What is Residue Management/Conservation Tillage

- Any tillage or planting system that maintains at least 30% crop residue cover on soil surface (leaves about a third of soil covered after planting).
This full-width tillage system usually only includes one or two tillage passes.

Yet after planting, at least a third of the surface remains covered with residue.
Residue Management, No-Till & Strip-Till

• No-till: Leaving the residue from last year’s crop undisturbed until planting.

• Strip-till: No more than a third of the row width is disturbed with a coulter or specialized shank that creates a strip. If shanks used, nutrients injected at same time.
Why Use a Conservation Tillage System? Environment:

1. Reduce sheet and rill erosion.
2. Reduce wind erosion.

<table>
<thead>
<tr>
<th>Residue Cover, % on Any Day</th>
<th>Erosion Reduction, % While Residue is Present</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>30</td>
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<tr>
<td>20</td>
<td>50</td>
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<td>60</td>
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<td>70</td>
<td>91</td>
</tr>
<tr>
<td>80</td>
<td>94</td>
</tr>
</tbody>
</table>
Why Use a Conservation Tillage System? Environment:

3. Maintain or improve soil organic matter content and tilth.
   - Each tillage trip oxidizes some organic matter
   - Continuous no-till can increase organic matter in top 2 inches of soil about 0.1% each year.
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Why Use a Conservation Tillage System? Environment:

4. Conserve soil moisture. (Improved infiltration and increased organic matter; tillage reduces available moisture by about 1/2” per trip)

Residue reduces evaporation:

<table>
<thead>
<tr>
<th>Surface Cover %</th>
<th>Relative Potential Evaporation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1.00</td>
</tr>
<tr>
<td>10</td>
<td>0.90</td>
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<td>20</td>
<td>0.78</td>
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<td>30</td>
<td>0.70</td>
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<td>40</td>
<td>0.67</td>
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<tr>
<td>80</td>
<td>0.58</td>
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</tbody>
</table>
Why Use a Conservation Tillage System? Environment:

5. Manage snow to increase plant available moisture.
6. Improves water quality
7. Provide food and escape cover for wildlife.
**Why Use a Conservation Tillage System?**

**Economic:**

1. **Yields** - are as good, if not better.
2. **Saves time and labor**

   On a 1000-acre farm, an additional 100 hours needed for every pass (example based on 18’ disk, 160 Hp FWD)
Why Use a Conservation Tillage System? Economic:

3. Reduces fuel consumption
   No-till can reduce fuel use by 3.5 gal/ac

4. Reduces machinery wear
   Less machinery means fewer pieces need to be replaced. Up to a $10/acre cost reduction
Differences in residue cover between Conservation Tillage practices

- No-till leaves the most surface residue
  - With high residue crops, e.g. corn, wheat, sorghum, 75% +
  - With low residue crops, e.g. soybeans, cotton, residue cover is significantly less
    - a cover crop may be needed to meet residue goals
    - In some climates, some residue cover may carry over from year to year
  - Winter annuals also add to surface residue
Differences in residue cover between practices, continued:

- Mulch-till residue levels can be significantly less than no-till
- With high residue crops, 30-50% possible
- With low residue crops, difficult to retain 30 percent
- May need cover crop to achieve residue goals
Management of Residue

- Surface residue must be evenly distributed
- Residue decomposes with time
- If target is 40 percent cover after planting, will need more over winter
- May need to control winter weeds in dryland areas
Management of Crop Residue, continued:

• Crop residue and moisture level impacts soil temperature - less variation
• Under no-till, soil temperatures will be cooler
  – May be critical in cool, wet springs
  – May be justification for strip-till
• Less extremes in soil temperature under no-till may result in increased root growth and improved soil biological activity
Residue Management - Irrigation

Surface residue

- slows flow - especially with furrow
- increases opportunity time, water holding capacity, random roughness (structure)
- decreases surface evaporation
- cools seedbed temperature
Residue Management - Irrigation

- More difficult - small seeded vegetables
- More requirements for incorporation of pesticides
- Management techniques may need modification
  - especially with furrow irrigation.
Potential Problems from Residue

- Residue may float off of field
- Accumulate in fence rows and road ditches
- If not evenly distributed can cause planting/weed problems
- May have cool, wet soils at planting
Low Residue Crops (i.e., Vegetables)

- Residue orientation and row orientation become more important
- Leave as much residue standing as possible
- Orient rows perpendicular to prevailing wind direction
Benefits of Increasing Organic Matter

- Soil aggregate stability increases
- Plant available water increases
- Cation exchange capacity of soil increases
Crop Residue and Microorganisms

- Provides an energy source for microorganisms
- As surface residue increases, microorganisms increase
- Through their life processes, they return humus to the soil
- When residue is plowed under, residue is rapidly consumed and microorganism processes end
Crop Residue and Microorganisms, continued:

- Microorganisms utilize surface residue slowly, remain active for longer periods, and significantly improve soil humus.
- When soils are tilled, it is similar to stirring a fire.
- $\text{CO}_2$ is one of the greenhouse gases.
Microorganisms can tie-up Nitrogen, continued:

- Microorganisms utilize N during decomposition process
- N is temporally tied-up, but released during growing season
- Under no-till systems, N release is more evenly distributed during growing season compared to conventional systems.
- No-till systems do not have typical flush of N released as in conventional systems
Soil Properties - Soil Structure

- Surface soil becomes more granular and friable with continuous residue management systems
- Extent of change is dependent on the residue management practice used, climate, and soil
Soil Properties - Soil Structure, continued:

- Changes apparent in about 3-5 years with no-till/strip-till and ridge-till
- Type of soil and climate strongly influence the rate of this change
Expected Changes in Soil Structure with Residue Mgt. Systems

- Improved soil aggregate stability
- Improved water holding capacity
- Increased granular structure at the surface
- Less surface ponding of rainfall
Soil Properties - Infiltration

- Major benefit from Residue Mgt.
- No-till/Strip-till and Ridge-Till
  - improved soil structure
  - slowed runoff
  - leaves old root and macropore structure undisturbed
  - fastest way to improve soil quality
Soil Properties - Infiltration, continued:

- **Mulch-Till**
  - full width tillage disturbs macropores
  - slows runoff due to increased surface roughness
  - chisel can break-up shallow compaction layers
Role of Macropores

- Develop from decayed root channels and earthworms
- If open to the surface infiltration may be significantly increased
- May be direct conduit for contaminants
Role of Macropores, continued:

- Full-width tillage disturbs macropores to depth of tillage
- In Argentina, years of tillage are referred to as “aggression” and years of no tillage are “recuperation”
Soil Properties - Compaction

- Compaction created by tillage and vehicle traffic can be corrected

- Other compacted layers occur naturally and may or may not be correctable
Soil Properties - Compaction, continued:

- May be extremely limiting factor in crop production
- Limits root penetration
- Reduces water and nutrient uptake
- Problem may not be evident if adequate moisture
Soil Properties - Compaction, continued:

- Correct compaction prior to no-till/strip-till or ridge-till
- Once corrected, stay off field when soils are wet
- Keep grain carts/trucks to certain areas
- Controlled wheel traffic with ridge-till is important benefit
Soil Properties - Compaction, continued:

- Soil surface bulk density may increase with no-till/strip-till
- May require adjustments at planting
Soil Properties - Crusting

- Serious concern in soils low in organic matter, like NM
- More prevalent on soils excessively tilled
- Can interfere with crop emergence
- May require operation to break crust
Soil Properties - Crusting, continued:

- Residue mgt. Practices can reduce crusting - especially no-till
  - Surface residue absorbs impact of falling raindrops
  - Organic matter is increased
  - Improved aggregate stability
Water Quality - Sediment

- Sediment is number 1 pollutant
- Creates physical problems
- Potential hazard to fish and wildlife
Water Quality - Sediment, continued:

- Residue mgt. practices can result in a major benefit through:
  - reduced soil erosion, improved aggregate stability, and increased organic matter
Water Quality - Sediment, continued:

- Greater amount of surface residue, the greater the reduction in soil erosion

- As erosion is reduced, sediment delivery is generally reduced
Water Quality - Nutrients

• Phosphorus attached to soil is slow to move in the soil profile
• But soil attached phosphorus can move with surface runoff
• Residue mgmt. practices reduce soil erosion, improve infiltration, and reduce runoff
Water Quality - Nutrients, continued:

- Nutrients that are dissolved but not infiltrated the soil can move freely in surface runoff

- Nitrate-nitrogen can move freely as water percolates through the soil
Residue mgt. practices often increase water infiltration - care must be taken when applying nitrogen.

If nitrogen is fall applied, consider nitrification inhibitor.

Apply nitrogen as close as possible when crop needs are greatest.
Water Quality - Nutrients, continued:

- Use caution when manure is surface applied
- Avoid applying on frozen ground
- Injecting manure reduces risk of surface runoff, but there are tradeoffs
- With mulch-till, manure may be incorporated using one of the planned tillage trips
Water Quality - Pesticides

- Pesticides can be soluble or attach quickly to soil particles.
- If soluble, can move with surface runoff.
- If attached to soil particles, can move offsite via erosion.
Water Quality - Pesticides, continued:

- Residue mgt. practices reduce erosion, surface runoff, and sediment delivery
- Increase infiltration which may be detrimental where shallow groundwater exists
- Extensive macropores, open to the surface raise some concern
Water Quality - Pesticides, Macropores and Solute Movement
Earthworm channels contain large amounts of O.M. This O.M. material can help absorb pesticides. Earthworm channels have increased microorganism activity.
• Timing and amount of precipitation important
• With small rain pesticide moves into soil profile
• If large storm occurs before pesticide enters soil, direct entry into macropore is possible
Avoid surface application of a pesticide, especially if highly soluble, just prior to an imminent storm if not immediately incorporated.
Water Quality - Pesticides, continued:

- Mulch-till provides opportunity to make a tillage pass to incorporate a pesticide
Air Quality - Particulate Matter

- Particulate matter of 2.5 or 10 microns (PM-2.5 or PM-10) is a potential health hazard
- Can occur from wind erosion events, smoke, and tillage operations
Surface residue reduces soil erosion caused by the forces of wind.

No-till/strip-till, ridge-till, and mulch-till should provide sufficient cover to reduce air quality hazards.

Exception, low residue-producing crops.

Air Quality - Particulate matter continued:
Surface roughness created with mulch-till may add additional temporary protection
Air Quality - Animal Manure Application - Odors

- With no-till/strip-till and ridge-till, surface application can present odor concerns
- Consider wind direction at time of application
- Consider nearness of neighbors
• Odors can be significantly reduced by injection
• Choose injection equipment that does not excessively disturb soil and surface residue
• A large application without secondary tillage may burn the new crop
Conservation Tillage – Bottom Line

• Helps keep topsoil, nutrients (P), and crop protection products on your fields and out of creeks, streams and lakes

• If you properly manage crop rotation, soil conditions, irrigation, equipment selection and adjustments, plant nutrients, and weed control, it helps improve yields and soil productivity