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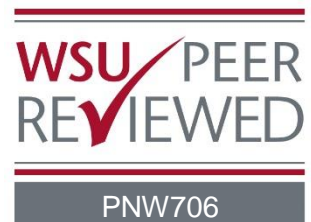
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CONSERVATION TILLAGE IN A WINTER WHEAT-FALLOW SYSTEM: RON JIRAVA

FARMER-TO-FARMER CASE STUDY SERIES: INCREASING RESILIENCE AMONG
CEREAL-BASED FARMERS IN THE INLAND PACIFIC NORTHWEST



CONSERVATION TILLAGE IN A WINTER WHEAT–FALLOW SYSTEM: RON JIRAVA

By

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Abstract

Ron Jirava farms near Ritzville, WA, in an area receiving 11.5 inches of annual precipitation. In this publication, Jirava discusses his tillage strategies, including his use of the undercutter sweep, and his experimentation with a no-till winter wheat–fallow rotation. In this [video](#), Ron introduces his approach to conservation tillage.

This case study is part of the Farmer-to-Farmer Case Study project, which explores innovative approaches regional farmers are using that may increase their resilience in the face of a changing climate.

Information presented in the case study is based on growers’ experiences and expertise and should not be considered as university recommendations. Mention of trade names or commercial products is solely for the purpose of providing specific information and does not imply recommendation or endorsement.

Grower quotes have been edited slightly for clarity, without changing the meaning.

Readers interested in other case studies in this series can access them at on the [REACCH website](#), as well as in the [WSU Extension Learning Library](#).

Table of Contents

Abstract.....	2
Past Experimentation with Intensified Cropping Systems	4
Current Tillage Systems.....	6
Undercutter	6
Winter Wheat on No-Till Fallow	7
Impact of Reducing or Eliminating Tillage on Residues and Planting	9
Benefits.....	12
Challenges	13
Managing Risk.....	14
Continuing to Experiment with Crop Diversity	16
Looking Forward	18
References	19

Conservation Tillage in a Winter Wheat–Fallow System: Ron Jirava



Ron Jirava. Photo: Darrell Kilgore, Washington State University.

Location: Ritzville, WA

Precipitation: 11.5 inches annual average

Cropping System: Predominantly winter wheat. Some spring wheat, winter triticale, and winter peas.

Watch the [companion video](#), Conservation Tillage in a Winter Wheat–Fallow System: Farmer-to-Farmer Case Study Series, introducing Ron Jirava and his conservation tillage methods.



Map: Kaelin Hamel-Rieken, Washington State University.

Ron Jirava (pronounced “Jeray”) has been farming near Ritzville since 1985 on the farm he grew up on. Jirava has experimented with direct seeding over the years, but has generally found that conservation tillage better retains the limited rainfall on his farm’s 6-foot-deep soils (Ritzville silt loam, NRCS 2013).

Conservation tillage helps Jirava maintain economic viability. It also helps with “keeping as much residue on the ground as possible, to keep the soil from moving...and build organic matter.” To facilitate residue management in the winter wheat–fallow rotation that is carried out on the vast majority of his farm, Jirava has been using an undercutter sweep as his key piece of tillage equipment since 2008. The undercutter has narrow-pitched and overlapping V-shaped blades (Figure 1). When used for primary tillage in the spring, these blades cut beneath the soil, severing capillary pores and channels that would bring water to the soil surface and deplete stored soil moisture. During the same undercutter operation, all the fertilizer needed for the next winter crop is injected.



Figure 1. The undercutter has overlapping 32-inch-wide narrow-pitch V blades on two tiers to slice below the soil surface at a depth of five inches, completely severing soil capillary pores and channels. This retains seed-zone moisture during the hot, dry summer months. Photo: Bill Schillinger.

More recently, Jirava has returned to experimenting with direct seeding, using no-till fallow on a small portion of his winter wheat–fallow acreage.

Past Experimentation with Intensified Cropping Systems

Jirava has long been at the forefront of efforts to develop cropping systems that are both economically and environmentally sustainable for his area. With fine silt loam soils and several hills with slopes of up to 40 percent, there is significant potential for soil erosion (Figure 2). Environmentally, direct-seeded annual cropping systems are winners, but they are not competitive economically under the conditions on Jirava’s farm. (See *The Economic Challenges of Direct Seed Annual Cropping in the Low Rainfall Area of the Pacific Northwest* sidebar.) For over 20 years, Jirava has experienced these challenges first hand, maintaining 320 acres of direct-seeded continuous annual spring wheat with financial support from USDA programs. A 2000 case study, now out-of-date, profiles his thoughts from his early years of direct seeding (Mallory et al. 2000).



Figure 2. Wind erosion on a field near the Jirava farm in early September, under wind conditions that were not unusually strong. Note the pulverized soil and complete lack of surface residue. Photo: Georgine Yorgey.

Jirava has also long experimented with conservation tillage on his farm. He started by replacing a disk operation with a modified sweep operation using his chisel plow for primary spring tillage. After removing the springs from the sweep to make solid shanks, the 18-inch sweeps, on a 12-inch spacing, followed by a single skew treader, achieved “good

[weed] kill on everything, and it was doing a nice job.”

A second reduction in tillage came after seeing WSU research results demonstrating the benefits of conservation tillage with an undercutter. (See the *Research on Use of an Undercutter in the Dry Region* sidebar.) When a cost share became available through the USDA Natural Resources Conservation Service (NRCS), Jirava took advantage of the opportunity and purchased an undercutter for his farm.

The Economic Challenges of Direct Seed Annual Cropping in the Low Rainfall Area of the Pacific Northwest

Direct seeding and no-till summer fallow can reduce wind erosion (Sharatt et al. 2010; Papendick 2004). However, regional studies in the inland Pacific Northwest’s low precipitation area (less than 12 inches annual rainfall) have consistently shown that annual cropping with no fallow and alternative crops such as spring wheat, barley, and safflower provide increased variability and lower average profitability than winter wheat–summer fallow (Schillinger and Young 2004; Schillinger et al. 2007; Young and Schillinger 2012). Lower economic performance is likely the result of water dynamics (Higginbotham et al. 2011; Wuest and Schillinger 2011). Untilled sandy soils have been shown to lose seed-zone water at a faster evaporative rate than soils managed with tilled summer fallow (Hammel et al. 1981; Wuest 2010; Schillinger and Young 2014).

However, water retention in no-till fallow is about the same as for tilled fallow silt-loam soils of the Jirava farm (Schillinger, unpublished data).

When it occurs, reduced seed zone moisture can make it difficult or impossible to plant winter wheat into carryover soil moisture in the late summer. Delayed fall planting of winter wheat has a strong, negative impact on winter wheat yields (Donaldson et al. 2001).

Research on Use of an Undercutter in the Dry Region

Bill Schillinger, Washington State University; and **Georgine Yorgey**, Washington State University

A six-year tillage management study, conducted from August 1993 to July 1999 at the Washington State University Dryland Research Station in Lind, WA, investigated the impacts of using an undercutter sweep to manage fallow. Three treatments were compared:

- Conventional tillage with a duck foot cultivator and attached four-bar spring-tooth harrow for primary spring tillage (two passes).
- A minimum-tillage treatment in which herbicides were substituted for tillage when feasible and a non-inversion undercutter V-sweep implement was used for primary spring tillage in March.
- A delayed minimum-tillage treatment, similar to the minimum-tillage treatment, except that primary spring tillage was delayed until mid-May or early June.

All treatments were sown at the same time. Further details of the tillage treatments, and the study, are available in Schillinger, 2001.

Surface residue and clod mass were consistently reduced by 45 percent or more under conventional tillage, compared with minimum tillage and delayed minimum tillage. Levels of surface residue, surface clod mass, and roughness on the soil surface are critical factors for controlling wind erosion in this low precipitation wheat production region. In years when wheat straw production was low, the minimum quantity of surface residue (348 lb/acre) required for highly erodible soils (for government farm program compliance) could not be achieved or was only marginally met using conventional tillage. In contrast, sufficient surface residue was present in all years with minimum and delayed minimum tillage (Figure 3).

Meanwhile, precipitation storage was similar across treatments (Table 1). There were no differences in seed zone water content among treatments (Figure 4). It is likely that in all treatments, the most important factor regulating summer evaporative water loss was the abrupt break, created by tillage, between the tilled and non-tilled soil layers. The break severed capillary channels (narrow vertical channels) from the subsoil to the surface that otherwise would have allowed water to be lost from the surface through evaporation.

There were no differences in grain yield among treatments during any year or when averaged across years.



Figure 3. An undercutter implement minimizes soil lifting and allows most of the residue to remain on the surface. Blowing dust emissions are reduced by 70 percent with undercutter tillage compared to conventional tillage methods. The tank cart in front of the undercutter contains aqua ammonia nitrogen and thiosol sulfur that is injected through tubes running on both sides of each V blade on the undercutter. Photo: Bill Schillinger.

Table 1. Precipitation storage averaged over six years. Differences in storage between treatments were not statistically significant.

Time period	Conventional tillage	Minimum tillage (undercutter)	Delayed minimum tillage (undercutter)
Over-winter	51	54	57
End of fallow cycle	24	26	26

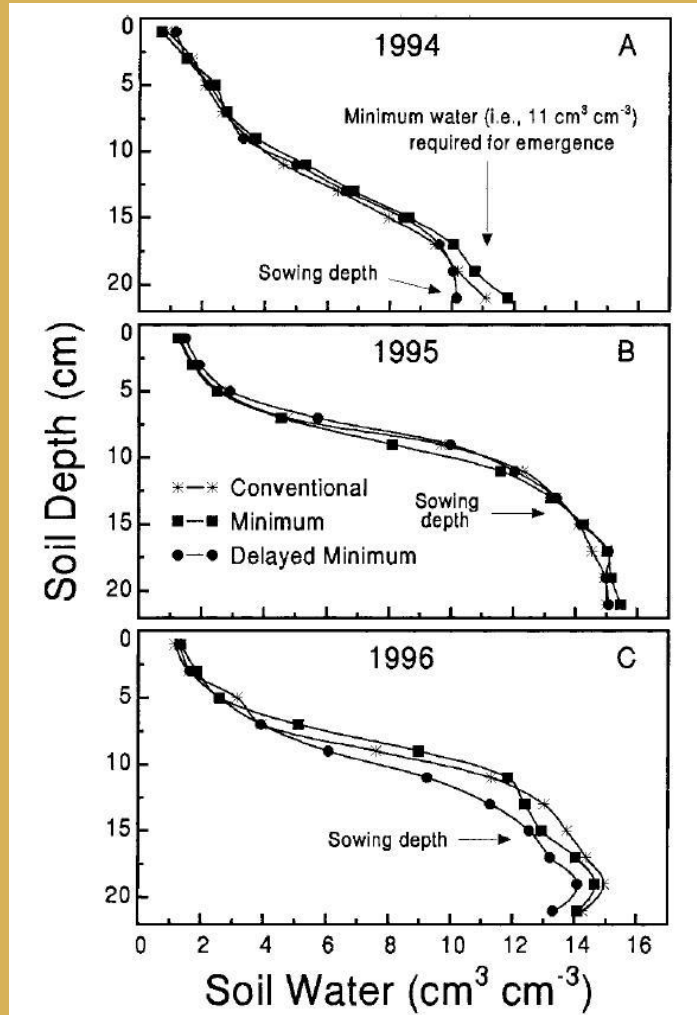


Figure 4. Seed-zone soil water content at time of sowing in September 1994, 1995, and 1996 as affected by conventional, minimum, and delayed minimum tillage during fallow. There were no water differences among treatments at any depth (0–22 cm or 0–9 inches) in any year (Schillinger 2001).

Current Tillage Systems

Currently, most of Jirava’s 5,000 acres are in a winter wheat–fallow rotation, managed using a Haybuster undercutter as the key piece of tillage equipment. He has eliminated the chisel plowing operation altogether. He also continues to maintain 480 acres of direct-seeded continuous annual spring wheat ground and, since 2012, has been experimenting with using

no-till on limited acreage in a winter wheat–fallow rotation.

Undercutter

Most of Jirava’s acreage is in winter wheat–fallow, tilled with the undercutter that has 32-inch-wide blades on 28-inch spacing. He says, “If we’re going to do tillage, the Haybuster [undercutter] is the tool

that gets used. Everything else has been parked.” He adds, “The Haybuster with the wide sweep leaves everything on top, so if it’s working the way it’s supposed to, you can hardly tell you’ve gone through there... [The thick residue has] made it a requirement to have precision guidance on the tractor so we know where we’ve been.” (See the *Jirava’s Approach to Precision Agriculture* sidebar.)

Jirava runs the undercutter at a depth of approximately four to five inches because “with our soils, if we go too deep, they get really loose, and they stay loose a long time. So we try and go as shallow as we can. But because we’re using deep-furrow drills to seed everything with, we have to take into consideration the depth of the furrow.”

Jirava uses the undercutter in the spring (typically in May) on fallow ground, after an application of glyphosate or another burn-down herbicide to control weeds. With wetter soils in the spring, Jirava recommends using chrome sweeps “so the soil doesn’t stick to the sweeps. It maintains depth better that way, and it pulls easier, there’s less drag.” Chrome sweeps also last roughly twice as long before needing to be replaced. Aqua nitrogen and thiosol sulfur is injected into the soil during the undercutter operation, saving a separate operation for this purpose. Weeds are controlled as necessary with a rodweeder throughout the summer.

Jirava occasionally also uses the undercutter to control Russian thistle (*Salsola tragus*) following harvest in the fall, to avoid the need to spray. Because it is more difficult to keep the desired shallow depth in drier late-summer soils, Jirava runs the undercutter at slower speeds, especially in areas with shallow or rocky soils, or caliche outcroppings.

Jirava has made some adjustments to help the undercutter work well in the conditions on his farm. He exchanged the original tires for heavy-duty aircraft tires and added one row of single-skew treaders (Mielke Mulcher) behind the undercutter. The skew treaders help reduce the size of large clods and also help close up the channel that forms where the undercutter shank holds the sweep. The undercutter is a relatively heavy piece of equipment on its own, and with the additional skew treader built in with the undercutter, Jirava uses at least a 350 horsepower tractor to pull it.

Jirava’s Approach to Precision Agriculture

Jirava has chosen not to invest heavily in precision agriculture technology. “I haven’t been convinced that, in an area where moisture’s the limiting factor, and I know pretty much every acre of the fields, that I will gain a whole lot from precision technology.” He feels that he is fertilizing fairly well and wouldn’t gain much by using yield monitors and precision nitrogen application. “We take soil samples, and we’re trying not to over-fertilize in the first place. And so, having every single acre mapped, and trying to test certain areas—it’s just spending more money. I don’t see the return.”

Guidance, on the other hand, has been a welcome technology on the sprayer and tractors, though Jirava occasionally loses contact with the satellites or experiences other technological glitches that cause it to not work properly. “That definitely helps with the Haybuster [undercutter], because it’s very difficult to see where you’ve been. It’s also nice for seeding in the fall.”

Winter Wheat on No-Till Fallow

In 2012, after an extremely dry winter, Jirava began experimenting on a limited basis with no-till fallow in his winter wheat (Figure 5). “There was no moisture at all coming into the spring, and so we decided to just leave it alone.” The first few years, he tried no-till fallow on 320 acres. In 2014, he expanded the experiment to 640 acres.



Figure 5. Residue remaining on a field planted to winter wheat, after being managed with no-till fallow for one year. Photo: Darrell Kilgore.

Though not all years are as dry as 2012, Jirava hopes to be able to maintain a small amount of no-till acreage by flexibly planting winter wheat or winter triticale during the cropped year, depending on conditions. The major limitation of no-till fallow in his area is that, despite a year of fallow, limited near-surface moisture is available for seeding winter wheat in late summer unless there is a late summer rainfall event. Waiting to plant winter wheat in the late fall, after fall rains arrive, has a risk of substantial yield loss (Donaldson et al. 2001).

To get around this constraint, Jirava is planning to plant winter wheat on the no-till ground only in years when adequate moisture is available for planting in

early September. In years when it is too dry to plant early, Jirava will wait for later fall rains and plant winter triticale rather than late-planted winter wheat. (See the *Late-planted Winter Triticale in the Dry Region* sidebar.) Winter triticale doesn't experience the same yield penalties as late-planted winter wheat. "If you have a dry fall, and you're looking at an October seeding date instead of an early September seeding date, you can plant winter triticale shallow in late October. It may take forever, but it will yield the same as a traditional winter wheat field [planted in early September] will. So, if your average winter wheat is 50 bushels, the late-planted winter triticale can do 50 just as well, whereas if you try to seed winter wheat in October, it can be a disaster."

Late-planted Winter Triticale in the Dry Region

Bill Schillinger, Washington State University; **Ron Jirava**, farmer collaborator; **John Jacobsen**, Washington State University; **Steve Schofstoll**, Washington State University; and **Georgine Yorgey**, Washington State University

Triticale, a cross of wheat and rye that is most commonly used as a feed grain, is not widely grown in the inland Pacific Northwest because feed grain prices have historically been low compared to wheat. However, with recent price increases, there has been renewed interest in this crop.

Beginning in the fall of 2010, winter triticale was incorporated after no-till fallow in the long-term cropping systems experiment on the Ron Jirava farm. Since then, heavy region-wide rain events of more than one inch occurred during July or August in many of those years or overwinter precipitation was greater than normal. This rainfall provided adequate seed-zone soil moisture for early planting in no-till fallow every year since the beginning of this trial. It was therefore possible to plant half of each triticale (variety 'Trimark 099') plot early, during the first week of September, and the other half late, in mid-October. These two triticale plantings were compared to early-planted winter wheat (variety 'Xerpha'), planted into tilled summer fallow in the first week of September. Seeding rates for early-planted winter triticale and winter wheat was 50 pounds per acre and for late-planted winter triticale was 90 pounds per acre. Experimental design was a randomized complete block with four replications with both the crop and fallow portions of all treatments present each year.

Late-planted winter triticale goes through the winter months in the two-to-three-leaf stage, whereas early-planted winter triticale is much further developed (Figure 6). However, unlike late-planted winter wheat, late planted winter triticale grows quickly in the spring and produces ample grain and straw biomass (Figure 7).

Over the seven crop years, grain yields for late-planted winter triticale and early-planted winter wheat were statistically equal (averaging 3,837 pounds per acre for late-planted winter triticale compared to 4164 pounds per acre, or 68 bushels per acre (bu/acre), for early-planted winter wheat) (Figure 8). Yields for early-planted triticale were 22 percent greater than early-planted winter wheat, averaging 5,082 pounds per acre.

Winter triticale can be grown in the same manner and with the same inputs and equipment used for winter wheat. In-crop grass weed herbicides such as Maverick and Olympus can be used on triticale. Winter triticale grows taller than winter wheat and produces ample residue. Federal crop insurance is now available for triticale in the Inland Pacific Northwest.



Figure 6. Late-planted winter triticale (left) compared to early-planted winter triticale (right) in mid-March at the Ron Jirava farm. Photo: Bill Schillinger.



Figure 7. Late-planted winter triticale (left) compared to early-planted (right) winter triticale in early July on the Ron Jirava farm. Photo: Bill Schillinger.

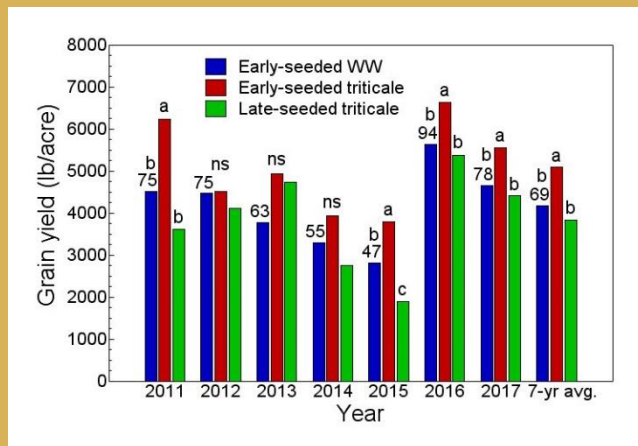


Figure 8. Grain yield of early- and late-planted 'TriMark 099' winter triticale planted into no-till fallow versus early-planted 'Xerpha' soft white winter wheat (WW). Within-year grain yields followed by a different letter are significantly different at the five percent probability level. Over the seven years, early-planted winter triticale produced an average of 22 percent more grain than early-planted winter wheat. Values over the blue bars indicate winter wheat yield in bu/acre.

Though planting winter triticale is a promising option, it is not without its limitations. First, winter triticale does not offer many benefits in terms of weed management, since it is similar to wheat. Second, prices for triticale aren't competitive with wheat, and price limits the acreage Jirava plants. "I generally need to have a 30-percent gain in yield over winter wheat to make up the price difference in what I'll get off of the crop."

Impact of Reducing or Eliminating Tillage on Residues and Planting

For Jirava, the greatest challenge to reducing or eliminating tillage has been making sure that his drill can successfully plant through surface residues. Planting through thick residue is particularly challenging following wetter growing seasons or growing winter triticale, when residue is heavy. Under these conditions, Jirava sets the combine to harvest a bit lower to leave shorter stubble than usual.

Over the years, Jirava has acquired a number of different drills. Multiple drills allow him to seed under different residue conditions and vary row spacing to take advantage of soil moisture where it

exists. His feeling is that “our farm can’t have enough different drills for the different conditions that we might run into.” (See the *Jirava’s Drills* sidebar.)

Jirava’s Drills

Jirava has more drills than most farmers, which he feels gives him flexibility to leave more residue, and to take advantage of extra soil moisture when it is available. While some drills are used across the farm, others are used in more specialized circumstances. He keeps his overall equipment investment reasonable by purchasing used equipment. “We’ve got a lot of older machinery and I do most of the maintenance. Some people would argue that you should use your time more valuably than by being the mechanic, but that’s the way we do it. Right now, we’ve got less than \$150,000 tied up in three combines, when a new one would be close to \$450,000.”

When Jirava initially started direct seeding annual spring wheat in 1996, he purchased a Flexi-coil 6000 single disk drill. Over time, he found that in his soils, the angled single disk “would push the silt loam, and it wouldn’t turn the way I wanted it to very nicely.” The many bearings also meant it was expensive to maintain, so he ended up trading this drill.

Over the years, he has found that under his farming conditions, a hoe drill with heavy springs and a solid shank work well. “You need to have something heavy and solid that maintains your seeding depth, regardless of whether the soil’s soft or hard. If you hit a hard spot, you need it to go in, and if it’s soft, you need it to stay where you put it and not sink.”

His current complement of drills includes:

A conventional deep furrow John Deere HZ drill on 16-inch spacing (Figure 9). “The HZ is the conventional drill that we’re using. Any more, we tend to have a little bit too much residue for the HZ drill, so we’ve made some modifications to it, putting straw pickers and straw straighteners on it.” When Jirava uses the HZ drill on ground that has been undercut, he generally packs the soil first, either with a coil packer, or by running the drill with packers but no seeding. This reduces plugging up during the subsequent seeding.



Figure 9. Jirava’s conventional deep furrow John Deere HZ drill (left), with a closeup of the planting implement (right). Note the low clearance of the drill. Left photo: Hilary Davis. Right photo: Darrell Kilgore.

A John Deere 9400 hoe drill with cultivator shank setup on 15-inch spacing (Figure 10). Jirava purchased this drill in 2012, and has been pleased with how well it performs under high residue conditions. It has a heavier shank and leaf spring assembly than many other drills as well as staggered spacing of the hoes. “We use [it] on the chem fallow, as well as the traditional fallow ground that has heavy residue. It pretty much goes through anything.”



Figure 10. Jirava’s John Deere 9400 drill (left), with close-up of shanks (right). Among the features that allow it to penetrate heavier residue well are the heavier shank and leaf spring assembly along with the staggered seed openers. Photos: Hilary Davis (left) and Darrell Kilgore (right).

The Flexi-Coil 5000 direct seed drill, a hoe-type drill on 7.5-inch spacing. This is the drill he uses most commonly on his direct-seeded spring cropped acreage.

A John Deere 9350 conventional hoe drill on ten-inch spacing. If Jirava gets really good moisture before fall seeding, he uses this drill, which under wetter conditions can get through all the residue conditions he encounters. As Jirava says, “It helps with weed control and with putting residue on the ground. And the combine drivers like it because it’s smoother.” He has also used this on the direct-seeded spring cropped acreage.

A John Deere conventional disk drill on seven-inch spacing. Jirava uses this drill for planting spring crops into conventional fallow. He also uses it in the fall for late seeding, when he is ‘dusting in.’ He finds that a denser planting helps compensate for weaker tillering and canopy formation in these late-planted crops, helping the plants compete with weeds.

When seeding into substantial residue, Jirava uses a John Deere 9400 drill (Figure 11). “The 9400 drill actually can seed the chem fallow (chemical fallow, or no-till) ground—it’s that strong and heavy.” Partly because he currently has only one John Deere 9400 drill, he also uses a John Deere HZ drill on some of his acreage, but finds it does not perform as well under high-residue conditions.



Figure 11. Jirava’s John Deere 9400 hoe drill, which under his farm’s conditions successfully penetrates the residue left by the undercutter, seeding evenly. Photo: Darrell Kilgore.

Benefits

The most immediate impact of conservation tillage was an observable increase in residue compared to Jirava’s previous sweep tillage. “After a couple of years of using the undercutter, I could see two years’ worth of residue out there when I was seeding (Figure 12). The residue does hang on that long, lying on top.” Jirava finds that with cover on the soil, there is less wind erosion. Though recent drought years in 2014 and 2015 have meant that residue production has been low, the dry conditions have also meant the residue plays an even more important role in preventing erosion.

These residues also seem to increase water retention. “When I’m out there after a snowmelt, or rain on frozen soil event, I can see that the water doesn’t run off quite as easily.” Jirava also notices that the undercutter benefits soil moisture at seeding compared to conventional tillage. “I can’t show it scientifically, but observationally, we usually have pretty decent moisture at planting time with the increase in amount of residue on the soil.”



Figure 12. Residue remaining in one of Jirava’s fields, after a year of fallow managed with the undercutter, followed by planting with a John Deere 9400 drill. Photo: Darrell Kilgore.

Jirava expects these same benefits from increased residue in his no-till winter wheat–fallow ground. He also strongly believes that over time, he will build soil organic matter.

In addition to the benefits achieved from eliminating tillage, Jirava appreciates the advantages of using different fertility management strategies on his no-till winter wheat–fallow ground. Generally, the no-till fallow ground is fertilized with aqua ammonia

and thiosol sulfur using a coulter fertilizer injection system, either before seeding in the fall, or in-crop during the spring. In contrast, the undercutter ground receives aqua ammonia and sulfur in May of the fallow year, during the undercutter operation. For the no-till winter wheat, waiting until spring allows Jirava to take a soil test and apply the appropriate amount of fertilizer, in-crop. As Jirava points out, “that’s changing when we’re actually spending the money on the crop by almost 12 months, which makes a big difference in cash flow.”

Overall, Jirava feels like conservation tillage enables him to run a more efficient operation, with lower labor and diesel costs. Though there might be slightly higher diesel costs to pull the heavy undercutter, he has also reduced the number of times he travels over the field offsetting the increased costs per pass. (See the *Undercutter Matches Economic Performance of Conventional Tillage* sidebar.)

Labor efficiency is especially important for Jirava, given that “my principal hired men the last few years have been my dad, who is 79, and the neighbor (now deceased) who was part-owner in AK Farms (Figure 13).” As his father has started working fewer hours, Jirava has been looking to find someone else but so far has not been successful. “I can’t drive two tractors at the same time. It just doesn’t work. But because we’ve cut back on the amount of tillage, I still can get a lot of it done.”



Figure 13. Ron Jirava and his father, Wayne, who still works on the farm. Photo: Hilary Davis.

Undercutter Matches Economic Performance of Conventional Tillage

Douglas Young, Washington State University; **Bill Schillinger**, Washington State University; and **Georgine Yorgey**, Washington State University

In 2008 and 2009, with funding from a USDA Natural Resources Conservation Service (NRCS) Conservation Innovation Grant, the Washington Association of Wheat Growers contributed 50 percent of the cost to purchase undercutters for 47 farmers in ten Washington and Oregon counties. As part of the project, farmers agreed to share economic information and be interviewed about their experience and opinions with the undercutter (Young and Schillinger 2012).

Grain yields were not reduced following the use of the undercutter when compared to conventional tillage, either in individual years, or across three years (from 2008 through 2010; Figure 14).

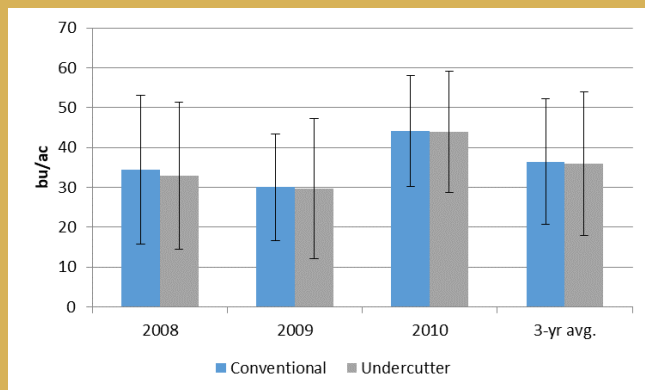


Figure 14. Winter wheat grain yields matched by farm and year for conventional tillage from 2008 to 2010 as well as the 3-year average. Adapted from Young and Schillinger, 2012.

Variable costs did not change for fertilizer, herbicides, seed, labor, diesel, lubrication, or maintenance. Farmers were initially concerned that they might have to increase the number of rodweedings to compensate for reduced primary tillage. However, the number of rodweedings was statistically equivalent (1.56 +/- 0.82 for undercutter tillage and 1.70 +/- 0.91 for conventional tillage; n=117). Glyphosate, fertilizer, seed, and other input costs were also statistically equivalent. There were no significant cost differences in fertilizer application or primary spring tillage. Because the

undercutters were new, it was not possible to calculate repair costs.

Thus, with equal revenues and costs, the undercutter tillage system performed as well as conventional tillage, while providing benefits in terms of reduced erosion and increased surface residues. (These environmental results are summarized in the *Research on Use of an Undercutter in the Dry Region* sidebar.)

Challenges

Planting through the higher levels of residue remains a challenge for both Jirava and other farmers in his region, though Jirava feels that having a drill that can plant through the residue has been important for successful implementation of conservation tillage (Figure 15). Jirava thinks that higher levels of residue is a main reason why many others in his region who have undercutters use them in the fall for weed control after harvest but not for spring tillage. Higher levels of residue can be particularly challenging for farmers who have a lot of money invested in a single drill, if that drill is not suited to higher residue levels. Other farmers in the Pacific Northwest have described their experience with the undercutter in an [Extension video](#).



Figure 15. Successfully penetrating and planting deep through residues is one challenge Jirava has had to overcome. Photo: Darrell Kilgore.

Jirava has also experienced weed management challenges from using the undercutter. “The less intense the tillage, the more you increase the possibility that grassy weeds are going to be a problem.” Jirava has used a Group 2 aerial spray, applied every six years to the growing winter wheat in the fall, to control cheatgrass (downy brome; *Bromus tectorum* L.) but has found that with higher levels of residues, the control this provides is less than optimal.

Russian thistle is another ongoing challenge, partly because there can be a number of flushes throughout the year. Especially after harvest, vigilance is key to timing sprays to control this weed. As for perennials and biennials, Ron says, “We’re just constantly chasing them, often with the four-wheel drive vehicle and a small sprayer in back. It’s that and re-learning their lifecycle, and figuring out which herbicides are available today that’ll do what we want them to do. But the challenge is that it’s a constantly moving target.”

Weed control is even more challenging on Jirava’s no-till winter wheat–fallow ground. When he first established the no-till winter wheat–fallow, he struggled to control salsify (*Tragopogon mirus*) though eventually found that 2,4-D works. In 2014, kochia (*Kochia scoparia*) became a problem, and Jirava is still trying to figure out which herbicide to use to control it. Jirava’s feeling is that “you never know what’s going to pop up, because you’ve changed the conditions out there by eliminating tillage. And so it’s always a guessing game, and you’re always a step behind the weeds.”

With multiple types of tillage and crop rotations across his farm, Jirava says that his final challenge is keeping it all straight. “The more different types of

tillage there are, the more it keeps you jumping. What did we do here? And what’s there? And so, it takes a little bit more thought, sometimes, on different pieces—to decide what we’re going to do. Are we going to use annual crop no-till to manage [jointed] goatgrass [*Aegilops cylindrica*], or are we going to chem-fallow it, or are we going to use the Haybuster [undercutter] for fallow? But they’re all options, and it’s good to have options.”

Managing Risk

In Jirava’s experience with the undercutter he found that, “there really isn’t any new economic risk, other than the challenge of getting the drills through. Yield-wise, as compared to what we were doing before, it’s the same. There may even be, not significant, but there may even be some increase in yield, due to the increased availability of moisture.” Meanwhile, he feels it reduces environmental risk by greatly reducing soil erosion and conserving residues.

This management strategy contrasts starkly with the smaller acreage where Jirava is planting no-till winter wheat–fallow. Though this practice reduces environmental risk, “there’s definitely an increase in the economic risk.”

No matter the tillage system, growing wheat in Jirava’s area will always be a risky proposition because of limited and variable moisture. “Moisture is the limiting factor. It always is, always will be.” To limit the impact of this risk, Jirava tries to think out of the box, creating as many opportunities as possible for his farm to succeed. For example, knowing that his soils were limited in organic matter, Jirava enthusiastically embraced an opportunity to receive biosolids on his farm. (See *Biosolids, a Win-Win Opportunity for the Jirava Farm.*)

Biosolids, a Win-Win Opportunity for the Jirava Farm

Jirava has accepted biosolids for use on his farm several times, beginning in the early 1990s, and he is enthusiastic about the benefits. “It is a great product for us out in the drier area. The nitrogen’s not going to go anywhere, it’s an organic matter source too...And we’re phosphorus-deficient in these soils, and it’s a wonderful source of phosphorus.” While phosphorus helps with winter survival, Jirava feels that the purchase cost for chemical sources of phosphorus is currently only justified for his spring crops.

Jirava first applied biosolids while working with Seattle Metro. Though he only got enough material to apply the biosolids to a limited number of acres, Jirava saw “a wonderful result in the crops that followed.” Beginning in 2010, he also accepted biosolids from Ritzville, Warden, and the Washington coast through a collaboration with a single company. Most recently, he has been accepting a third source of biosolids, this time from Hayden, ID.

Despite the overwhelmingly positive impacts, accepting biosolids has some drawbacks. As Jirava points out, “It is a lot of work. It takes up to approximately eight tons of what they call ‘semi-dry’ biosolids to the acre to get the amount of nitrogen that you’re looking for. That means that you make about one tractor pass every half-mile, and then you go back and you refill, and you make another pass.” (Figure 16). Supply is also limited; Jirava currently receives enough biosolids to amend about 160 acres per year.



Figure 16. Biosolids being loaded (left) and applied (right) on the Jirava farm. Photos: Ron Jirava.

Jirava has also worked hard to try to minimize the negative perceptions from his neighbors, and that primarily means limiting the number of storage piles, and ensuring that the biosolids are applied to soils promptly. Once material is spread in a dry climate such as Jirava’s, it quickly dries out, eliminating odors.

Resources

Sullivan, D., C.G. Cogger, and A.I. Bary. 2015. [Fertilizing with biosolids](#) (revised February 2015). Pacific Northwest Extension Publication PNW 508. Oregon State University, Washington State University, and University of Idaho, Corvallis, OR.

Jirava also views participation in research projects as a form of risk management. When asked why he participates so actively in research, Jirava laughs. “Free education! ...But more seriously, I farm for a living. And so it’s just part of the operation, knowing what’s going on, knowing how to improve things. It can be something as simple as having the variety testing plots here. I get to look firsthand at how they perform in my soil, and I can watch them all year long as they grow.” Currently, he hosts a long-term alternative cropping systems project with Washington State University that was initiated in 1997 (Figure 17).



Figure 17. Jirava checked seeding depth in a plot involved in the 20-acre WSU long-term cropping systems project in September 2014. Photo: Hilary Davis.

Continuing to Experiment with Crop Diversity

Jirava has done a great deal of experimentation with alternative crops over more than 20 years. “We’ve had up to 80 acres of different crops from safflower to flax to sunflowers to yellow mustard.” Of all the alternative crops he has tested, he has had sporadic success with canola, and good success with winter triticale and winter peas. Today, he primarily grows winter wheat, with smaller amounts of winter

triticale, continuous spring wheat (without fallow), and winter peas.

While he used to successfully grow winter canola, planting 160 to 200 acres, Jirava currently finds it difficult to find suitable varieties. “Over the years, the varieties have changed. I think I was using some Swedish seed, and they’ve gone to ‘Ardmore Argentines’. The genetics aren’t the same, and stand establishment has gotten even more difficult. It doesn’t like the heat that we get after seeding—you know, 90-degree temperatures during the day creates 100-and-some degree temperatures on the soil surface. That heat will literally cook the cotyledons right off as the plants come through the soil.”

Although he is not yet growing large acreages, Jirava is quite excited about winter peas (Figure 18). (See the *Winter Pea Crop Rotation Study at the Jirava Farm* sidebar.) They seem to yield well in his farm’s conditions, and he finds that the large seeds germinate well in both tilled and no-till systems. The crop fixes nitrogen, and “because it’s a legume, its herbicide spectrum is completely different than cereal grains. We can spray for grasses, cheatgrass and [jointed] goatgrass, and everything else that might be in the peas that we can’t do as easily in the wheat.” Insurance is available, and the market for winter peas is larger and more established than the markets for some other alternative crops. It is possible that new upcoming edible green varieties might expand the market, as current winter pea varieties are limited to split yellow or feed peas.



Figure 18. Winter pea in late May, grown on the Jirava Farm within the WSU alternative cropping systems study. Photo: Bill Schillinger.

Winter Pea Crop Rotation Study at the Jirava Farm

Bill Schillinger, Washington State University; **Ron Jirava**, farmer collaborator; **John Jacobsen**, Washington State University; **Steve Schofstoll**, Washington State University; and **Georgine Yorgey**, Washington State University

Beginning in the summer of 2010, winter pea was incorporated into the long-term cropping systems experiment on the Ron Jirava farm (Figure 19). The variety ‘Windham’ was used, based on the recommendation of Howard Nelson of Central Washington Grain Growers in Wilbur, WA because of several desirable traits. ‘Windham’ is a feed pea with an upright growth habit and good cold tolerance. It can be direct combined with a regular header (that is, neither swathing nor a pick-up header are required). Winter pea has a large seed that is capable of emerging through five inches or more of soil.



Figure 19. Winter pea (shown on the right), and winter wheat (shown on the left) in early May. Photo: Bill Schillinger.

Two three-year crop rotations were tested in the experiment: winter pea – spring wheat – summer fallow, and winter wheat – spring wheat – summer fallow.

The experimental design was a randomized complete block with four replicates in each treatment. All treatment combinations were present each year, and plots were 100 feet long. Winter pea was planted in the first week of September at a seeding rate of 120 pounds per acre.

Yield of ‘Windham’ winter pea yield ranged from 1,515 to 2,820 pounds per acre for a seven-year average yield of 2,273 pounds per acre (Table 2). Winter pea was killed by cold temperatures during the winter of 2013/2014, and plots were replanted to the ‘Banner’ edible spring pea, which yielded 775 pounds per acre. Spring wheat yield after winter pea was 34 bu/acre versus 32 bu/acre after winter wheat averaged over the years. Average winter wheat yield over the seven years was 73 bu/acre (Table 2).

Water dynamics may help explain these results. Winter pea used significantly less soil water than winter wheat (Figure 20). However, over the winter months, a higher percentage of precipitation was generally stored in the soil following winter wheat compared to winter pea. There are several reasons for this:

- Very little winter pea residue remains on the soil surface after harvest compared to winter wheat.
- The drier the soil, the more precipitation will be stored in the soil over the winter.

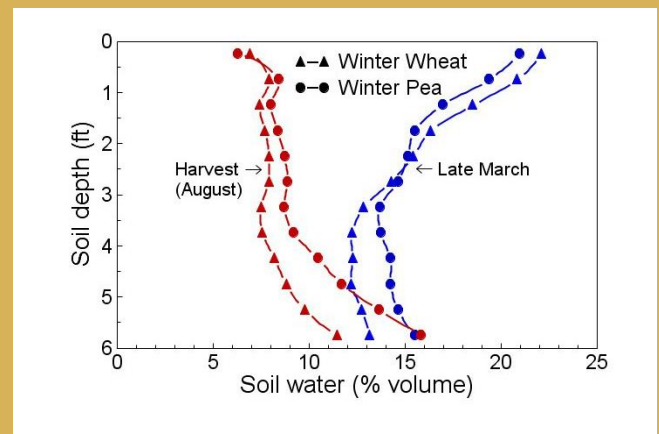


Figure 20. Soil volumetric water content to a depth of six feet in early August after harvest of winter pea and winter wheat (red lines on left) and overwinter soil water recharge following these two crops measured in late March (blue lines on the right). Data are averaged over six years.

Based on these promising results, this experiment will be continued until at least 2018. Beginning in 2014, winter pea is also being grown in a four-year no-till crop rotation consisting of winter pea–no-till fallow–winter triticale–no-till fallow. In addition, an annual replicated winter pea varietal trial was initiated at the WSU Lind Dryland Research Station in 2014.

Table 2. Yield of winter pea (WP) and winter wheat (WW) as well as the subsequent yield of spring wheat (SW) following both WP and WW over a seven-year period at Ritzville, WA.

	Grain yield (bu/acre)							
	2011	2012	2013	2014	2015	2016	2017	Avg.
Winter crop								
Winter pea (lb/acre)	1,960	2,820	2,085	-----*	1,515	2,530	2,730	2,273**
Winter wheat	77	85	87	50	63	73	79	73
Spring crop***								
SW after WP		30	45 a	16	34 a	47	33	34 a
SW after WW		32	40 b	14	25 b	46	34	32 b
Crop-year precipitation (mm)****								
	330	294	254	207	208	222	297	259

* WP was winter killed in 2014 and replanted to Banner edible spring pea, which yielded 775 lb/acre.

** Winter pea average is for five years (i.e., 2014 not included).

*** ANOVA is for SW only. Within column means followed by a different letter are significantly different at $p < 0.05$.

**** Crop-year precipitation at site from Sept. 1 to Aug. 31.

Jirava is considering where peas might fit within his existing crop rotation. “I’m going to try putting the peas after fallow. And, possibly, chem-fallowing after the peas, because there’s not a whole lot of residue [from peas]—or we can go in there and [plant] spring wheat. And then, a chem fallow or an undercutter fallow before going back to winter wheat. So, I’m looking at how to change the fallow rotation, as well as maybe push to a three-year rotation.”

Looking Forward

The potential risks that concern Jirava most are changes in federal or state policy that could impact insurance and farm regulations. Otherwise, he has gotten used to fluctuating markets. And while the climate may change in the future, he feels that many of the associated impacts would be masked by the high level of natural variability that already exists in

his region. “I don’t know that I can say that I’ve actually seen a difference in the trends, because it’s so variable.” He thinks that “with climate change, we continue as we are. We try and plant when we can, and we harvest when we can. I try and deal strictly with the things I have control over, and work within the parameters of the things that I can’t control.”

From Jirava’s perspective, adaptability to respond to future changes has two equally important parts, the logistical and the mental. On the logistical front, “that’s why I have all the different types of drills. We need to be able to go out and try something, and say, ‘You know what? This isn’t working. We need to go hook onto something else.’” On the mental front, there is a need for flexibility. “If the cultivator didn’t work well, why are we cultivating? Well, let’s go hook onto the undercutter and do the undercutter. Or if the undercutter’s not working—it’s too dry—let’s

do chem fallow on it instead and not disturb it at all. That’s the type of adaptability that we deal with every day, and it’s second nature; we don’t even think about it.”

Advice for Others

Be ready for some mistakes, because you are going to make them. “It’s not going to work perfectly the first time out. And if it does, do it again, because it probably won’t work perfectly the second time.”

It really boils down to attitude. “If you think it’s not going to work, I can guarantee you: it’s not going to work. Because consciously or subconsciously, you will make that happen. So attitude’s a big thing.”

Make sure you that you can successfully plant through residues. “Make sure you’ve got a drill that you’re happy with, that you can get through the residue and plant the way you want to. We can do all sorts of things with combines and harvesting, and straw management, to manage the residues up front, but when it comes time to plant, all those things have already got to be done.”

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