Agronomic and Environmental Impacts of Soil Compaction

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What is compaction?
- It's simply a reduction in the macro-porosity of soil
- It is relative to an initial or inherent condition

UNM extension
Problems caused by compaction

- Reduced aeration
  - Root health
  - Denitrification
- Reduced water infiltration
  - Increased drought stress
  - Increased runoff and potential offsite nutrient transport
- Root growth restrictions
  - Nutrient deficiency
  - Drought stress

Most common causes of Compaction

- Crusting and Slaking
- Traffic Compaction!
- Pinch Row Compaction
- In furrow sidewall compaction/smearing
- Tillage Compaction!
- Grazing
Soil Crusting
- Reduces water infiltration
- Reduces crop emergence
- A soil's susceptibility to crusting is influenced by texture, sodium content, and organic matter.

Slaking
- Occurs when water is applied to dry soils rapidly.
- The soil aggregates can explode if not stabilized by organic matter or other adhesive constituents.
- Image this occurring in the soil profile
- Clogs macropores
How do we manage crusting and slaking

- We manage for soil health improvement
  - AKA conservation management
- No-till is the most effective way to illuminate crusting
- No-till will improve aggregate stability and reduce slaking
- High surface residue crops with fibrous root systems will be most effective.
- Minimum tillage that maintains residue can limit crusting as well.

Tillage compaction

- Cause by the pressure at the bottom of the cutting blade
- Can also simply be smearing from the cutting blade
- Not as common as use to be
- Alternating tillage depths is best strategy for prevention
Traffic Compaction

- As equipment size increases this has become a greater concern.
- It's important to think about surface compaction as well as subsurface compaction.
- Subsurface compaction is influenced by axial load.
- Surface compaction is controlled by contact pressure.

Contact Pressure

- Controlled by tire pressure and footprint.

Source: Soehne, 1958.
**Subsurface Compaction**

- Dictated by axle load
- A larger footprint does not reduce the depth of pressure transfer

![Diagram of Subsurface Compaction](image)

**General considerations for managing traffic compaction**

- Minimize axle loads traveling across fields
  - Hard to do with today's equipment unless we add more axles
- Check tire pressure
  - Anything below 10psi is doing good by the soil
- Avoid field activity during wet conditions
- Consider Controlled traffic lanes with possible.
**Controlled Traffic.**

- I like this concept for farms with large equipment
- Minimizes whole farm subsoil compaction
- Can cause intense surface compaction
- Can allow more rapid re-entry after rainfall
- Must have capital to set it up.

**Pinch Row Compaction**

- Intense compaction from central seed hopper planters
- Can stunt plant growth due to drought stress reduced nutrient availability
In furrow sidewall smearing

- Planting in wet conditions can cause roots to be concentrated in furrow.
- Very problematic if dry conditions follow planting.

Crop yield response to compaction

- As mentioned compaction reduces root exploration, water infiltration, and therefore nutrient and water availability.
- Much of this is in the soil surface.
- Sub soils often have much more strength to hold up against compaction.


What about ruts??

- Ruts are inevitable in years like 2019
- They are mostly a surface roughness problem and after they are smoothed often don’t cause long-term limitations
- Saturated soil is hard to compress
- Subsoil strength limits its compression
What should we do to remove them?

- Nothing?
  - I am not a fan of this plan even in no-till systems
  - Ruts provide a non-uniform planting surface
  - Results in appropriate seed placement which in itself can explain reduced yields

Impact of Seeding Depth on Corn performance

- Whether it be from poor planter setup or irregular soil surface conditions. Seed placement is important.
Early on, many producers were fearful of compaction in no-till. However, as soil aggregation improves no-till soils can become less susceptible to compaction. Stable macro-porosity can form from root channels and borrowing insects and worms.
Soil Health and No-till

- Soils were compacted at increasing moisture levels.
- The Maximum bulk density to which No-till could be compacted was lower

No-till and Compaction

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Artificial layers are not the same as soil horizons which have structure which varies in strength and size across the landscape.

If we historically plowed 2ft deep then this might represent our compaction.

As I have mentioned much of the detriment of compaction is from its effect on the soil surface.

This is because it’s made to be friable, to allow for prolific root growth and rapid water infiltration.

Generally has lighter texture and granular structure.

Easily compacted.
How does the Inherent soil Characteristics Impact Compaction

- Sub soils have increased clay content and will have blocky or prismatic structure.
- The structure in a subsoil is often firm or very firm.
- Meaning it has strength to resist compaction.

Common Ideal structures

- **Soil Structure**
  - Granular
  - Blocky
  - Prismatic
  - Peds

Images from NASA Soil Science Education website.
This soil has a dense layer at 36”
Rooting depth appears to be 28”
May be useful to break plow pan at 8-11”
Eldean series

- This is not a great soil
- It's shallow to clay layers and parent material
- Fine roots are only found to 23"

Kokomo series

- The clay content and firm structure limit subsoil compaction
- Fine roots are found to 50"

- Loam Granular Friable
- Loam Subangular Blocky Friable
- Clay Subangular Blocky Firm
- Clay Subangular Blocky Firm
- Very Gravelly Clay Subangular Blocky Friable
- Sand and gravel Single grain Loose

- Silty Clay Loam Granular Friable
- Silty Clay Loam Subangular Blocky Firm
- Silty Clay Loam Subangular Blocky Firm
- Silty Clay Loam Subangular Blocky Firm
- Loam Massive Friable
This soils presents the most potential for subsoil compaction problems

Fine roots are found to 38”

Kokomo series

Deep Tillage to alleviate Subsoil compaction

I am not a big proponent

There is very little consistent data to show that it pays off

If we can get to below historic tillage layer (12 inches), we may just be destroying the deep structure

We need dry soil moisture to allow fracture

However in many soils this will just result in a bunch of sheared bolts
Deep Tillage to alleviate Subsoil compaction

- Remember that just because pressure from heavy loads is transferred to depth, it doesn't mean we have caused a problem that we should try to fix.
- This is especially true in soils with clay contents equivalent or greater than clay loam.

The Problem with Rippers

- If your fracturing real limiting compaction your likely pulling clods
- Secondary tillage is then needed which could recompress the soil.
- In general its better to use management to minimize deep compaction
- 12 inches is the deepest I would generally try to alleviate
Smoothing ruts in No-till

- Think about what other issues we might be able to address when choosing an tillage implement
- Is deep compaction relief needed
- Is incorporation of lime needed
- Is nutrient stratification an issue?
- I generally prefer a chisel or sweep but if inversion is needed then could be persuaded to use a disk.

Let's take it one Component at a time. Soil pH.

Each point is the average of four samples, 1 per rep.
Summary

- Soil compaction can provide for limitation to yield.
- The increasing size and weight of equipment will make this a growing challenge.
- Generally deep compaction plays a minor role due to strength of subsoil.
- No-till provides resilience but this takes time to develop.
- If you have ruts fix them but be thoughtful.

Questions

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