WASHINGTON STATE UNIVERSITY **GRANT/ADAMS COUNTY EXTENSION** 

December 2, 2009 Big Bend Community College, Moses Lake, Washington

# High Residue Farming under Irrigation

# Workshop Digest

his publication summarizes speaker presentations from the 2009 High Residue Farming under Irrigation workshop. For more information contact the WSU Extension office in Ephrata (509-754-2011 ext. 413, amcguire@wsu.edu).

Specific pesticides or uses of pesticides mentioned in this publication may not be labeled for use in Washington State. Always use registered pesticides according to their label.



Roller Crimper used in Organic No-till

#### Workshop Agenda

High Residue Farming Resources, Andy McGuire, WSU Extension Soil Compaction and High Residue Farming, Randall Reeder, Ohio State University, Columbus Soil-Air-Water-Residue Interactions in HRF Planting, Andy McGuire Opportunities for Organic No-till Vegetables, Doug Collins, WSU Extension Worst Case Scenario: Results of the HRF Demo Project, Andy McGuire Getting Into Controlled Traffic, Randall Reeder Grower Panel, Dave Gossett – Observations from the HRF Demo Project Lorin Grigg – Strip-tilled sweet corn and onions Tom Gregg – Strip-tilled corn

Andy McGuire, WSU Extension

1) What is high residue farming?

Classification		Primary Tool(s)	Tillage Intens	Tillage Intensity Residue Cov		overage		
Clean-till		Moldboard plow	High, soil inver	sion				
Clean-till			Heavy offset disk	High				
Reduced-till			Chisel plow, disk	High				
Reduced-till, Minimum-till, Mulch-till		a a	Chisel plow			>30%		
Strip-till	ming	ı tillagı	Strip-till implement					
Zone-till	ue Far	rvatior	Gang of coulters on planter, row cleaners					
Direct seed, No-till*	Resid	Conse	Planter with row cleaners					
Direct seed, No-till	High		Planter without row cleaners			80	-10	0%
* Direct seeding and No-till refer to the same practice			practice					

- a) The name *high residue farming* draws attention to the fact that many of the benefits of these systems are a result of keeping the soil covered with a layer of residue.
- b) Many topics related to high residue farming are covered in previous workshops and available in online digests at <u>http://csanr.wsu.edu/pages/High\_Residue\_Farming\_Under\_Irrigation.</u>

# Soil Compaction and High Residue Farming

Randall Reeder, Ohio State University, Columbus

- 1) The main cause of soil compaction is heavy machinery
  - a) Tractors
  - b) Combines
  - c) Grain carts
    - i) Farmers often run heavier loads per axle on their fields than is allowed on highways
  - d) Heavy equipment traffic results in deep compaction, below plow depth
- 2) Effects of compaction on yield
  - a) Research plots were compacted 3 years in a row, in the fall, after harvest. Shallow compaction was removed with a chisel plowing.
  - b) Yields following compaction continued to be reduced every year compared to uncompacted plots. About 5% yield loss.
  - c) After compacting was stopped, yields increased slowly, but even after six years, were below the uncompacted plots

- d) Bottom line: The effects of compaction last for many years.
- 3) Solutions to soil compaction
  - a) Avoid compaction
    - i) Stay off wet soils
    - ii) Tires and tracks
      - (1) Low pressure radial tires (6-7 psi) give equal compaction to rubber tracks
      - (2) Bottom line: the lower the tire pressure, the lower the compaction
    - iii) Grain carts
      - (1) At high axle loads, reduced tire pressure did not make a difference.
        - (a) Need to reduce axle load
        - (b) Tandem better than single axle.
    - iv) Effects of practices on the soil's resistance to compaction (ranked best to worst)
      - (1) Continuous no-till, controlled traffic, cover crop
      - (2) Continuous no-till with growing cover crop
      - (3) Continuous no-till, heavy residue, no cover crop
      - (4) Continuous no-till, light residue or bare ground
      - (5) Intermittent no-till
      - (6) Shallow tillage (Aer-Way, Phoenix harrow...)
      - (7) Strip-till
      - (8) Subsoiling, wide spaced shanks
      - (9) Moldboard or chisel plow, finely tilled seedbed
      - (10) Subsoiled, deep ripped, full surface tillage
  - b) Restore compacted soil
    - i) Freeze and thaw action will not remove deep compaction.
    - ii) Subsoiling to relieve deep compaction, 14-18" deep
      - (1) Research results
        - (a) The benefit of subsoiling was about a 3% yield increase when soils had deep compaction. Did not completely remove the compaction from a 20 ton (per axle) load. A 10 ton load is generally not a problem on silt loam or silty clay loam soils.
        - (b) Effects of subsoiling last if controlled traffic is used or if grain cart loads are limited to less than 10 tons per axle.
        - (c) Average of 5 subsoiler designs (1991-1992)
          - (i) Soybean yield increases: 1.3-3.0 bu/ac
          - (ii) Corn yield increases: 2.5-5.0 bu/ac

- iii) Subsoiling vs. No-till, effects on deep tillage
  - (1) Subsoiling reduced yields compare to continuous no-till
  - (2) WHY? Soil structure is built up in continuous no-till which resists compaction better than annually tilled soil.
- iv) Subsoiling vs. cover crops
  - (1) Can deep rooting cover crops provide a biological solution to soil compaction?
  - (2) Subsoiling can
    - (a) Change soil structure immediately to 18" deep
    - (b) Increase infiltration
    - (c) Leaves soil susceptible to future compaction
  - (3) Cover crops can
    - (a) Change soil structure slowly, 3' deep or deeper.
      - (i) Can cover crop roots break up compaction? If the crop you are growing cannot penetrate the compaction, why would a cover crop be able to do this?
    - (b) Increase infiltration, over time
    - (c) Protect soil from erosion
    - (d) Add nutrients and organic matter
      - (i) Legume cover crops
        - 1. Must save enough on future N fertilizer to pay for the cover crop costs
    - (e) Improves soil's resistance to future soil compaction
  - (4) Cover crop considerations
    - (a) Must fit into a continuous no-till system
    - (b) Some crops have more aggressive roots than others (cover crop choice)
      - (i) For deep roots, need a good stand and time to grow roots deep (timely planting)



(c) "Tillage" radish cover crops

i.

- (i) Oilseed radish is being used for this purpose
- (ii) Winterkill and decay leaving holes in the spring. Seem to attract earthworms.

#### 4) Considerations

- a) Do you have a compaction problem?
- b) Does it pay at current crop and fuel prices to treat the compaction?
- c) If you have deep compaction, subsoil tillage can help
  - i) However, if you really want to solve compaction, use a subsoiler and then adopt controlled traffic. This will avoid future compaction.
- d) Avoid future compaction
  - i) Lower pressure tires and tracks
  - ii) Consider continuous no-till
    - (1) With controlled traffic
      - (a) RTK auto-steering needed in most cases
        - (i) If you have invested in this, you should consider controlled traffic to add value to your investment.
    - (2) With crop rotations
      - (a) Diversity is good when markets allow
      - (b) Cover crops add diversity to rotations
- 5) Randall Reeder, Extension Agricultural Engineer, Ohio State University, Columbus, Ohio, reeder.1@osu.edu

#### Soil-Air-Water-Residue Interactions in HRF Planting

Andy McGuire

- 1) The multiple benefits of high residue farming are a result of these conditions:
  - a) Crop residues covering the soil surface
  - b) Untilled soil
- 2) However, these same conditions can be a disadvantage in some situations, mainly in the spring with early planted crops such as corn:
  - a) Cold soils, which delay emergence
  - b) Wet soils
    - i) Only in heavier textured soils
    - ii) Not often a problem in our dry climate. Sometimes this is an advantage over a tilled system because crops do not have to be irrigated to get germination.
- 3) The balancing act:
  - a) Produce a profitable crop
  - b) Obtain benefits from high residue farming
  - c) Manage to overcome the challenges and take advantage of the benefits
- 4) What is needed?
  - a) Requirements for seed germination:
    - i) Soil temperature. Need the right soil temperature for the crop germination and emergence:

	Minimum, °F	Optimum range, °F
Wheat	40	54-77
Peas	40	40-75
Corn	50	60-95
Beans	60	60-85

- ii) The soil temperature at the time we plant wheat and peas is usually close to what these crops need for germination.
- iii) Beans are planted much later when air and soil temperatures are usually warm enough for quick emergence. No-till beans are less of a problem than no-till corn.

- v) Corn is a tropical crop and so needs higher soil temperatures. Our conditions when we plant corn are often marginal for good germination and the conditions in high residue farming can keep the soil even cooler, *if you do not manage them*.
  - (1) We are at a high latitude, equal to the Northern corn belt of the Midwest, so soils warm up more slowly. The rays of the sun come in at a low angle and do not warm the soil as much as at lower latitudes.
- b) Soil water. Seeds must have sufficient water, either as
  - i) Water vapor. Seeds can germinate with just water vapor, but it slows the process. The humidity in untilled soils is higher than in tilled soils.
  - ii) Liquid water. This speeds the process.
- c) Requirements for seedlings
  - i) Water
  - ii) Nutrients
  - iii) Good soil conditions for shoots to emerge
  - iv) Good soil conditions for root growth
- 5) Use the tools available to manage the system in order to get the right conditions at the right time.
  - a) Manage for soil temperature by far the most limiting factor (esp. with corn) in high residue farming systems in our region
    - i) Increase energy getting to the soil
    - ii) Decrease losses of energy
    - iii) Question: which increases soil temperature more, tilling the soil or removing the residue?
      - (1) Research results from a 3-year experiment in Iowa (Kaspar et al. 1990).
        - (a) Comparison of growing corn in either 1) plowed or 2) untilled soil, both <u>without</u> residue.
        - (b) Results
          - (i) "No-till corn plants reached 50% emergence and 50% tasseling 0.8 and 0.9 days *sooner*, respectively, than plants in the moldboard plow system."
          - (ii) "Earlier germination and emergence of no-till plants probably resulted from greater soil moisture in the no-till system"
          - (iii)"Thus, the no-till system did not reduce corn growth and yield compared with that of the moldboard-plow system when both systems had similar surface

residue conditions."

- (c) "Residue removal from the seed row had greater effects on plant growth and yield than either tillage or residue type."
- (d) <u>The effects of residue removal on emergence and early growth were greater than the effects of plowing.</u>
- (2) Local on-farm research
  - (a) Location: a fall strip-tilled field between Ephrata and Quincy
  - (b) Spring soil temperatures measured at 2" depth in the middle of:
    - (i) Tilled, bare strip
    - (ii) Untilled, residue covered strip
    - (iii)Untilled strip, surface residue removed
  - (c) The increase in growing degree days resulting from tillage was much less than that resulting from just the removal of surface residue.



- i) Implications
  - (1) <u>Residue, not lack of tillage, is keeping the soil cool.</u>
    - (a) We must manage the residue to get equal corn yields
    - (b) <u>Tillage is not required to do this.</u>
    - (c) If we can remove residue without tillage, we can both warm the soil and save money.

- ii) Residue management to increase soil temperature
  - (1) We produce a lot of residue with our high yielding wheat and corn crops.
  - (2) What happens to crop residues on the soil surface in our climate?
  - (3) Decomposition of surface residue is mainly controlled by temperature and moisture; higher relative humidity conditions result in higher decomposition rates.
  - (4) We dry corn to 15% moisture or below to prevent decomposition. This is equivalent to 75-85% relative humidity (RH). While some microorganisms are active down to 75% RH, most are inactive below 80-85%. Therefore, most decomposition will take place at night when RH is higher, especially during warm humid nights.
  - (5) If we choose 75% relative humidity as the minimum needed for decomposition of surface residues, we can see above that when the air temperatures are conducive to decomposition (summer) the relative humidity is too low in our climate (Yakima).



- (6) The residues are wet during, and for a short time after, irrigation, but other than that, they are too dry to decompose, except for right at the soil-residue interface.
- (7) Canopy closure helps keep the humidity levels higher and so we can get more decomposition then, but the effect is relatively small.
- (8) Conclusion: Our relative humidity levels do not support decomposition of surface residues during the time of the year when air temperatures are also conducive to decomposition (summer). Therefore, <u>our residues here decompose much more slowly</u> <u>than they do in the Midwest</u>.

iv) So how do we get rid of the residue over the row, without tillage and still maintain it between the rows?



- (1) It starts at harvest
  - (a) Spread the residue uniformly, at harvest
    - (i) Variable residue cover leads to variable soil temperature and moisture, which leads to variable germination speed and emergence, which leads to reduced corn yields.
  - (b) Tools
    - (i) Chaff spreaders
    - (ii) Straw choppers
    - (iii)Corn header modifications to break up stalks better (see Jasa presentation, 2005 workshop digest)
    - (iv)Heavy harrows, stalk rollers, stripper headers
  - (c) Considerations
    - (i) Advantages of leaving residue <u>upright</u> and <u>attached</u> (See Jasa presentation, 2005)
      - 1. Will not have to cut it
      - 2. Will not have to move it
      - 3. Does not block emergence
      - 4. Decomposes more slowly (may not be a benefit for us)
      - 5. Does not cool the soil as much as horizontal residue
      - 6. Allows for more soil drying than horizontal residue
      - 7. Still get wind erosion control
      - 8. Is easier to cut if it is still attached

- 9. Will not be moved by the wind
- (ii) Smaller pieces break down quicker, but they also move easier with water or wind
- (iii)Horizontal residue will decompose sooner, but has to be moved or cut at planting
- (2) Increase decomposition after harvest
  - (a) Cover crops, once they close canopy, create a microclimate over the residues that



increases decomposition.

- (3) Before planting
  - (a) Grazing, but not over grazing
    - (i) Do not want all residue flat on the ground because you will have to cut through it
  - (b) Bale off wheat straw
- v) At planting
  - (1) Move the residue off of the row
    - (a) Allows the sun to warm and dry the soil
    - (b) Increases accuracy of seed depth and spacing
    - (c) How much to move?
      - (i) There are diminishing returns from making the bare strip wider and wider...

(iii)Research (Kaspar, 1990) shows that the decrease in days to emergence is less than a day when going from a 12" bare strip to completely bare soil (30" rows). Over half of the decrease comes from a strip only 3" wide.



(iv)There is also a trade-off between higher soil temperatures and lost soil moisture

- 6) Timing considerations
  - a) Moving residue in the fall does not help the soil warm up because the soil has not dried out yet. It also has a long time to be blown back over the bare strip.
    - i) Wait until planting, or just before planting with a two pass system.



8) Use row cleaners to move residue at planting



i) Move without cutting,



ii) Move after cutting,



iii) Move and then cut,

- b) The cutting operation is often used to also band fertilizer
- c) Leave residue between rows to reduce evaporation, increase infiltration rates, reduce wind erosion
- 9) Soil moisture management for high residue farming
  - a) Desired moisture conditions:
    - i) Dry loose soil above the seed for easy emergence

- ii) Wet soil below the seed and between the rows, for good germination and water supply to seedling
- b) Important factors
  - i) Loose, tilled soil will dry faster than undisturbed soil
    - (1) In untilled soil, the evaporating water at the soil surface is replaced by water transported from deeper in the soil through capillary action. This delays soil drying.
    - (2) Tillage breaks these pores so that once the water is evaporated from the surface, it is not replaced by water from below. This is the reason for making a dust mulch in the dryland areas; the deeper moisture is conserved because it cannot easily move through the tilled surface soil.
    - (3) Tillage also opens up the soil to increased air flow which dries the soil further.
    - (4) Once the soil is relatively dry, incoming energy goes to warming the soil, not evaporating water.
  - ii) Like hair on an animal, residue traps a layer of still air close to the soil surface which slows down evaporation. It also shades the soil surface from sunshine
  - iii) The relative humidity of pore space in an untilled soil remains about 100% at all liquid water levels down to the permanent wilting point
    - (1) Tilling the soil below seed depth reduces the humidity below 100%. In a tilled soil, the relative humidity may reach 90% after a rain or irrigation.
  - iv) Balance the need for warmer soils with the need to conserve soil moisture and limit tillage

#### 10) Solution

- a) Press the seed into the untilled soil at the bottom of the seed vee. This will give the seed optimum moisture conditions for germination: high humidity and contact with wet soil.
  - i) Water is brought up to seed level by capillary action from down deeper if needed
- b) At planting, use the closing wheels to loosen the soil right above the seed. This will allow the soil above the seed to warm up which will speed germination. It also provides a loose soil for the seedling to emerge through and protects the moist soil below the seed from drying out too quickly (similar to dust mulch).
  - i) Spiked closing wheels are needed to do this. They also break up any compaction of the seed vee sidewalls.

#### 11) Other considerations

a) With our well drained soils, we don't generally have problems with soil that is too wet for an April corn planting

- b) Full width tillage can be an unnecessary waste of water.
- 12) Manage for good seedling growth
  - a) Easy access to water. This is not a problem in untilled soils as they do not dry out as fast as tilled soils.
  - b) Easy access to available nutrients
    - i) Apply pop-up fertilizer in the seed furrow
      - (1) Limit rates to allow good germination
    - ii) Band fertilizer to the side of and below the seed
    - iii) Why?
      - (1) In a cool soil, the root will not grow as fast and so will not be able to intercept as many nutrients as in a warmer tilled soil
      - (2) The availability of some nutrients is decreased in cool soils because of the decreased breakdown of soil organic matter, for example Zinc.
  - c) Easy access to sunshine.
    - i) This is another advantage of putting loose tilled soil over the seed and a disadvantage of closing wheels which compact soil over the seed.
- 13) Farmers must manage field conditions to benefit their crops. This is done in tilled fields and it must be done in high residue fields too. <u>Bottom line: manage for the detrimental conditions of high residue farming and enjoy the benefits.</u>
- 14) Questions?
  - a) Planting direction, E-W or N-S?
    - i) N-S is an advantage in the higher latitudes, especially when residue is left standing in the field
  - b) Dammer-diking?
    - i) Generally not needed with high residue farming because the residue over the soil surface increases infiltration rates.
  - c) Does surface application (broadcast) of P work?
    - i) Long-term no-till experience in the Midwest says it does (also with K) because with residue covering the soil surface, the soil surface will stay wet allowing plant roots to grow right up to the surface and access the nutrients from fertilizers broadcast there.
    - ii) P will also move down into the soil slowly

- d) Spiked vs. Rubber closing wheels?
  - i) Rubber closing wheels use down pressure to close the seed vee. In untilled soils, the required down pressure can cause compaction of the soil around the seed. Some Midwest no-tillers are using a combination of a rubber wheel on one side and a spiked wheel on the other.

#### Opportunities for Organic No-till Vegetables Doug Collins, WSU

#### Doug Collins, WSU

- 1. What does tillage do?
  - a. Creates macro-pores for a short time
  - b. Destroys soil aggregates and structure
  - c. "Results suggest that no-till soils need to be continuously maintained to protect aggregation and physically stabilized C pools." Grandy 2006
- 2. Why no-till?
  - a. Decreases
    - i. Erosion
    - ii. Surface crusting
    - iii. Dust
    - iv. Sediment
    - v. Fuel use
    - vi. Greenhouse gases
    - vii. Labor hours
  - b. Increases
    - i. Organic matter
    - ii. Resistance to soil compaction
    - iii. Soil organisms
    - iv. Soil structure
    - v. Aggregate stability
    - vi. Water holding capacity
    - vii. Water infiltration
    - viii. Carbon sequestration
    - ix. Field access
    - x. Profitability?

4. Research with no-till organic pumpkins



- a. Rye average biomass production = 4.7 tons dry matter/acre
- b. <u>Mechanical killing of the cover crop is the key to making this work and also the greatest</u> <u>challenge</u>



- i. A roller-crimper was used:
  - 1. Filled with water to add weight
  - 2. Front mounted is an advantage since tires interfere with killing of crop where they tread. Can also have a one-pass roll/crimp and plant operation.



- ii. Success depends on the growth stage of the cover crop
  - 1. Rye: flowering vs. milk vs. soft dough stage
  - 2. Had trouble getting the rye killed. Possible reasons:
    - a. Wrong growth stage
    - b. Direction of crimping on roller

- c. Speed of operation
- c. Results
  - i. Pumpkin plants grew faster in tilled plots
  - ii. More weeds emerged in tilled plots
  - iii. Weeds emerged in untilled plots later in season due to less competition from pumpkins there.
  - iv. Infiltration:



- v. Nematodes: no significant difference
- vi. Yield: no significant differences
- 5. No-till organic symposium: lessons from around the country
  - a. Jeff Moyer, Rodale Institute Kutztown, PA
    - i. Inventor of the roller/crimper design that we use
      - 1. 2-step organic no-till production: Roll/plant & harvest
      - 2. vs. 9-step conventional till: Plow, disc, pack, plant, rotary hoe, rotary hoe, cultivate, cultivate, harvest
    - ii. Insufficient weed control with less than 4,500 lbs/acre cover crop biomass



- b. Carmen Fernholz, A-Frame Farm, Minnesota
  - i. Stressed the *inflexibility* of the organic no-till system, in terms of
    - 1. Cover crop planting date
    - 2. Cover crop rolling date
    - 3. Sufficient biomass needed for weed control
    - 4. Weather
  - ii. "lots of opportunity for failure, but failure is not an option"



- c. Ronald Morse, Virginia Tech
  - i. Challenged the nomenclature
    - 1. "Cover Crop-based Conservation Agriculture for Organic Vegetable Production"
      - a. No-Till (cover crop killed and retained over entire field)
      - b. No-Till Living Mulch (living mulch zones and grow zones)
      - c. Green Manure Zone Till (cover crops shallow tilled in grow zone)
      - d. Green Manure Conventional Till (shallow incorporation of cover crop over entire field)

WASHINGTON STATE UNVERSITY World Class For the Control of Control		
Situations likely to succeed with NT	Situations unlikely to succeed with NT	
Highly eroded soils	Compacted poorly drained soils	
Late summer planted crops	Cold, wet spring soils	
Crops that form rapid dense leaf canopy	Weedy fields, esp perennials	
Staked or erect-growing crops		

d. John Luna, Oregon State University

- i. Pragmatic and non-idealistic
- ii. Strip Tillage Experience
- iii. Cover crop suppression is a problem with rye
  - 1. Is trying Phacelia tanacetafolia
- 6. Next steps for organic no-till in Western Washington
  - a. Cover crops are the key

WASHINGTON STATE UNIVERSITY Hordd Class. Face to Face.	Cover	crops
Functions	Parameters	Variables
Weed control     Supply N     Trap N     Feed     Prevent     compaction     Organic matter     H <sub>2</sub> O -holding     capacity     Aggregation     Nutrient bank	<ul> <li>Biomass</li> <li>N content</li> <li>Time to maturation</li> <li>Mechanical termination</li> </ul>	<ul> <li>Species</li> <li>Variety</li> <li>Planting date</li> <li>Termination date</li> <li>Seeding rate</li> </ul>

- b. Equipment
  - i. Work with affordable small tractors
  - ii. Alternatives to rolling/crimping
    - 1. Flail mowing
    - 2. Strip application of organic herbicides
    - 3. Roll/crimp followed by flail mowing or flaming
    - 4. Strip tillage
  - iii. Transplanters
- c. Rotation

WASHINGTON STATE UNIVERSITY World Class. Force to Force.		Cash Crops		
Brassicas / mustards	Cucurbits	Solanacea	Solanacea	
Cabbage	Squash	Tomatoes	Potatoes	
Broccoli	Cucumber			
Kale				
Collards				
Asteracea	Poaceae	Apiacia / Umbelliferae	Legumes	
Romaine	Sweet corn	Carrots	Peas	
		Parsnip	Beans	
		Parsley		
		Cilantro		
		Dill		

- i. Must get good establishment of cover crop
  - 1. May require tillage
  - 2. Many growers already having trouble with this
- ii. Legume incorporation a must for organic production

- iii. For early planted cash crops will need to consider using:
  - 1. Winter-killed annual cover crops
    - a. Forage radish, spring oats
  - 2. Some tillage (e.g. zone tillage)
- iv. Late planted crops could work well with high biomass winter annuals especially with some selection.
- Contact information: Doug Collins, http://small farms.wsu.edu, <u>dpcollins@wsu.edu</u>, 253-445-4658

#### Worst Case Scenario: Results of the High Residue Farming Demo Project

### Andy McGuire

- 1. HRF Demo Project
  - a. Three years, starting in 2007
  - b. Two fields
    - i. Northern Franklin county, Shano silt loam
    - ii. Grant county, south of Ephrata, Gravely silt loam
  - c. The question: how far can we push direct seeding under irrigation?
    - i. Try things that farmers would not because of high risk
    - ii. Implement recommendations from other regions here
    - iii. To help farmers choose a tillage system that will work for them
    - iv. Why not strip-till? Strip-till is already accepted by many farmers
      - 1. Direct seeding in high residue is much more of a challenge, and as yet, unproven

#### 2. Worst case scenario

- a. All high residue crops
  - i. No residue removal
  - ii. No tillage
  - iii. Non-uniform residue distribution after custom harvest
- b. Corn after corn
- c. Cool spring temperatures in both years 2 and 3
  - i. lost 12-16 growing days in 2008
- d. Planted between the old rows where wheel traffic compaction was the highest.
- 3. Rotation
  - a. Yr 1: spring wheat in tilled soil
    - i. 139 bu/ac

- ii. Fall cover crop drilled through residue in August
  - 1. Did not work very well because of tough wet residue that resulted in hairpinning
  - 2. Not much sudangrass emerged
- b. Yr 2: direct seeded corn for grain
- c. Yr 3: direct seeded corn for grain
- 4. Management
  - a. We followed the principles and practices recommended by past workshop speakers
  - b. Modified WSU planter
    - i. Heavy duty down pressure
    - ii. Row cleaners
    - iii. Ability to apply pop-up fertilizer
    - iv. Seed firmers
    - v. Spiked closing wheels

![](_page_21_Picture_13.jpeg)

- c. Followed recommended planting steps
  - i. Cut residue
  - ii. Place seed
  - iii. Attain seed-to-soil contact
  - iv. Close seed vee
- d. Applied pop-up fertilizer
  - i. Zn deficiency in '08, Zn applied in pop-up in '09
- e. Chose varieties rated high for high stress emergence
  - i. 97-99 day maturity varieties
  - ii. increased seeding rates by 5-10%

6. Planting conditions

![](_page_22_Picture_1.jpeg)

- a. 2008, into wheat residue,
  - i. Planting went well with no problems

![](_page_22_Picture_4.jpeg)

- b. 2009, into corn residue,
  - i. Row cleaners could not handle residue, especially long stalks laying on the ground. After we removed them, planting went smoothly.
- 7. The results indicate that direct seeding, with appropriate adjustments, can be a viable option
  - a. Emergence was slow but stands were adequate.
    - i. 2008 planting date, May 7, emerged after ~14 days
    - ii. 2009 planting date, April 22, emerged after ~25 days

	Plant spacing	Std. deviation	Plant pop.	Gaps per 30 plants
2008	5.4"	2.3"	38,880	0.5
2009	6.1"	3.3"	34,556	2.2

- iii. Planted at 40-41,000 seeds per acre
- b. Getting a stand is NOT the problem in these conditions.

# 9. Problems

a. We may have had a temperature induced Zn deficiency in '08.

![](_page_23_Picture_2.jpeg)

- i. Stunted plants until the soil warmed up and they grew out of it.
- ii. In 2009, we put Zn in the pop-up fertilizer mix and did not see this again.
- b. The corn grew normally after the 6th leaf stage.
  - i. This is when the growing point emerges from below the soil surface and soil temperatures no longer matter for growth

![](_page_23_Picture_7.jpeg)

10. 2009, heavy residue,

12. Yields at S. field

	Variety	Yield, tons/ac	Pioneer trials, tons/ac (tilled)
2008	37Y11 (97)	6.22	4.73 – 6.86
2009	37K11 (99)	6.06	6.44- 7.16

- a. <u>Yields show that more must be done to alleviate poor growing conditions, mainly cool</u> soils, in the spring.
- b. Move residue off of the row for corn (See Soil-Air-Water-Residue...presentation above)

#### 13. Conclusions

- a. Not a disaster considering the conditions
- b. Many things could be done to improve these yields
  - i. Spread residue uniformly
  - ii. Move residue off of the row
  - iii. Rotate high residue crops with lower residue crops. Do not grow corn after corn.
  - iv. Band fertilizer
- 14. Let these demonstration results help you decide whether no-till might be an future option for your farm
  - a. Clean tillage: low risk, most expensive, no other benefits
  - b. Strip-till: can be a successful compromise, less expensive, tillage may not be needed
  - c. Direct seeding: must be managed to compete with other systems, but it is the least expensive and potentially has the most benefits.

#### 15. Questions

- a. Planting depth?
  - i. Aimed for 2", but because of non-uniform residue coverage, the actual planting depth ranged from 1.5" to 3" where the soil was bare.
- b. Planting speed?
  - i. 4 mph
- c. Extra nitrogen needed?
  - i. Yes, as soil organic matter is being built, more N will be needed for the same yields. The nutrients in the residues is not released because they do not decompose quickly on the soil surface
- d. In the long-term, extra N will not be needed because it will be supplied from the increased organic matter levels.

# Getting Into Controlled Traffic

# Randall Reeder

- 1. What is controlled traffic?
  - a. A system that controls traffic separates wheel beds and root beds. "A road is good for *driving, a field is good for growing*" from controlledtrafficfarming.net.

![](_page_25_Picture_4.jpeg)

- 2. The benefits of controlled traffic/auto steer
  - a. Faster machine operation (~0.5 mph)
    - i. farm 10% more acres, or save 10% of your time
    - ii. Better traction on firm traffic lanes
  - b. Less fatigue (extra 2 to 4 hrs per day)
  - c. Saving inputs (eliminating overlaps)
    - i. pesticides, seed, fertilizer, fuel, labor, machine depreciation, even labor
      - 1. improved sprayer operation
    - ii. If you save 5% on pesticides, seed, and fertilizer, you can save about <u>\$1 per acre</u>
  - d. Darkness, dust and fog... no problem
  - e. 24-hour operation is possible
  - f. Row markers or foam markers not needed
  - g. Higher yields, due to:
    - i. Less compaction
    - ii. More timely planting and harvest, especially in higher rainfall areas
    - iii. Yield effect depends on your soil type, soil moisture, machine size
  - h. Manage, don't just steer the tractor
- 3. Controlled Traffic set up
  - a. Requires auto-steer
    - i. Multiple uses for auto-steer the more you use it the less it costs per acre

- 1. For controlled traffic
- 2. For strip-tillage
- 3. To assure driving straight lines through the field
- ii. Examples of economics not a large investment per acre
  - 1. Simple
    - a. Cost: \$35,000 for a RTK system
    - b. Farm: 2000 acres
    - c. Life of system: 5 years
    - d. Simple payback: \$3.50/acre/year
    - e. Is it worth that to you?
  - 2. RTK Network subscription
    - a. Cost: \$20,000
    - b. Farm: 2000 acres
    - c. Life of system: 5 years
    - d. RTK Subscription.: \$1000/yr
    - e. Simple payback: \$2.00/acre/year + \$0.50/acre/year (for subscription)
    - f. Total: \$2.50/acre/year
  - 3. 2008 costs
    - a. Cost: \$20,000-\$25,000
    - b. Farm: 2000 acres
    - c. Life of system: 5 years
    - d. RTK Subscription: \$1250/yr (\$900/unit for 3 units)
    - e. Simple payback: \$2.00/acre/year + \$0.60/acre/year
    - f. Total: ~\$2.60 to \$3.20 per acre per year (3 units ~ \$8 to \$9)

#### b. How do you do it?

- i. Select basic machine operating width
- ii. Determine tire/track spacing
  - 1. Must fit between the rows
  - 2. Planter and drill tires do not matter, only heavy equipment tires
- iii. Select tires/track sizes
- iv. Plan machine purchases and changes
- v. Investigate auto-steer options

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Combine	Sprayer Planter

- c. Machinery management
  - i. Choose your basic width. Usually determined by the width of the corn head in the Midwest). Everything will be a multiple of this.
    - 1. 20 ft
    - 2. 30 ft
    - 3. 36 ft
    - 4. 40 ft

![](_page_27_Picture_7.jpeg)

- ii. Header widths; on-the-go unloading
- iii. Wheel widths and spacing
  - 1. 10-foot Wheel Spacing
- iv. Possible with rubber tracked tractors
- v. Set up permanent driving lanes (wheel beds)
- vi. Problems
  - 1. Mismatched machines in your current inventory
    - a. Must be done over time as equipment is replaced

- 2. Yield differences depend on the crop, corn vs. soybeans and small grain
- 3. Desired header widths
- 4. Grain cart management
  - a. May need combine auger for 30 ft.+ widths for on-the-go unloading
- 5. Hay or forage crops in the rotation
- 6. Future flexibility?
- 4. The value of combining controlled traffic + continuous no-till
  - a. Controlled traffic: random compaction from wheel traffic is minimized while leaving the rest of the soil in an ideal state for plant growth
  - b. Continuous no-till: maintains these conditions, especially with
    - i. Crop Rotations
    - ii. Cover Crops
- 5. Questions
  - a. Soil types where he works?
    - i. Silty clay loams
  - b. Does controlled traffic have a benefit if you are sub-soiling?
    - i. Yes, if you do not subsoil your traffic lanes. You want a certain amount of compaction in traffic lanes to support the machinery.

# Grower Panel

Dave Gossett – Observations from the HRF Demo Project

Lorin Grigg - Strip-tilled sweet corn and onions

*Tom Gregg* – Strip-tilled corn

- 1. Dave Gossett
  - a. Skeptical of high residue farming at start of project
  - b. Visited Dwayne Beck's farm in South Dakota (Dakota Lakes Farm)
  - c. Concerns
    - i. Loamy sand, "given a chance they compact like concrete"
    - ii. Tillage is done to keep soil mellow, soft, good seedbed
  - d. Observations
    - i. As a result of not tilling and keeping the soil covered with residue, the soil stays mellow
    - ii. There was no problem cutting through residue and getting seed into the soil
    - iii. By not disturbing the weed seeds, there was low weed pressure

- iv. It could work here
- v. There are psychological aspects to overcome for farmers used to tillage:
  - 1. "Weird sensation to plant into all that residue"
- e. Planting operations
  - i. We used the basic equipment, nothing fancy, which demonstrates the feasibility of this
  - ii. Planting into wheat residue was easy
  - iii. Planting into corn stalks was more challenging
    - 1. Row cleaners were close to working, but needed some more tweaking
    - 2. Larger diameter row cleaner? Too many teeth on those we had
    - 3. Got a good stand
    - 4. Would have had better yield with residue cleaned off row
  - iv. Nutrient management
    - 1. 1<sup>st</sup> year tried to water run all of the nitrogen
    - 2. 2<sup>nd</sup> year broadcast N preplant worked better
      - a. Needed to frontload the N for the season to account for cool soils and tie up by residues
- 2. Lorin Grigg
  - a. Farms E. of Quincy in sandy soils
  - b. Rotation
    - i. Strip-till sweet corn and onions
    - ii. Following either onions or potatoes with sweet corn
    - iii. Onions follow sweet corn, wheat cover crop

![](_page_29_Picture_21.jpeg)

- c. Strip planter, developed in last 2-3 years, for wheat cover crop, leaves 6" bare strip where onions are planted
  - i. Spring wheat, allowed to deveop stalk.
  - ii. Right before it heads, it is fumigated (Vapam) to kill it in the fall
  - iii. Problem: Wheat falls over once it dies, sometimes crosses planted strips

- iv. After fumigation, wheat is rolled with drum roller so that it is laying the same direction as planting will go in the next spring
- d. Rototiller used to strip-till ground in front of onion planter

![](_page_30_Picture_2.jpeg)

- i. Tills soils
- ii. Injects fertilizer
- iii. Applies insecticide

![](_page_30_Picture_6.jpeg)

- e. Planting in strips
  - i. Good uniformity, consistent seed depth
  - ii. Better than when they would spray out strips because there is no wheat root mass

![](_page_30_Picture_10.jpeg)

in the soil

- iii. Problem
  - 1. Residue gets stalks in chains. Solution is to monitor the planting equipment constantly
- iv. Residue breaking down stalks stay to almost harvest time

![](_page_31_Picture_3.jpeg)

- v. Residue does not bother harvest at all
- vi. No runoff problems other than in wheel tracks
- vii. Has done strip-tilled onions since 1993
- 3. Tom Gregg
  - a. Farms S. of Quincy in sandy loam soil
  - b. Strip-tilled corn on corn
  - c. Puts high residue farming to the test
  - d. WA corn yields highest in nation on a per acre basis, 210 bu/ ac, 5.88 tons/ac
    - i. Means we have the highest residue production also
    - ii. Western states have the highest yields but Midwest states produce the most corn.
      - 1. Equipment manufacturers focus on the acres not the high residue conditions of the Western states, who don't have a lot of corn acres
    - iii. Yield correlates with residue
    - iv. Columbia Basin farmers will have to innovate to make this work with our high residue levels.
  - e. Challenges unique to our conditions
    - i. We live in a desert, organic matter breaks down slowly
      - 1. Until canopy is closed over the residues
    - ii. Variety of crops which require unique conditions
    - iii. Few periods to grow cover crops
    - iv. We have 20% more residue than most places doing no-till corn
      - 1. How do we manage this residue?

- f. Managing residue in corn on corn
  - i. Disking, does not work well, costs a lot
  - ii. Chopping stalks; wheels knock stalks down before they are chopped
  - iii. Vertical tillage with turbo-till; worked OK, but not good enough
  - iv. Baled stalks off; may work in a rotation with crops other than corn
    - 1. Removing \$ in nutrients does this pay?
  - v. Cattle, leaves residue on the ground, some compaction
- g. Spreads lagoon water from dairy
  - i. Cannot leave stalks horizontal to do this
  - ii. Good supply of nutrients
- h. In strip-tilled fields, it is best to go across the rows with sprayer. It gets pulled in to soft rows if you try to go down the rows
- i. Uses an Unverferth Ripper Stripper
- 4. Questions for panel speakers
  - a. How effective is broadcasting N over the residue?
    - i. Gossett: it gets through with irrigation water, but some it tied up by the residue
  - b. How much N was applied to direct seeded corn?
    - i. Gossett: 300# N total per acre for corn
    - ii. Gregg: 300 lbs N/ac needed for 6-7 ton/ac corn. Needs to be applied early, but it will get through the residue.
  - c. How to get row cleaners to work better?
    - i. Off-set row cleaners. Gregg: it helps some to have them offset
      - 1. A larger wheel with less teeth would work better in corn
      - 2. Yetter?
  - d. Studies on dry matter per acre in relationship to yields?
    - i. Harvest index relates biomass to grain yield
    - ii. Corn producing 6-7 tons of residue
  - e. What surprised you the most as a farmer working with the demo project?
    - i. Gossett: thought getting a stand would be the challenge, but that was not the problem. Also, the good condition of the seedbed under the residue was a surprise.
    - ii. Did compaction contribute to the lower yields?
      - 1. Gossett: could have, compaction in top 6" from wheel traffic. Corn stuggled in early season –cool temperature, maybe some compaction?
  - f. Can this be done with furrow irrigation?
    - i. Modified ridge-till in the Midwest
    - ii. No examples in our region

- iii. Infiltration rates get too high with no-till and slows water movement across the field in the furrows
- iv. Controlled traffic and permanent beds with furrow irrigation in Mexico
- g. How are sweet corn residues handled before onions?
  - i. Grigg: cannot have corn stalks at onion planting or harvest
    - 1. Uses two passes of the Great Plains turbo-till, then one pass of a large disk to bury the residue
- h. What about circle tracks?
  - i. Gossett: deep circle tracks can break seed firmers on planters
    - 1. 1<sup>st</sup> year we used the Williamson's circle track filler
    - 2. 2<sup>nd</sup> year with corn stalks, did not do anything and eased over the ruts while planting
    - 3. They did get quite deep and eventually something would have to be done
  - ii. Grigg: boom backs on circles has cut depth of wheel tracks in half
  - iii. Long term solution is to fill wheel tracks with rock or gravel (See 2005 Workshop digest, Tim Melville)

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