Soil particles are re-arranged and compressed

- Reducing pore space and increasing bulk density.

Compaction occurs when applied force is greater than the soils load bearing strength.
Adverse Effects of Compaction

- Poor aeration
- Poor water infiltration and drainage
- Poor root growth
- Reduced nutrient uptake and water availability
- Difficult to plant into compacted soils!
- Emergence limitations
  - Surface crusts
Normal Soil
Compacted soils

- Compaction reduces number and volume of macropores
- Reduced aeration, drainage and root growth
Compacted soils can have more significant aeration problems when wet.
Are hard soils always compacted?

- No!
- Dry soils are hard!
- Clayey soils can be hard but not necessarily compacted.
  - Clays can have production limitations similar to compacted soils

Hard = resists penetration or forms clods that are difficult to break apart.
Hard vs. Compacted Soils

- Compacted soils will always resist penetration
  - Even when moist.
- These distinctions are important when trying to diagnose and alleviate compaction.
Evaluating Soil Compaction

- Using a Penetrometer.
  - *Sensitive* to soil moisture
  - Dry soils will have high resistance to penetration
  - Used when soils are at field capacity
  - Root growth is restricted at 300psi
Evaluating Soil Compaction

- Best tools are a shovel and your eyes
- Look for horizontal soil structure and root growth
- Evaluate root growth of tap rooted plants. Fibrous roots can also show compaction.
Influence of Soil Texture on Compaction

- Moderately coarse soils such as Sandy loams are most susceptible to compaction.
  - Large pores between sand grains fill with smaller silt and clay.

- As the clay content increases, potential for compaction decreases.
  - Less air filled pore space under moist conditions (must move water out to compress soil)
  - Clays are more cohesive, (more difficult to move around).
Soil Moisture and Compaction

- At field capacity, water lubricates soil particles.
- Pressure is distributed deeper into profile.
Soil Moisture and Compaction

- Traffic on wet soils causes ruts and significant subsurface compaction
- Of course, compaction occurs without ruts too!
Tire width and inflation

- Wide tires reduce surface compaction
- Less effective at reducing subsurface compaction

Tire: 6,5-20  10-18  6,5-20  10-18
Pressure: 40  20  10

(PSI)
Compaction in No-till vs Conventional tillage

- Surface tillage provides **short term** reduction of compaction at surface:
  - Provides ideal seed bed
  - BUT can create a plow pan

- Heavy traffic and grazing can compact soils in both systems

- No-till can alleviate plow pan but surface compaction can still be a problem.
Effect of No-till on Plow Pans

- Removes pressure applied by tillage implement
  - Concentrated and uniform pressure at depth causes plow pan.
- Allows soil processes to break plow pan apart
  - Freeze and thaw cycles
  - Shrink and swell during drying and wetting
  - Root penetration
No-till effect on Subsurface Compaction
Effect of No-till on Surface Crusts

- Force of raindrop hitting the soil surface forms surface crusts.
- Crop residues protect soil surface from raindrops
  - Can improve emergence.
Alleviating Compaction in No-till

Sub-Soiling

Generally a short-term solution with inconsistent yield response
Sub-soiling

- Soils should be dry when sub-soiled
  - Dry soils will shatter
- Sub-soiling a wet soil will simply create a narrow channel.
Alleviating Compaction in No-till

Control Traffic

How do we do it?

- Limit Grazing
- GPS guidance
- Tramlines
Limit Grazing

- Minimize grazing during wet periods
  - Spring graze out.
- Maintain surface residue
  - OM accumulation will limit shallow compaction
GPS Guidance and Tramlines

- Limits compaction to confined areas of field.
- Return accuracy of GPS will determine size of compacted area.
GPS Guidance and Tramlines

- **Tramlines:**
  - Created during planting by plugging rows
  - Provides accurate return to traffic pattern
Final Thoughts

- Some level of soil compaction is inevitable in modern crop production.
- If soils are very susceptible to compaction, prevention is the key
  - Control equipment traffic and grazing, and maintain surface residue.
- Deep tillage may be warranted for severe compaction
  - Cause of compaction must be removed
Questions?