Direct Seeding in the Inland Northwest

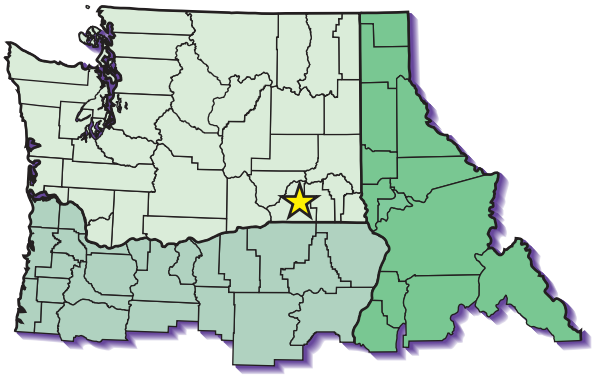
THOMAS FARM
case study

Location: Walla Walla County, WA

Annual rainfall: 15 inches

Drill type: Home-built chisel-type drill

Crop rotation: Winter wheat/
Spring wheat/Chemical fallow



BACKGROUND

Soil conservation has long been a critical concern for the Thomases, since they farm some of the steepest land in the Inland Northwest. Their farm, located in the Skyrocket Hills near Prescott, WA, has slopes as steep as 50%. In an effort to halt erosion, Mike Sr. says, "We haven't cultivated any ground around here since 1985. ...If we don't till or disturb the soil, the erosion stops immediately." The Thomases direct-seed all their crops with chisel-type no-till drills they designed and built themselves. They currently burn to reduce heavy residue levels before seeding, but are actively working on ways to direct-seed without burning.

Since his father is in semi-retirement, Mike Jr. and one employee handle all field operations on their 1,700-acre farm, hiring additional help only at harvest. They also rent their drills to other farmers to seed about 5,000 acres per year. The low labor demands of direct seeding allow Mike Jr. to fly a commercial spray helicopter.

"This land has been farmed for about 100 years. I'm second generation and my son is third. We've already lost about half of our topsoil, but we still have plenty of it left, if we save it. However, if we don't stop erosion somehow, whether it be with direct seeding, CRP, or something else, a lot of this land in south-eastern Washington and in Idaho and Oregon will be out of production in another 100 years."

~Mike Thomas Sr.

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A NEW WAY OF FARMING

Even before the Thomases switched to direct seeding, they were recognized in their county for their conservation efforts—the Walla Walla Conservation District elected Mike Sr. and his wife, Jean, "Mr. and Mrs. Conservation Farmer of 1969." Some of the early erosion control efforts they tried included sweeping instead of plowing, and annual cropping —growing continuous spring cereals instead of the traditional erosion-prone winter wheat/fallow. While these early efforts helped, direct seeding (in conjunction with chemical fallow) has been, by far, the most effective soil conservation method they've tried. Mike Sr. says it also offers other benefits: "The big reason we wanted to direct-seed was for soil conservation, but I also was really impressed that you didn't have to do all that summer fallow work. It appealed to me—using the chemicals to fallow the ground rather than cultivating."

When the Thomases decided to try direct seeding in 1983, not one no-till drill on the market would work on their steep hills, so they built their own. They converted a Jeffrey chisel into a no-till drill by adding a ground drive, seed boxes, fertilizer tanks, and points to deliver the seed and fertilizer. Mike Sr. recalls, "We built one in the winter of 1983 and then another the next winter. Then we decided we were on the wrong track. We could see the concept was good, but that particular design wouldn't work because the center section of the chisel was so narrow it would try to tip on steep hillsides. The next year we had Stoess Manufacturing build us a frame, and that is what we're using now." The frame has an 11-foot center section and two 9-foot wings. They built a total of four drills using the newer frames in the late 1980s. They sold

THE THOMAS NO-TILL DRILLS

The Thomas no-till drill is a 29-foot, home-built, chisel-type drill. A key design feature is the patented point that separates the seed from the fertilizer by about 2.5 inches, creates 2.5-inch deep furrows, and, as Mike Sr. says, "changes a chisel into a no-till drill." Optional press wheels, which have adjustable down pressure, pivot horizontally and vertically. The furrow openers are on three ranks on 36-inch centers for an overall row spacing of 12 inches. The pumps and metering systems are chain-driven off of the carriage wheels of the drill. Operated at 4 to 5 mph, the drill can seed 80 to 100 acres per day and, typically, 12 to 13 acres per fill.

Pros and Cons of no-till drill according to the Thomases

+ No straw tucking because chisel point moves residue away from seed row.
+ Soil disturbance under the seed row can help control *Rhizoctonia* and *Pythium*.
+ Drill creates deep furrows that improve winter survival.
+ Full amount of fertilizer delivered in one pass.
+ Simple to operate and maintain.
+ Runs straight on steep hillsides.
+ Furrows prevent combines from slipping off steep hillsides.

- Can't seed through stubble after greater than 40-bushel per acre crop.

"People don't realize how easy it is to build a drill. We just used what we had on the farm, modifying it to do what we wanted to do."

~Mike Thomas Sr.

The Thomases' home-built no-till drill seeding winter wheat into chemical fallow, and close-up of their patented seed and fertilizer opener.

two to neighboring direct seeders, rent one out to seed 2,000 to 2,500 acres a year, and use the fourth on their own land and for custom seeding.

One challenge the Thomases faced when they started direct seeding was the lack of other direct seeders in their area to look to for guidance. Mike Sr. says, "We just tried it and felt the concept was right." They have been working on the details ever since. Switching from a 2-year to a 3-year rotation, and more consciously controlling the "green bridge" were important changes they made. The Thomases currently are working on drill modifications to allow them to seed into heavier residue without prior burning or tilling. "We still haven't gotten all the way there, but we're close enough we'll never go back to cultivating again, unless something goes wrong. You know, down the road in 5 or 10 years, maybe it will be shown that direct seeding stimulates some disease, or other problem. Nobody knows. But from what I've seen so far, I have no intention of ever going back to cultivating."

CURRENT DIRECT-SEED SYSTEM

Rotation

One of the most important changes the Thomases made to their direct-seed system was switching from a winter wheat/chemical fallow rotation to winter wheat/spring wheat/chemical fallow. Mike Sr. explains the benefits of this 3-year rotation: "In any given year, two-thirds of our farm is in crop, instead of half, and two-thirds is in a cheat-reducing program." (See "Weed management.")

Residue management

The Thomases chop and spread residue at harvest with choppers and fins on the back of their combines, which have 20-foot headers. They do not use chaff spreaders, but think those would be a good addition. When the residue is too heavy to seed through with their drill (more than "40 bushels"), the Thomases burn in the spring before seeding. Mike Jr. points out the advantages to burning. "You don't have to worry about your drill plugging, the soil warms up faster, which is better for germination, and diseases of a wheat-on-wheat rotation are reduced." He also notes, "We never get a complete burn. It usually burns just the straw rows, which is where we would plug up the drill." In three-quarters of the cases, they must burn winter wheat residue before seeding spring wheat. In contrast, they usually can seed winter wheat directly into spring wheat stubble after chemical fallow.

Burning has enabled the Thomases to use a direct-seed system that controls erosion, but they are seeking alternatives for two reasons. They are concerned burning may not be an option in the future, and as Mike Sr. says, "I would like to leave the residue out there for the soil if we can manage it." To this end, the Thomases built a new no-till drill, ready for testing during the 1999 season. They have made two changes to their previous design to facilitate movement of residue through the drill: a row of front-mounted, 20-inch, smooth coulters to cut residue ahead of the three ranks of shanks, and adjustable, wider row-spacing (from 12 to 16 or 20 inches).

Fertility

The major difference in the Thomases' fertility program under direct seeding is banding fertilizer below the seed. They place aqua ammonia (with ammonium polysulfide) and liquid starter (10-34-0) fertilizers 2.5 and 1.5 inches below the seed, respectively. The Thomases use the same rates they would under a conventional system. Winter wheat receives 90 lbs of nitrogen (N), 30 lbs of phosphorus (P_2O_5), and 6 lbs of sulfur (S). Spring wheat receives 77 lbs of N, 20 lbs of P_2O_5, and 5 lbs of S.

Weed management

Rotation has been the most critical change in the Thomases' weed management program. "We had a real downy brome problem for years before starting this 3-year rotation, where you put on a spring application of [preplant, nonselective] chemicals 2 years in a row. First, you spray before seeding spring wheat, then you follow with the chemical fallow. Now I don't worry about downy brome anymore. It does a lot for the goatgrass too. If we [were to] quit this 3-year rotation, they would come back in a hurry." (See "Managing Downy Brome in Conservation Tillage Systems.")

Important aspects of this between-crop weed control strategy include helping weeds and volunteer crop germinate, and obtaining effective coverage of the nonselective herbicide. A postharvest harrowing, which the Thomases carried out when downy brome populations were higher, knocks down and distributes downy brome and other seeds, encouraging germination. Given enough fall moisture, the seeds

will germinate and can be killed with a fall burn-down treatment. Mike Sr. explains, "A good Roundup application in November really pays off. First, the weeds and volunteer crop are easier to kill when they are small. Second, you won't spend all your plant food growing weeds you're going to kill next spring anyway. Third, when it comes time to plant the next crop, we don't have to worry about waiting a full 3 weeks between spring spraying and seeding since we don't have a sod, or tall green growth. We always get some new growth in the spring, so we do have to spray a second time, but everything is small and easily killed." If the Thomases do not get a "green-up" in the fall, they'll apply the first burn-down treatment in early spring, followed by another closer to seeding. Mike Jr. uses a ground rig to apply the nonselective herbicides because he believes even coverage of between-crop herbicide treatments is important for controlling weeds in their direct-seed system.

The Thomases typically spray three times during chemical fallow: early spring, early summer, and late summer. They use Roundup or Landmaster (a mixture of Roundup and 2,4-D). About one-third of their chemical-fallow acres receive another application of Roundup before fall seeding, to kill wild oats. The Thomases have added Banvel to their early summer treatments to combat China lettuce (also called prickly lettuce) and marestail (also called horseweed). In winter and spring wheat, the Thomases follow a standard postemergence herbicide program. They have effectively controlled common rye by spot-spraying paraquat or glyphosate, or by roguing.

Disease management

Fundamentals of controlling root diseases in direct-seed systems include:

- Spraying weeds and volunteer crop 2 to 3 weeks before seeding. This practice creates a "green-free" period between crops and prevents the carryover of diseases.
- Disturbing the soil in the seed row, which breaks up the web of fungal root diseases.

FREQUENTLY ASKED QUESTIONS

Q: *I need to rodweed to set the dust layer and try to keep the moisture there. Chemical fallowing will only dry out the soil and the moisture level will be too deep when it comes time to seed fall wheat.*
Mike Sr.: I don't think so. I think leaving stubble on top of the ground, shading the soil and cutting down the wind erosion saves more moisture. And I think you keep the moisture closer to the top of the ground than if you black fallowed and then used a rodweeder to try to set the moisture level. We tried to set the moisture level when we were rodweeding, but we must not have been doing it right because we still had dry soils. We just went out and dusted our seed in the ground because we couldn't get to moisture.

Q: *Isn't a 12" row spacing too wide for spring crops?*
Mike Jr.: Although wheat on 12-inch spacing does take longer to fill the canopy than wheat on narrower rows, that gives us another 2 to 3 weeks to delay broadleaf spraying so we can get more of the later germinating weeds.
Mike Sr.: 12-inch spacing is not too wide for fall wheat and has worked fine for spring wheat. We're now trying 16-inch spacing, which for the HZ drills has proven to be very satisfactory for fall wheat seeding. We don't know yet for spring wheat since it doesn't have the chance to stool.

Q: *Direct seeding has worked these last few years because they've been wet years. Aren't you afraid of what will happen when it turns dry?*
Mike Jr.: Direct seeding is even more important to do in a dry year. We're wasting absolutely no moisture in the field. We don't lose it to tillage and we don't lose it to runoff. I would bet the yield difference between direct-seeded and conventional wheat would be even more dramatic in a dry year.

Q: *With the price of herbicides as they are, I think I can conventionally fallow my ground cheaper than chemically fallowing it. Rodweeding is practically free.*
Mike Jr.: I would say costs are about even. You would have a larger expense in chemicals [using chemical fallow], but you would have less expense in fuel and tractor and implement repairs because your only heavy tillage job is your seeding operation. We use less than half the diesel of conventional fallowing. We also don't have ditches and soil erosion and the time spent filling in holes. By the time you add in cracking the combine frame from going through all of the ditches, I would say that you easily end up ahead [using chemical fallow]. You have to look at all the factors, not just chemical versus tillage costs. When you start looking at all your other factors, like less maintenance on your equipment, then it makes a difference."

- Placing starter fertilizer below the seed provides easy access to early roots that might be under disease stress.

The Thomases were unaware of these fundamentals when they first started direct-seeding, but were lucky. Mike Sr. remembers, "We just stumbled right through potential disease problems because, usually, it would be a week or 10 days after we sprayed before we could get around to seeding. We also didn't know anything about the benefits of placing fertilizer or of disturbing the ground under the seed, but our drill just did that." Now the Thomases consciously control the "green-bridge" (see "Weed management"). They have expanded their rotation to include spring wheat. Although susceptible to many of the same pathogens as winter wheat, spring wheat provides a break from soilborne pathogens favored by winter environments (e.g., Cephalosporium stripe, strawbreaker (Pseudocercosporella) foot rot, snow molds and dwarf bunt). Mike Sr. says they have not had any problems with diseases in their direct-seed system so far, but they are cautious.

Seeding strategy

The Thomas no-till drill creates furrows 2.5 inches deep. Mike Sr. says, "We designed the drill to provide furrows because that gives winter protection. [Furrows protect seedlings from the wind and trap snow.] Also, with furrows, you can put the wheat in the ground 3 inches and only cover it with a half an inch of soil. It emerges quickly and it's down where the moisture is. The deep furrow concept is still a viable plan for seeding dryland wheat." For winter wheat, "we start seeding right around the 25th of September, regardless of whether we have moisture. The no-till magazine said to seed shallow, moisture or not, because when it rains, it'll come up. And if it doesn't rain, you're not going to get any wheat anyway. So we seed shallow."

This field of winter wheat direct-seeded on chemical fallow shows the slopes the Thomases are farming.

Mike Jr. says they plant spring wheat as early as possible; "spring crops need all the growing season they can get." They typically apply a nonselective herbicide near the end of February, wait for the weeds to die and brown; and then burn, if needed, before starting to seed in mid-March. They seed shallow at first (1/2 inch), but as the surface dries, they will seed down to 1 inch, to reach moisture.

ADVANTAGES

Erosion control. "Saving the soil is the biggest benefit, although it's not the easiest to recognize because soil is something you don't miss until it is gone," says Mike Sr. Erosion reduces the future productivity of land, but also has immediate effects. "I tell you, when you jump these combines over those ditches out there, fall in holes and have to do repairs, it just isn't worth it." Mike Sr. notes it might take a few years to see other types of soil benefits, such as increases in soil organic matter and permeability, "but you can stop erosion immediately."

Soil improvements. Mike Sr. says, "The tilth of our soil has changed. They talk about chiseling the ground to let the water in. Well, you don't need a chisel. You no-till, and the ground automatically gets more permeable and develops better tilth. You can just walk on the ground and feel it." He's also noticed "we no longer have a hard pan. All I can figure is the roots have broken it apart. ... I think if you leave the soil alone, it will take care of itself, like it has done for the last 4 million years."

Yield increases. "I can safely say we've increased our yield by more than 5%, and I would not be too far out to say 15% to 20%, and that's factoring out the last few years of good weather," says Mike Jr. The Thomases attribute the yield increases to improved water availability—not only has water infiltration increased, but evaporative losses have decreased because the Thomases have reduced soil disturbance and have left more residue to shade and protect the soil.

Efficiency. "Direct seeding is faster and simpler than conventional [seeding], especially in the spring. You don't have to do all that spring cultivation. All you have to do is spray in the fall once, spray in the spring, maybe burn, and then seed." They've

reduced their tractor hours from 1,000 to 500 hours per year. Mike Sr. says, "One half the fuel used saves oil, soil, and toil."

Simplicity. The Thomases find direct seeding less complicated than conventional farming. Not only do they perform fewer operations, but also they feel the operations they perform are relatively simple. Their drill is easy to operate and maintain, and the sprayer pulls more easily than cultivation equipment. However, using herbicides instead of tillage can be more complicated.

DOWNY BROME MANAGEMENT STRATEGIES IN CONSERVATION TILLAGE SYSTEMS

Downy brome has been a major weed problem for generations of winter wheat/fallow growers. As the Thomases and other direct seeders have found out, it can be an even more intense problem in direct-seeded winter wheat/fallow systems. Commonly called cheatgrass, downy brome is a winter-annual weed that germinates primarily in the fall. It grows and matures rapidly in the spring and competes vigorously for moisture and nutrients. Because winter wheat and downy brome share similar life cycles, selective control is difficult. The traditional control method of burying the seed (plowing under) has been effective because downy brome germination drastically decreases with soil depth, and the seed rarely remains viable for more than 2 years. In contrast, downy brome readily germinates from shallow soil depths (0-2 inches) given favorable moisture and temperature conditions. Surface residues, maintained under direct seeding, create an ideal soil surface environment for downy brome germination and establishment. When tillage is eliminated as a weed control tool, other weed management strategies must be developed.

A 1998 publication, PNW509 *Managing Downy Brome under Conservation Tillage Systems in the Inland Northwest Cropping Region*, outlines the biology of downy brome and strategies for its control in winter wheat cropping systems. The authors emphasize, although no "magic bullet" can control downy brome, it can be managed effectively in conservation tillage using a combination of cultural and chemical strategies that maintain a low soil seedbank. The Thomases' experience controlling downy brome supports this multi-tactic approach. Some of these strategies are summarized here. For a complete discussion, please see the publication.

Rotate using spring crops
Rotation using spring crops is the most effective method to reclaim fields heavily infested with downy brome and to maintain low weed levels. Since downy brome seeds are short-lived, the soil seed bank can be effectively depleted in 2 or 3 years out of winter wheat. Spring crops provide the opportunity to apply a nonselective herbicide either in late fall, early spring, or both. Another benefit to growing winter wheat no more than once in 3 years is the reduction of soilborne diseases of winter wheat, such as Cephalosporium stripe, strawbreaker foot rot, and various root diseases.

Stimulate downy brome seed germination
Use chaff spreaders to evenly distribute weed seeds, escaped grain, and residue. Uniform distribution improves seed-soil contact, thereby stimulating germination when rain occurs. Harrowing, or other light tillage after harvest in dry stubble further improves residue distribution and seed-soil contact.

Apply a nonselective herbicide between crops
Eliminate downy brome between crops by using a nonselective herbicide. For spring crops, if fall rains have stimulated germination and growth of downy brome, apply the first spray in the fall. Downy brome plants will be smaller and easier to kill. Follow in the spring with another application before seeding. If a fall application was not possible, it may be necessary to spray twice in the spring, once very early, and once before seeding. Be sure to wait 2 to 3 weeks between spraying out any substantial growth of weeds and seeding to avoid the "Green Bridge" carryover of root diseases.

Place fertilizer to enhance winter wheat competitiveness
Deep band N fertilizer rather than broadcasting to increase winter wheat competitiveness over downy brome. Make sure adequate phosphorus is readily accessible to early primary roots, in the deep band or with the seed. Do not spring topdress N fertilizer in winter wheat that has downy brome infestations; the fertilizer will benefit the downy brome more than the wheat.

Don't let downy brome get a head start
Seed winter wheat at the optimal date in your area to produce early vigorous wheat establishment and growth. Excessively early seedings of winter wheat are more susceptible to certain diseases and pests that reduce the wheat crop's competitiveness and yield. If rains occur just before anticipated planting, delay seeding until downy brome emerges and can be controlled using a nonselective herbicide before seeding.

From: Yenish et al. 1998. *Managing Downy Brome Under Conservation Tillage Systems in the Inland Northwest Cropping Region.* Pacific Northwest Extension bulletin PNW509 (Available from your local county extension office or online at <http://caheinfo.wsu.edu> under publications).

CHALLENGES

Achieving a stand in heavy residue. "This is our number one challenge and why we are experimenting with our drill," says Mike Sr.

Using herbicides effectively. Mike Jr. has noticed that while it is relatively easy to achieve a good kill of weeds and volunteer plants in the fall, the efficacy of spring and summer nonselective herbicide applications are influenced more by weather and field conditions. Dusty conditions in summer are particularly challenging.

Making the change. Mike Sr. says, "Changing to no-till is similar to changing from using a horse to using a tractor. People resisted that change. My father resisted—he was still using horses when he died." Then Mike Sr. took over and bought a tractor. Interestingly, this pioneer direct seeder adds, "I don't like change, but it happens and you have to do something about it."

THE BOTTOM LINE

Direct seeding provides many benefits, but is it profitable? It is for the Thomases. Table 1 shows their typical production costs for each phase of their 3-year rotation, as well as average yields and costs per bushel (total costs divided by average yield). These figures are based on budgets developed by Washington State University economists from information provided by the Thomases.

By these estimates, the Thomases' costs per bushel (the bottom line in Table 1) are below or equal to 5-year average market prices* of $3.72/bu and $3.74/bu for soft white winter wheat and soft white spring wheat, respectively. The Thomases' seeding operation is remarkably cheap, making up only a small portion of their overall costs. They achieve this by using two low-cost drills (less than $50,000 in 1998 dollars) over many acres (1,100 acres of their own plus 5,000 rental acres). In contrast, their harvest costs are relatively high because they use three combines over only 1,100 acres. The combines are older ('73, '78, and '81) and were paid for long ago, so now the Thomases' yearly expenses are actually quite low in a cash flow sense. However, standard economic accounting uses the straight-line method of depreciation, whereby you spread the cost of a machine evenly over the crops produced during the life of that machine. The Thomases' other major expenses are herbicides, fertilizer, and overhead.

* Average market prices are for marketing years 1993/94 to 1997/98.

Table 1. Estimated costs per acre, average yields, and costs per bushel for the crops in the Thomases' winter wheat/spring wheat/chemical fallow rotation.

Operations and materials	Chemical fallow Variable costs[1]	Chemical fallow Fixed costs[2]	Winter wheat Variable costs	Winter wheat Fixed costs	Spring wheat Variable costs	Spring wheat Fixed costs
	$/acre					
Herbicide	35.37	0.00	8.15	0.00	14.91	0.00
Spray application	3.84	9.59	5.00	0.00	7.38	5.90
Burning	0.00	0.00	0.00	0.00	1.50	0.00
No-till seeding[3]	0.00	0.00	2.97	7.19	2.97	7.19
Wheat seed	0.00	0.00	12.60	0.00	12.60	0.00
Fertilizer	0.00	0.00	27.90	0.00	22.00	0.00
Harvest[4]	0.00	0.00	19.12	44.25	19.12	44.25
Interest on op. capital	0.84	0.00	4.68	0.00	2.79	0.00
Overhead[5]	7.43	5.16	9.45	95.54	9.59	59.83
Sum	47.48	14.75	89.87	146.98	88.30	117.17
Total Costs	**62.23**		**236.85**		**205.47**	
Average yield (bu)			85		55	
Cost per bushel ($)[6]			**3.52**		**3.74**	

[1] Variable costs include materials, services, labor, and machinery fuel, lube and repairs.
[2] Fixed costs include machinery depreciation, interest, insurance, land taxes and housing.
[3] Includes no-till drill and hauling seed. Excludes seed and fertilizer.
[4] Includes combine and hauling.
[5] Includes land costs, taxes, utilities, trucks, and miscellaneous.
[6] Total costs divided by average yield. Winter wheat cost per bushel includes the costs of chemical fallow and winter wheat.

ADVICE TO NEW DIRECT SEEDERS

"**Start at least a year in advance.** If you want to set a field up to no-till in the fall or even the following spring, you've got to start a spray program the previous spring and get any weeds under control. Then, depending on the drill you will use, you may have to do something with the residue one way or the other."

Rotate. "The 3-year rotation worked well for us. It will knock out the downy brome. Then you can manage the broadleaf weeds with chemicals."

"**Find a good drill.** It has to be one that will work on your ground." If you don't want to buy a drill, the Thomases recommend renting since it is less expensive than hiring custom application.

Just try it. "I don't see that it's a big deal. Anybody can try it out. We went whole hog right off the bat, but if you are skeptical, try it on a small piece of ground for a few years in a row to see what it will do for you."

Harvesting soft white spring wheat (70 bushels per acre). The Thomases chemical fallowed this field the next year.

What is a direct-seed case study? Each case study in the Direct Seeding in the Inland Northwest series features a grower(s) who has substantial experience with direct seeding. They provide a "snapshot" description of the direct-seed system in 1998-1999, as well as the growers' experiences, evaluations, and advice. The cases are distributed over the range of rainfall zones in the wheat-producing areas of Washington, Oregon, and Idaho. They also cover a variety of no-till drills and cropping systems. Information presented is based on growers' experience and expertise and should not be considered as university recommendations. To order this and other case studies in the series, contact the WSU Cooperative Extension Bulletins office—1-800-723-1763; the University of Idaho Cooperative Extension System Ag Communications Center—208-885-7982; or Oregon State University Extension and Experiment Station Communications—541-737-2513. For more information, please contact WSU Cooperative Extension in the Department of Crop and Soil Sciences—509-335-2915, or visit our web site at <http://pnwsteep.wsu.edu/dscases>

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