
  - Rice - aerenchyma pipe air down
  - Mangrove - surficial roots
  - Wetland species

What is the big fuss about wetlands?

- Remember how aerobic organisms (humans and plants) use carbon for energy and dump the electrons on oxygen?
- In wetlands, there is not enough oxygen to go around
- Alternative electron acceptors

Without oxygen

- As the number of electrons needing a home goes up
- eH (or electron pressure) goes down
- Alternatives, such as N, Fe, Mn, S, are used by specialized organisms (anaerobes) as a home for the electrons

\[ N_{(\text{valence } = 5^+)} + O_3 \rightarrow N_2(\text{valence } = 0) \]

- N is an ion
- N is a gas

- This is why wetlands are so good at getting rid of excess nutrients