Climate Action Initiative

Date:
October, 2019

Factsheet #4

Soil, Water & Residue Management Tools

Peace Agricultural Adaptation Strategies Working Group

The working groups consists of representatives from many Peace agriculture organizations including:

- ⇒ BC Branch Canadian Seed Growers Association
- ⇒ BC Grain Producers Association
- ⇒ BC Ministry of Agriculture
- ⇒ Peace Region Forage Seed Association
- ⇒ Peace River Forage Association of BC
- ⇒ Peace River Regional Cattlemen's Association
- ⇒ Peace River Regional District

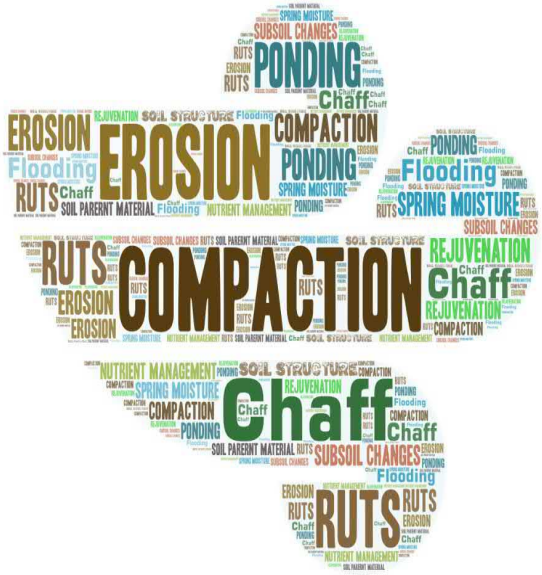
The Peace Agricultural Adaptations Strategies Working Group is committed to delivering Climate Action projects in the Peace Region.

Overview of the Factsheet

This factsheet is part of the technology transfer for the Runoff, Erosions and Drainage project, a BC Climate Action initiative. There are four factsheets in this series *(see sidebar on the left).*

To facilitate productive conversations about mechanical tools (equipment) available to producers that can effectively manage or conserve soil, water and residue, this factsheet answers the following questions:

1. What are the differences or similarities between high speed tillage, vertical tillage, deep tillage and zero tillage?
2. Which equipment and tools are best suited to address surface compaction?
3. Which equipment and tools best address sub surface compaction?
4. What equipment are best for minimizing runoff, erosion and soil loss?



Runoff, Drainage and Erosion: Tillage Equipment

- ⇒ Vertical Tillage - Surface Compaction
- ⇒ High Speed Disc - Rejuvenation
- ⇒ Subsoiling - Subsurface Compaction
- ⇒ Zero Tillage, Minimum Tillage, Direct Seeding - Reducing Soil Loss

Project Factsheets:

#1: Runoff, Erosion & Drainage Project
#2: Erosion Risk Mapping
#3: Conversations About Runoff, Erosion & Drainage
#4: Soil, Water & Residue Management Tools

For More Information:

Factsheets & more info at
www.bcgrain.com
www.peaceforageseed.ca
www.peaceforage.bc.ca

Geographic Applicability	This study was conducted in the Peace River Region of BC and the approaches taken can be applied to other areas in BC.
Commodity Relevance	This study was conducted on agricultural lands in the Peace region. It was cross commodity in scope with relevance to cattle / livestock operations, grain/ oilseeds, forage /grazing, and legume / grass seed production.
Project Timeline	February 2019 to October 2019

Project Objectives:

1. Assess the extent and nature of current runoff, drainage and erosion management practices currently in use in the Peace.
2. Review & summarize relevant management practices that are not currently used in the Peace Region (but have potential for adoption).
3. Identify the management practices with the greatest potential (high applicability & economic feasibility) for adoption in the Peace Region.
4. Deliver information to producers through effective knowledge transfer.

Vertical Tillage - A Tool For Annual Cropping

What is it?

In the early 90's the term "vertical tillage" used to refer to subsoiling, ripping and other activities that were deeper than six inches, or below the conventional plowing depth.

The current definition of 'VT or Vertical Tillage' was introduced in the mid to late 1990s and involved shallow tillage of less than 2.5 inches ahead of the planting equipment. It did not create stratification, or a dense horizontal layer like a plow layer, under the seed drill opener that could interfere with root growth.

Why use this tool?

When performing vertical tillage, the goal is to still have a firm seed bed when finished, but have provided a vertical disturbance to enable better **water infiltration** through the soil.

How it works?

If you run the discs deeper than 2.5 inches, or if you have any horizontal soil movement, then you're not doing true vertical tillage. When you do it right, the field should look like a stick of butter after you gently pulled your fork over the top...just parallel lines on the surface...that's all.

8 wave disc - higher disturbance

13 wave disc - med disturbance

20 wave disc - lower disturbance

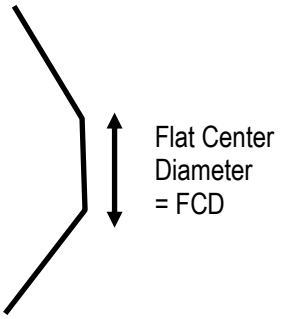


Figure 1: Flat Center Diameter - used to describe severity of a vertical tillage disc.

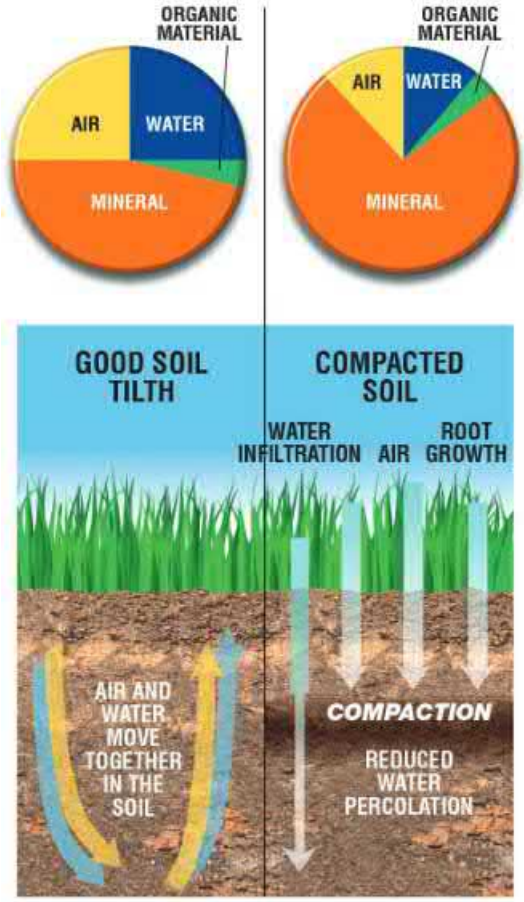


Figure 2: Healthy soil layer structure (left side of figure) & soil compaction (right).

Tilling in a vertical format is ideal, because it is similar to the way water and nutrients move up and down in the soil profile *(see Figure 2, lower left)*. First remove all horizontal stratification layers from the past. Vertical tillage utilizes straight waved blades at a shallow depth, zero degree angle. The implements all have harrows or some form of residue management following the discs.

Vertical tillage is supposed to **fluff or open the soil** by lifting the soil with the waved blade moving it vertically and leaving it directly behind the blade. Vertical tillage also serves to **chop up surface residue** and mix it with some of the soil being lifted from the waved blade. Vertical tillage will not, in the opinion of many, unroot crop stubble and/or weeds that are present.

The companies who have been building true vertical tillage machines for a while include, nut are not limited to, Salford, Summers, Great Plains and McFarlane**.**

Disc shape is variable for most vertical tillage implements. The **shape of the disk determines the severity** of the vertical disturbance. Critical characteristics of vertical tillage disc include:

- ⇒ **No concavity** This is what causes soil shearing in traditional discs.
- ⇒ The **more waves/ripples** the **less severe** the vertical tillage.
- ⇒ **"Flat Center Diameter"** is a way of describing the disc. The larger the value the **less severe** the disc *(Figure 1, upper right)*.

Remember vertical tillage should not be deeper that 2.5 inches to ensure a firm seed bed.

Vertical Tillage *Continued*

A photo of surface conditions that vertical tillage may 'fluff' or improve seed bed.

2018 Salford vertical tillage implement.

What is the best timing?

The best time to vertically till is in the **spring right before seeding,** this can **help dry out soils** that a producer has concerns about crusting after seeding or too wet to get seed drill on. Some producers have used this implement and **seeded the following day**. On the other non vertical tilled portion of the field they had to wait another 7-10 days for adequate conditions to seed with minimum till.

In short season areas like the Peace, farmers are concerned about **colder** (spring) soil temperatures and **wetter** soils when they have lots of residue covering the soil surface. If your morning air temperature is 10 C and your soil temperature is 7° C, if you work that field with your vertical till machine to get some air movement, the soil could be up to 21° C by early afternoon. Seeding 5 days earlier could mean 8.5 bu/ac canola (approx. $76/ac as shown in Table 2), dates may vary from year to year.

Table 2: Approximate crop yield decline for each day of seeding after May 1

Crop	Yield Decline / Day %
Barley – Malt	1.2
Barley – Grain	1.3
Barley – Silage	1.0
Wheat – Hard Red Spring	0.8
Wheat – CPS	1.0
Canola	1.7
Flax	0.6

Source: Government of Alberta 2011, Southern Alberta

What is the range of costs?

- ◊ $90,000 Used 2018 Salford I-1200 Vertical Tillage 31' with Spacing 20" 13" Wave Blades, 3 - 1/2" x 20" Finger Tines, 14" Roller.
- ◊ $90,000 Used 2019 McFarlane IC5127 30' wide.

Table 1.

Size	Frame Sections	COIL-TECH II # of Coulters	Transport Height	Transport Width	Approx. lbs with harrows	H.P. Required*
20'	3	33	11'2"	13'3"	15,700	220 - 260
31'	3	49/55**	14'6"	15'8"	20,500	350 - 410

Vertical Tillage Tools

Machine Size	Purchase Price	Ownership Cost ($/hr)	Repair & Maint. (R&M) Cost ($/hr)	Margin on Ownership and R&M ($/hr)	Rental Rate ($/hr)	Power Unit Cost ($/hr)	Custom Rate ($/hr)	Work Rate (acre/hr)	Custom Rate ($/acre)
Compact, high-speed disk									
Small 10-30FT	$80,000	41.25	28.00	10.39	79.63	165.31 225+ hp	244.94	19	12.89
Large 31-50 FT	$110,000	56.71	38.50	14.28	109.50	215.76 500 hp	325.25	39	8.34

Vertical Tillage Effective For:

1. Warming the soils by "fluffing" the soils and getting air movement.
2. Disturbing soil surface soil crusting.
3. Chopping up surface residue.
4. Spring work.

Vertical Tillage Not Effective For:

1. Compaction below surface.
2. Weed control.
3. Rejuvenation of sod.
4. Incorporating residue into the soil; i.e. blackleg risk won't be reduced using vertical tillage.
5. Fall timing (generally speaking).
6. Rut management (will not disturb enough to fill in soil loss areas).

High Speed Tillage - A Tool for Quickly Rejuvenating Forage & Forage Seed Fields

What is it?

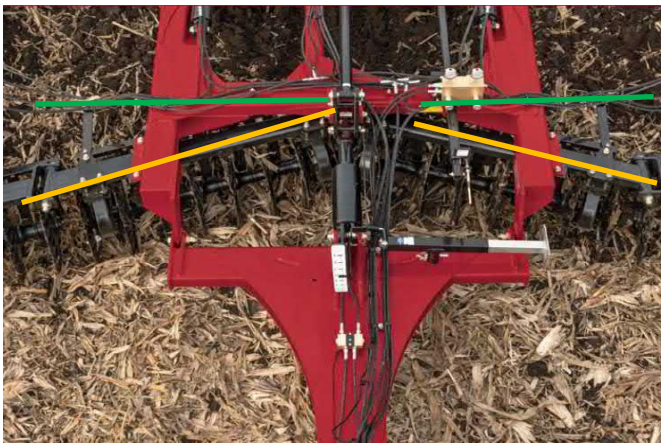
High speed tillage is designed to decrease the size of crop residue and mix it with soil to speed its decomposition. It levels the soil and prepares it for seeding. These implements are also effective for incorporating fertilizer too.

A Horsch high speed tillage disc working up perennial forage stand in the fall after being sprayed out.

Why use this tool?

This is an effective tool for single pass rejuvenation. This tool drastically reduces the time that a field is left vulnerable to erosion. With most rejuvenation practices, land is left vulnerable in a fallow like condition for several months or most of a season.

In 2011, 39,512 acres were reported in fallow in BC. By 2016, 9,234 acres were in fallow. (Please note by fallow we mean the land did not produce a crop that year and was repeatedly tilled.) Fallow acres increase the risk of soil erosion especially if it is in tilled fallow. Historic work done in the region indicates that under some conditions a field under fallow loses **0.9 T/ac - 1.1 T/ac** *(see NLC in Table 5 on page 9)*. At that rate it would take 900 years to lose 6.5 inches of topsoil. At another site in Beaverlodge in fallow, if 7.2 T/ac were lost, it would only take **139 years to lose the top 6.5 inches or furrow slice of topsoil.**



A high speed tillage implement is shown here. Following the angle of the disk gang with the yellow lines, it is high speed tillage because it is angled. If the gang followed the angle of the green line a perpendicular angle & depending on the concavity of the disc shape, the tillage would be considered vertical tillage.

The Agricultural Institute of Canada's (AIC) Soil Conservation Committee (1979) estimated that the average annual replacement cost of nutrients lost through erosion in Canada was **$6 - $12 per acre.** Factoring the change in cost of fertilizer it would mean that in 2018, a **$30 - $60 per acre loss** of nutrients annually through soil erosion was occurring in the late 1970's.

Tools like high speed tillage allow for rejuvenating perennial stands in a short period of time. Farmers are using this as a single pass spring till in a perennial field. The fields can be seeded immediately following the tillage, reducing the window of time where bare ground is exposed, and the opportunity to lose topsoil via water erosion.

How it works?

Putting their reference to 'high-speed' tillage tool into context, dealers report the optimal speed is between 8-12 mph, but some say they're seeing them run at 7-14 mph. The dealers are urging "If you go any slower than 8 miles an hour, it really doesn't do a very good job and anything faster that 12 doesn't do any better of a job." Discs are often concave and the shape is ideal for straw chopping but may shatter in rocky soils *(see image to the right)*.

Concave straw chopping high speed disc.

"Each 1% increase in soil organic matter adds 0.1 inch of available water holding capacity per foot of soil."
Dr. Bill McGill, UNBC

"An acre furrow slice is an acre of land to a depth of 6.67 inches, using a bulk density of 1.3 g/cc it is equivalent to 2 million pounds of soil."
Les Henry. 2010. Henry's Handbook of Soil & Water.

High Speed Tillage *Continued*

Where & when to use it?

This is a tool being considered and utilized by the forage seed industry and may have a place in forage rejuvenation as well. High speed tillage does mean that is needs to be utilized at 10 -14 mph.

Reduction in soil erosion risk would be highest with spring use and immediate seeding following tillage.

What is the value of topsoil?

In the soil erosion work done in the 80's and 90's in the Peace it was taking 10 years to increase soil organic matter by 2% under newly adopted conservation tillage practices *(see page 9)*.

What are the benefits compared to costs?

- ◊ a 1 % increase in soil organic matter directly results in 4-7 lbs of N/ac available to the crop = **$1.30-$2.25/ac.**
- ◊ plus 1 in/ft plant soil moisture status increases observed in Peace field plots can mean increases in yield of 7-11 bu/ac of barley valued at **$21-$33/ac**.

High Speed Tillage Effective For:

⇒ Replacing a conventional disc, field cultivator and a rolling stalk chopper
⇒ Working well in fall or spring
⇒ Leveling out ruts once the soil has dried.
⇒ Incorporating straw and residue

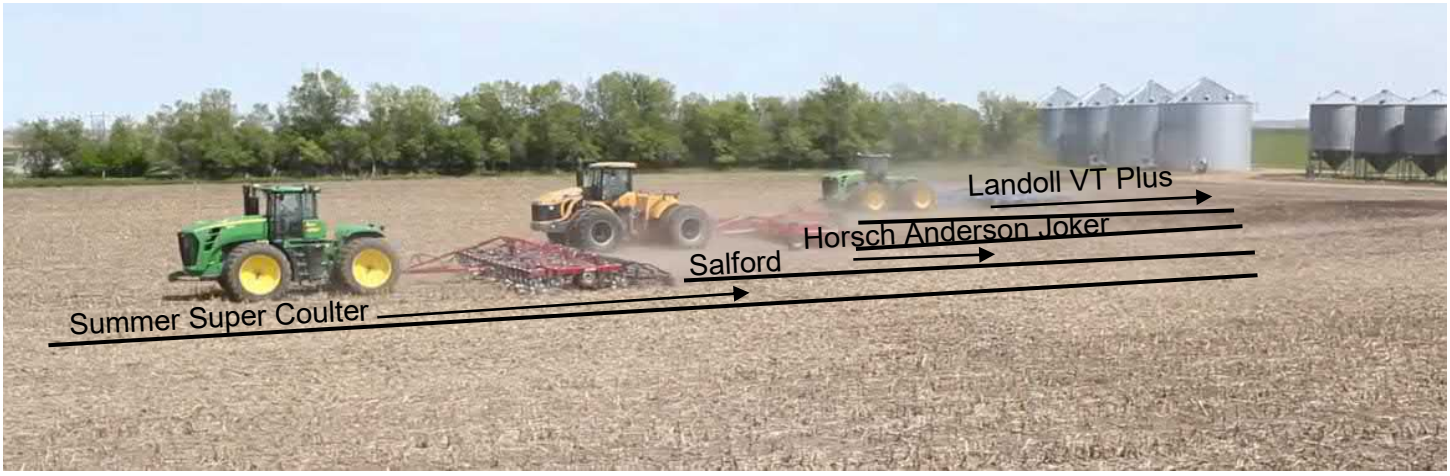
High Speed Tillage Not Effective For:

⇒ Dealing with subsurface compaction - as it creates a shear layer in the soil
⇒ Establishing a firm seed bed if used in the spring.
⇒ Erosion protection if it is used and the field is left fallow for any extended length of time before seeding.

Table 3: Vertical Tillage Tools

Machine Size	Purchase Price	Ownership Cost ($/hr)	Repair & Maint. (R&M) Cost ($/hr)	Margin on Ownership and R&M ($/hr)	Rental Rate ($/hr)	Power Unit Cost ($/hr)	Custom Rate ($/hr)	Work Rate (acre/hr)	Custom Rate ($/acre)
Heavy duty, compact high-speed disk									
Small 10-25 FT	$95,000	48.98	33.25	12.33	94.56	165.31 225+ hp	259.87	17	15.29
Large 26-40 FT	$160,000	82.49	56.00	20.77	159.27	215.76 500 hp	375.02	32	11.72

Source of Table 3: 2021 Cost of Production Projections by Manitoba Agriculture.



Above is a clip from a youtube video called Horsch Anderson Joker versus Salford RTS, Summers Supercoulter & Landoll VT Plus that shows the different level of disturbance from vertical & high speed tillage implements. The vertical tillage choices include Summer Super Coulter (closest to the bottom pass that has already gone by) & Salford RTS (second from the bottom). The high speed tillage include a pass using the Horsch Anderson Joker implement (third pass from the bottom; notice the black soil behind from the more aggressive disturbance and incorporation of straw). The final pass is with a Landoll VT plus (closest to the top).

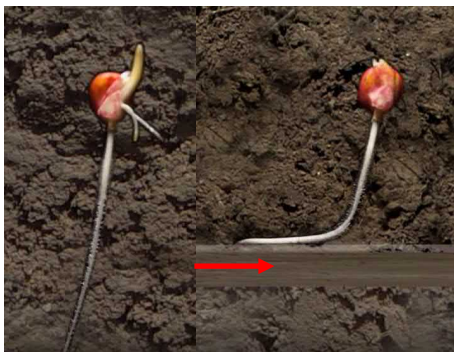
Subsoiling - A Tool With Limitations

What is it?

Subsoiling here is defined as tilling at depths of 6" or more to a depth just beyond the plow layer. It is a potential way to break up hardpan layers in the soil caused by compaction. Please note that we are not talking here of the much deeper subsoiling to 24" tried in the past in solonetzic soils and in forestry applications.

Why use this tool?

If plants roots are showing signs being inhibited by compaction *(see photos to the right)* or if soils are poorly drained, fields may benefit from subsoiling. Subsoiling is often utilized to break up a compaction layer deeper than 6 inches in the Peace this layer is often affiliated with a plow layer that is preventing root penetration and water infiltration. Simply shattering this pan allows for deeper root development.



Healthy root penetration through the soil (left) compared to root reacting to compacted layer (red arrow on left) caused by repeated plowing or discing.

Photo of healthy corn root (shown on left side of photo) compared with compaction (right,side of photo). Photo credit: Real Agriculture 2019.

How it works?

Subsoiling pulls a shank through a compaction layer creating a fracture zone where water and roots can penetrate a previously impermeable layer. Knowing what kind of subsoil and information about water table in each field planned for use is essential, or subsoiling may just be creating more issues.

When & where to use it?

Determine the depth of the natural pan to make certain the shanks of your subsoiling equipment can penetrate at least 1 inch below it. Make a narrow slot through this "hardpan" without bringing subsoil to the surface. There is no advantage in using a shank point more than 2 inches in width**.** Do your subsoiling when the soil is moist, not wet. Moist soil requires less horsepower and will cause less wear on the points. With some exceptions, subsoiling should be done in the fall.

To be effective, deep tillage needs to be performed when the entire depth of tillage is sufficiently dry and in the friable state. The practice tends to be more effective on **coarse textured soils (sands, gravels),** as crops on those soils respond better to deeper rooting. In **fine textured soils**, the entire subsoil often has high strength values, so the effects of deep tillage are less beneficial. In some cases it may even be harmful for those soils, especially if the deep tillage was performed when the subsoil was wet and caused smearing, which may generate drainage problems. After performing deep tillage, it is important to prevent future re-compaction of the soil by keeping heavy loads off the field and not tilling the soil when soil moisture conditions make it inappropriate.

What is the cost?

Here we use the 2017 Agrowplow $30,000 for 11 ft', 5" spacing, rental rate at $6-$10 / ac + 350-450 hp tractor $23-$30/ac assuming 7 ac/hr.

Total cost $30-$40/ac

Returns: For each day of delayed seeding, there is a significant yield decline *(see Table 2 on page 3).* If this subsoiling enabled a week earlier seeding without hindering water availability for crop during the growing season, or without introducing salinity there may be a return. There is currently no conclusive research on this.

Subsoiling Effective For:

1. Fracturing compaction layer up to eight inches.
2. Improving water infiltration in some instances.

Subsoiling Not Effective For:

1. Long term solutions to soil compaction in heavy clay soils or in luvisolic soils.
2. Introduces new challenges of subsoil issues to topsoil, most commonly associated with solonetzic or saline soils.
3. May introduce drainage issues to fields with high water tables or poor drainage. It may result in fully saturated soils that are a challenge to get equipment onto in the spring.

Aerating- A Tool For Forage Producers

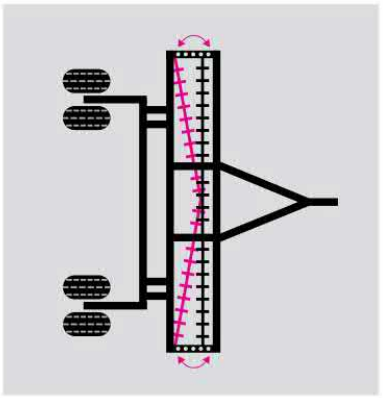
What is it?

The AerWay pull-type model was developed to maximize hay and pasture productivity by increasing air, fertilizer, and water movement into the soil profile. Patented AerWay shattertines gently lift and shatter tough soils 8 in. and deeper to increase air and water movement.

Why use this tool?

Soil compaction, and **reduced water infiltration** can cause a producer to look at a temporary or short term fix to lengthen out the life of a perennial forage stand. When the balance between basic soil elements: air, mineral, water, and organic matter get shifted out of its optimal range the production and soil health will be affected. Air and water balance in the soil is the key to good root growth. Compaction stresses plants because air and water are "squeezed" from the soil. Biological and chemical activities which depend on air and water become severely restricted. Root growth is impaired and crop production can suffer.

AerWay's® Quick Adjust Advantage
The patented AerWay® Quick Adjust rollers allow you to control the degree of aeration and renovation. For example the lesser swing angles are used for aeration and compaction relief and the more aggressive angle for renovation and overseeding.



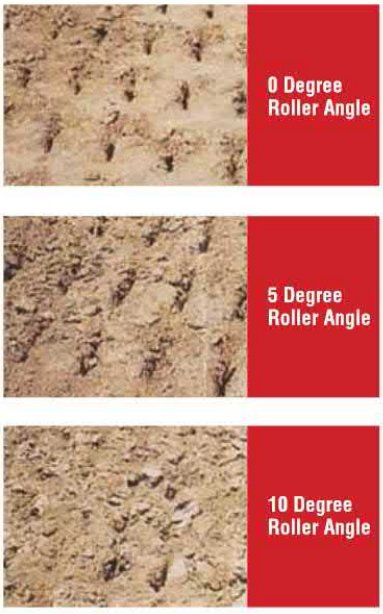


Figure 3: Illustrating the angle changes and the resulting soil disturbance on the right. This tool has been useful in increasing water infiltration in coarse textured soils in the Peace.

Closeup of AerWay tines.

How it works?

The AerWay tine pattern is designed to prevent erosion. This is unlike many other pasture aeration tools that have blades or shanks in a row. The alternating position of the AerWay roller tines are arranged in an offset pattern that ensures there is never a continuous furrow or groves in the soil that would channel water and cause erosion

When & where to use it?

Based on several years of testing in the Peace, it seemed like the most benefits were realized from fall use, as this allowed optimal infiltration of spring runoff.

Soils with sandy textures seem to have the most lasting response, soils with tight clay soil texture seems to close back up quickly.

Aerating Effective For:

1. Forage hay and pasture, especially if used in combination with applying nutrients.
2. Fracturing compaction layer in the top 8".
3. Effects last longer in coarse texture soils e.g. Beryl sandy veneers present in Groundbirch, Willow Valley, Lone Prairie, Jackfish, Beryl Prairie, and Sloan and Codessa soils in Doe River and Flatrock areas.

Aerating Not Effective For:

1. Tight clay soils.
2. Long term compaction solution if cause of the compaction continues, or is innate in the soil.

Table 4: Specifications for AerWay Series

Table 4. AWS Series Specifications (Straight Frame / Quick Adjust)					
Model Number	Cultivation Width	Travel Width	# of Tines	Weight	Horsepower Required*
AWST125	12.5 ft.	12 ft. 2 in.	80	2515 lbs	75-125
AWST150 - 2 Rollers	15 ft.	14 ft. 8 in.	96	2800 lbs	90-150
AWST200	20 ft.	19 ft. 8 in.	128	4200 lbs	120-200
AWSS150 HAS FOUR SHORT ROLLERS • AWST150 HAS TWO LONG ROLLERS					

$12-$17/ac custom rates

Erosion & Conservation Tillage Research

In the 1980's and 1990's there were erosion plots set up by a team of collaborating researchers from AAFC, Univ. of Alberta, BC Ministry of Agriculture in 5 locations in the Peace Region:

1. Jim Collins farm in Montney, BC
2. Northern Lights College farm, Dawson Creek, BC
3. Frank Breault's farm in South Dawson; BC
4. LaGlace, AB
5. Beaverlodge Research Station, AB.

The plots were 30 m x 5 m or 0.01 ha. There were 3 replicates of each crop, tillage or rotation being tested. Tanks were buried at the base of each plot to collect runoff and sediment after spring runoff and summer storm events over 3 to 10 years, depending on the location and funding. Keith Carroll has compiled the results from these 5 sites in a table below.

Air photo of erosion plots in South Dawson (photo credit Jack Dobb).

Keith Carroll checking rain gauge with Rob Kline & Murray Tenove.

Laurens Van Vliet & Rob Kline constructing erosion plots.

Table 5: Peace Region Soil Erosion Plots Summary Compiled by Keith Carroll, 2020.

	Runoff mm/ yr	Runoff % ppt/ yr	Soil loss t/ ha/ yr
Beaverlodge 1979 - 1982, Comparing Rotations, 11 - 12% slope			
Fallow			16.5
Barley, canola			1.1
Fescue			1.9
LaGlace 1985 - 1986, snowmelt only - winter precip. was 68% of normal, 5% slope			
Barley fall till			0.7
Barley stubble			0.4
Canola fall till			0.8
Canola stubble			0.3
Fallow			0.8
Fescue			0.2
Montney 1983 - 1989, Comparing Rotations, 13% slope			
Fallow-canola-barley-fallow-canola-barley	229	8 %	4.9
Canola-barley-barley/fescue - fescue-fescue	172	6 %	1.0
Northern Lights College Farm 1981 - 1988, Comparing Crops, 11% slope			
Fallow	65		2.6
Barley	49		0.6
Canola	32		0.3
Alfalfa-brome	47		0.1
South Dawson 1987- 1991, Comparing Tillage, 8% slope			
Conventional till	171	38 %	2.4
Reduced till	105	23 %	1.4
Zero till	180	40 %	0.6

Notes: *The high values for fallow at Beaverlodge are misleading as the control was continual fallow & not a true control or practice common with Peace farmers. By about the 3rd or 4th year there was exposed subsoil on the Beaverlodge continuous fallow plots.*

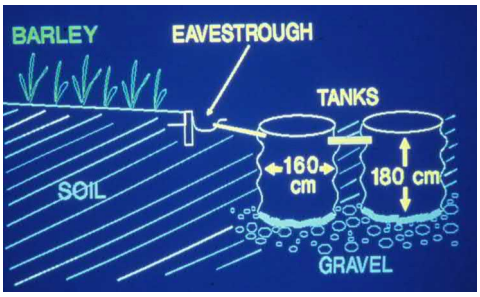


Figure 4: Side view diagram of plot layout showing collection tanks buried into the ground to collect runoff & sediment during spring melt & summer storms. (Source: Rob Kline).

Jack Dobb, Frank & Dan Breault in the first zero till field in the Peace. The first crop in 1979 of barley yielded the same as the conventional till (69 bu/ac). (Photo credit Jack Dobb).

Tank full of water & soil after summer storm event during the first season at the erosion plots in South Dawson. (Photo credit Rob Kline).

The Story of Conservation Tillage Adoption

The story of conservation tillage efforts in the BC Peace Region spans 15 years and includes 15 drills. Despite obvious and widespread erosion problems, there were only a few isolated cases of zero till testing.

Breaults, Graws, Molsons & Esaus were the early pioneers testing zero till. In 1979, Jack Dobb and Frank Breault set up a long term zero till plot near Dawson Creek. They borrowed a Melroe-Bettison seed drill from Airdrie. Meanwhile in northern Alberta, the Graw brothers were building their own drill, copying many features from the Pioneer Yielder drill from Palouse, Washington. They started zero tilling their whole farm in 1984. In 1986, Bill Molson bought a Haybuster 1000 with paired row double disc openers. He and his sons teamed up with PFRA staff to set up a zero till research plot on their farm near Bonanza.

Brad Esau from Clayhurst was also one of the conservation tillage pioneers. He was frustrated with having to bury crop residues or trash to get seed placement and he wanted better fertilizer placement. So in 1986 he bought a Haybuster 107 disc drill with banding option. He had problems with hair pinning and "slabbiness" in their heavy clay soil. In 1988 he traded it for a Haybuster 7000 hoe drill, which eliminated hair pinning and left more trash on top. Brad had zero till barley test plots 1986 to 1989. The yields were similar to conventional till except the very wet 1988 when the conventional yielded better.

In 1987, The Peace River Soil Conservation Association was the first producer group to initiate field scale testing. There were only about 3 options for drills available at that time.

Summary of Zero Till Research

- ◊ Zero till produces the highest total annual and snow melt runoff *(see Table 5).*
- ◊ Zero till produces much less soil loss than conventional till during both snow melt and rainfall events.
- ◊ In further research it was found that these soil loss measurements are conservative. The 'depth-integrated sample' under estimated soil loss when compared with the known total quantity of soil and sediment leaving the slopes.
- ◊ At the zero till field scale plots on heavy clay soils at 'No-Till Bill' Molson's farm near Bonanza, there were a higher number of water stable aggregates with less tillage (conventional tillage 1.4 mm compared to 32 mm with zero till, John Heinonen & Randy Graw).
- ◊ After 9 years of farm scale continuous zero tillage at Breaults' farm, soil organic matter improved from 4.3 to 6.1% in the top few inches or 7.5 cm (Charlie Arshad & Jack Dobb, 1989).
- ◊ Rain water infiltrates into the soil much better under zero tillage than into soil under conventional tillage (Charlie Arshad & Jack Dobb, 1989).

Zero Tillage Effective For:

1. Seeding through surface residue.
2. Reducing the time that land is vulnerable to erosive forces & reducing soil losses.
3. Increasing soil quality e.g. increasing organic matter & infiltration into the soil profile.
4. Reducing variable costs & increasing gross margins.

Zero Tillage Challenges:

1. Residue management long before seeding is critical.
2. Weed control focus changes.
3. Disease issues change.
4. Crop rotation vital to avoid disease.
5. Clay soils can be challenging to manage, especially in cool wet spring.
6. Denitrification, especially in the early years of zero till & especially in saturated or heavy textured soils.
7. Rejuvenating perennial forages with direct seeding needs more research attention.

Peace River Soil Conservation Association

Active: 1986-1996

Farmers Involved:
John Miller, Ron Scobie, Garnet Berge, Wayne Melia, Dennis Torkelson, Vic Mattson, Gavin Rosie, Ken & Ray Piper, Bill & Mike Molson, Frank Breault, Walter Henderson, Clarence & Eldon Veiner, Kane Piper, Don & Dick Miller, Bill & Rod Strasky, Stan Mracek.

Contractors:
Sandra Burton, MaryAnn McClarty, Dean Mattson, Joanne Anderson, Darlene Bray.

Objectives:
⇒ Set up farm scale plots comparing conservation & conventional tillage.
⇒ Compare soil quality, weed / pest control, yields, crop quality & economics of tillage practices.
⇒ Conduct an erosion study on watershed basis.
⇒ Share results through field days, workshops, trade shows & presentations.

Source: Excerpts from: Sandra Burton et al. 1994. 15 Years & 15 Drills: The Story of Conservation Tillage in the BC Peace. An annotated slide collection on contract for BC Min. of Ag.

"We need to understand how we got to this place, to know how to go forward. We don't want to slide back. We need to understand carefully how each new tillage tool fits a very specific use & soil, landscape or cropping situation."
Julie Robinson

Direct Seeding with Producer Groups

What is it?

Direct seeding is placing seeds and nutrients directly into the soil with no tillage in the fall or spring to prepare the seedbed. The original term zero tillage was used and debated to mean zero soil disturbance, but over the years it became more practical to use the term direct seeding and focus on working with farmers to make it work.

Why is direct seeding so widespread in the Peace River Region?

In the mid 1990s, the BC Peace had one of the highest rates of adoption of direct seeding in Canada. This was the result of collaboration & 5 factors:

1. Credible information coming from 15 years of research from erosion plots in several locations.
2. Frank Breault & Jack Dobb committed to a long term farm scale tillage comparison.
3. A producer group took the lead integrating research info into farm system complexities. Other groups followed.
4. The equipment dealers finally took interest & developed more options.
5. The BC Ministry of Agriculture & ALDA setup a program of low interest loans for farmers to purchase their first direct seeding equipment.

In 1987, there were only 6 options for zero till drills and about 900 ac of direct seeding in total in the BC Peace. In 1990, Frank Breault was the first farmer to purchase two JD752 drills through the ALDA loan program. As more drill options became available 30 more drills were purchased and by 1994, there was over 50,000 ac of zero till in the BC Peace.

Dennis Torkelson tried double cropping with zero tilled barley & winter wheat in 1987 (left photo). Peace River Soil Conservation Association field day in 1993 (right photo).

Sandra Burton & John Miller & Peace River Soil Conservation Association with ARDSA funding. Notice John's first zero till crop in background. (left photo).
In 1990, Frank Breault was the first farmer to purchase JD752 drills through ALDA (right photo).

Direct Seeding with Producer Groups *Continued*

BST or Baldonnel Sunrise Two Rivers Soil Conservation Association members tour in 1992.

Knifing fertilizer into fescue fields worked better than the spoke wheel injector (left photo). In 1992, Gord Oullette direct seeded alfalfa & birdsfoot trefoil with JD752 (right photo).

North Pine Farmers Institute field day in 1992 (left). Seeding with JD777 at Bill Bickfords (right).

Looks can be deceiving, especially in early spring. Thomas' wheat crop yielded better with zero till (seeded with JD 752 drill, yield 63 bu/ac, on left side of photo above) compared to conventional till (seeded with JD777/610, yield 54 bu/ac on right side of photo above).

Ron Moffat used the JD752 zero till drill to reseed an alfalfa crop. It was quite a sight in 1993, 10-15 inches high in August & great hay yields. A lot of tillage & input expenses to prepare another seedbed (as in conventional rejuvenation practices) were saved.

Baldonnel Sunrise Two Rivers Soil Conservation Association

Active: 1991-1995

Farmers Involved: John Aalhus, Gord Oullette, Cliff Bennett, Ed Hadland, Arthur Hadland, Malcolm Lucas, Jerry Hill, Glen Aalhus, IngvarJensen, Martin Odermatt.

Contractors: Lothar Torheiden

Objectives:

⇒Evaluate direct seeding in a new area with several drills & nutrient application methods.

North Pine Farmers Institute

Active *: 1991-1995

** Active in conservation tillage plots*

Farmers Involved:
Jim Collins, Ken Marsh, Ron Moffat, Frank Thomas, Blaine Meek, Brian Johnston, Maurice Fines, Bill Bickford

Contractors: Henry Braun

Objectives:

⇒Evaluate zero, minimum & conventional tillage with several drills.

⇒Evaluate tillage methods with annual & perennial crops.

Henry Braun sampling with King tube for soil moisture.

Where Next?	Well Done Awards	Opportunities for Progress: Producers are encouraged to continue to:
Annual Crop Producers	⇒From 1991 to 2011 there was significant changes in tillage practices across Canada. Over 55% adopted conservation tillage practices ensuring the stabilization & retention of topsoil. ⇒The BC Peace producers led this adoption curve with the highest speed & adoption rates. ⇒Effective nutrient management, utilizing fall/ alternate pass application timing to address too much nitrogen going down with the seed.	⇒Manage straw residue while maintaining soil armour to prevent soil erosion. This involves utilizing growth regulators or new varieties with reduced stem height. ⇒Improve water infiltration through increased organic matter. Note: 1% increase 5-7 years under zero-till practices. ⇒Manage traffic to reduce compaction in high risk areas. ⇒Reduce contact pressure with tires, i.e. less than 5 tons axle by utilizing flotations tires to minimize depth & extent of compaction.
Perennial Forage Seed Producers	⇒Seed producers have improved the rejuvenation process, limiting the days that the field is exposed to high soil erosion risks. ⇒This group utilized high speed tillage & chemicals to limit plowing/ discing rejuvenation. ⇒These producers have improved effective timing of application of fertility to maximize seed growth & raindrop interception.	⇒Maintain market access to world markets to enable the crop competitiveness in cropping rotations. ⇒Support research demonstrating long term soil health benefits from including perennial forage stands in crop rotations. ⇒ Continue on their reduced tillage for rejuvenation theme & are applauded for the value they continue to see in maintaining grassed waterways in the fields.
Perennial Forage & Livestock Producers	⇒Led the way in the Peace in the last 10 years with improvement in soil health through beneficial management practices such as bale grazing, rotational grazing & effective manure utilization & spreading. ⇒These producers have seen significant increases in organic matter, water infiltration, plant utilization & improvements to soil pH.	⇒Reduce rejuvenation tillage & reduce time land is vulnerable. ⇒Explore offsite watering systems to reduce erosion risks. ⇒Explore new varieties & the genetic advantages of disease resistance to reduce the frequency of rejuvenation. ⇒Support increasing local capacity for custom operators on small acres to enable producers to take advantage of improved rejuvenation practices.

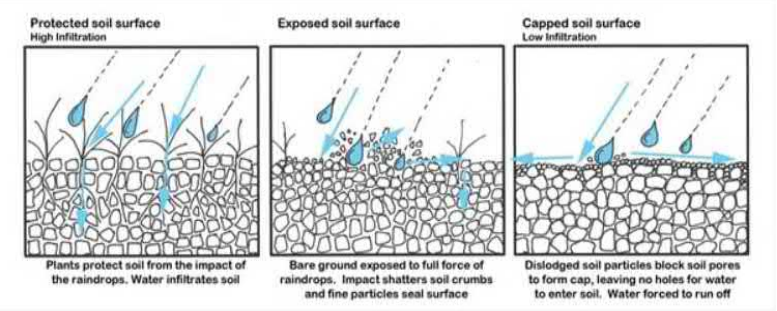


Figure 5. Raindrop action & role of crop / residue cover. from Ground Cover Standards for Central Queensland Grazing Lands, Fitzroy Basin Assoc.

Key Messages:

1. The key is intercepting the erosive power of raindrops & slowing runoff water rather than this water being drained off our unique Peace landscapes quickly.
2. Practices that increase soil quality, organic matter & infiltration into the soil are critical.
3. The producers in BC Peace in all sectors have led the way in innovating to control runoff & soil erosion & improve their soil quality. Their efforts require further support & funding.

Compiled by: Julie Robinson, Sandra Burton, Keith Carroll & Matthias Loeseken
With contributions from: BC Grain Producers Association, Peace River Forage Association of BC, Peace Region Forage Seed Association, Canadian Seed Growers Association, Peace Region Cattlemen's Association, PRRD.
Published & Circulated through: Runoff, Erosion & Drainage Project, a BC Climate Action Initiative.

Funding for this project has been provided in part by:

Climate Action Initiative BC AGRICULTURE & FOOD
CANADIAN AGRICULTURAL PARTNERSHIP
ardcorp BC AGRICULTURAL RESEARCH & DEVELOPMENT CORPORATION
Investment Agriculture Foundation of British Columbia