Direct Seeding in the Inland Northwest

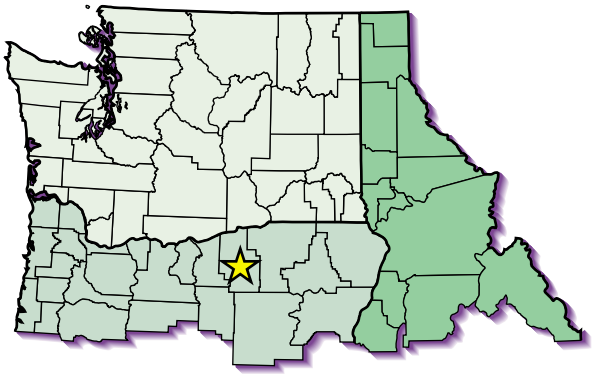
JEPSEN FARM
case study

Location: Morrow County, OR

Annual rainfall: 12.5 inches

Drill types: Conserva Pak®

Crop rotations: Continuous spring cereals, some spring mustard and other broadleafs



BACKGROUND

Bill Jepsen is somewhat of a newcomer to continuous cropping and direct seeding. Nevertheless, he has a strong commitment to this new way of farming, based on careful study of rainfall records on his farm, his soil's water storage capacity, research information, and the experience and knowledge of other direct seeders. Since 1997, Bill has been growing continuous spring wheat, spring barley, and occasionally spring mustard on 3,000 acres located 18 miles west of Heppner, Oregon. The land he farms has shallow (2 to 3 feet) silt loam to clay loam soils, which fully recharge with moisture in most years. While the slopes are mostly gentle—the steepest are 25 to 35%—almost 100% of the land is classified as highly erodible. It is particularly susceptible to frozen-soil runoff.

Bill is conducting a number of trials on his farm to enhance the success of direct seeding annual crops. These include "variety trial" plots of alternative crops in cooperation with Oregon State University Extension Service, and a 26-acre, Monsanto "Center of Sustainability" study (see "Crops and Rotation"). Bill also has an EQIP (Environmental Quality Incentive Program) cost sharing NRCS

The Bill Jepsen Family

"If we are going to make annual cropping work in our dry climate, it will have to be with the kind of practice that conserves every drop of moisture we get, and that has to be a one-pass, no-till system."

~Bill Jepsen

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grant to direct-seed a 113-acre tract for five consecutive years with at least one alternative crop.

Bill and his wife, Nancy, recently received two awards recognizing their conservation efforts: the 1999 Morrow County Conservation Farm of the Year, and the 1999 Oregon Wheat Growers League Environmental Stewardship Award.

A NEW WAY OF FARMING

"This farming area had been traditional winter wheat/ fallow for years. Usually the only reason people raise spring crops is to clean up ground." Cleaning up weeds and disease was the reason the Jepsens began experimenting with more spring crops in the early 1990s. Early seedings of winter wheat had brought on strawbreaker (*Pseudocercosporella*) foot rot and Cephalosporium stripe, and their two-year rotation of winter wheat/fallow had encouraged an increase of jointed goatgrass and other winter annual weeds. "We're in an area where jointed goatgrass is terrible. It has forced us to change, if nothing else has."

"We didn't have a way to band fertilizer under the seed, so we mixed them in the truck bed and then put the mix in the drills. We raised some excellent spring crops doing that. Of course, we were getting good spring rains those years (1994 to 1997). During that time we raised annual spring crops that matched traditional winter wheat on fallow yields. The experience encouraged us to continue the annual spring cropping practice."

By 1995, the Jepsens were conventionally seeding spring wheat and spring barley on about 40% of their acres. "As long as we had adequate rains, we grew some great crops." They planned to raise annual spring crops on a portion of the farm when the soil profiles were filled with winter moisture and to use summer fallow in the drier years. "Then the farm program changed and took away the planting restrictions. That's when we started looking seriously at annual cropping the entire farm, and at direct seeding." Bill said, "If we are going to make annual cropping work in our dry climate, it will have to be with the kind of practice that conserves every drop of moisture we get, and that has to be a one-pass, no-till system."

Soil erosion was another major motivating factor. In spite of "miles and miles of terraces on this place…we've lost topsoil here by the hundreds of tons." Runoff on frozen ground has been their biggest problem. Bill thinks he can prevent this erosion by leaving the soil undisturbed and keeping residue cover year round (see "Advantages Jepsen Sees").

In spring 1997, a neighbor custom-seeded some of Bill's spring crops using a Concord® no-till drill. That May, Bill took a trip to Canada to look at no-till drills and came home with a Conserva Pak® drill (see "Jepsen's No-till Drill").

Bill used 36 years of annual soil moisture and precipitation data from their own farm to evaluate the feasibility of converting to annual cropping. (See "Giving up Fallow.") His entrance into annual cropping coincided with a string of higher-than-average-rainfall years, up until 1999. That spring Bill said, "Our spring cropping has been very successful—it has helped buy equipment and pay for the no-till drill—but I don't know about this year. It's going to be a tough one." It was; Bill's crops had only 4 inches of available moisture during the growing season (see "Giving up Fallow"). Bill uses crop insurance to manage the risk of crop failure in dry years. The decision to carry strong crop insurance was an integral part of his annual cropping strategy. He believes the improved water conservation he has witnessed in undisturbed soils will minimize the impacts of dry years.

CURRENT DIRECT-SEED SYSTEM

Crops and rotation

Bill grows primarily spring wheat and spring barley. He is more confident about growing continuous spring barley than about continuous spring wheat. "We've grown barley 6 years in a row in one field and I don't think we've had a yield reduction from lack of rotation." Barley yields on this field were 1.9, 1.1, 1.7, and 1.5 ton/acre from 1995 through 1998; 0.5 ton/acre during the drought year of 1999; and 1 ton/acre in 2000. "However, I'm concerned whether we will be able to grow continuous spring wheat. I haven't been in it long enough to know. That's why we're looking at some alternative crops." For now, Bill uses barley as the primary rotation crop for wheat.

Bill has been experimenting with alternative crops and varieties since 1996. His "variety trials" have included mustard, canola, lentils, garbanzo beans,

narrow-leaf lupine, flax, durum wheat, dark northern spring wheat, and different varieties of soft white spring wheat. Bill says the major advantage of the broadleaf crops is they break cereal disease cycles and, in many cases, allow him to spray in crop for grassy weeds. However, he has not found one crop consistently profitable. "The only alternative crop successful here is mustard. But it is hard to make it work when the price gets down to 10 cents per pound or less." Bill also is keeping his mind open to alternatives to continuous spring crops, such as planting winter wheat when fall moisture allows (once the ground is clean of jointed goatgrass), and using chemical fallow in dry spring seasons.

In addition to his variety trials, Bill is hosting a Monsanto "Center of Sustainability" study.

JEPSEN'S NO-TILL DRILL

Renting a no-till drill or having crops custom seeded was not an option for Bill. "For us, that early seeding window is critical, and you have to own your own drill to be able to seed then." The question was "What type of drill?" Bill says he looked for eight key features:

- Minimum disturbance,
- High residue clearance,
- Chisel grooves to deep band all fertilizer,
- Precise seed placement,
- Light press over seed, good seed-to-soil contact,
- Pulls easily,
- Wide enough to cover a lot of acres,
- Simple design, and
- Reasonable cost.

He read a lot of literature and, in 1997, made a trip to Canada to look at a number of types of no-till drills running during their seeding time. He finally settled on a Conserva Pak® 3912. Bill says, "There are five things about a Conserva Pak that I think make it an excellent drill." The drill does minimal disturbance because the shanks are only 5/8 of an inch wide. It handles rocks well. It is hard to plug with residue. It provides precise seed placement; the seed delivery tube moves up and down with the press wheel, independent of the main shank, and places seed on an undisturbed shelf. Bill says this is a great seed placement system for small-seeded crops. Finally, the drill pulls easily. Bill pulls it with a D-5B 26X crawler. He notes, "The drill is a light, 5th-gear load. We do most of our seeding at 4.8 miles per hour."

Bill finds the main disadvantages to the drill are tailing on hillsides, creating uneven row spacing, and not handling heavy residue loads as disk drills can. These are not big concerns for Bill, whose land lays well and whose average crops do not produce excessive residue. Conserva Pak now offers a hillside hitch for the drill to prevent tailing on slopes.

Jepsen's Conserva Pak drill (below left) with independent suspension openers (right) and a hydraulic hillside hitch (below) to reduce downhill drift on steep hills.

These long-term plots demonstrate the agronomic and economic feasibility of direct seeding annual crops, as well as test the possibility of diversifying small grain rotations with alternative crops. The study compares eight crop rotations: continuous soft white spring wheat, continuous durum spring wheat, continuous spring barley, winter wheat/conventional fallow, winter wheat/chemical fallow, and three 3-year rotations (spring wheat/spring barley/either lupine, canola or mustard). The trial, established in 1999, will run for at least 5 years.

Residue management

Like most direct seeders, Bill starts his residue management strategy behind the combine, using straw and chaff spreaders to distribute the residue evenly over the field. He says this also helps manage weeds. "Spreading the seeds is as important as spreading the chaff so you don't have a big shoddy mass of volunteer behind the combine anymore. When the volunteer comes up now, it's spread pretty evenly."

Spring barley direct-seeded into spring barley stubble .

Canola direct-seeded into spring barley stubble.

In most cases, Bill's residue management strategy also ends behind the combine. His philosophy is "leave it standing and leave it anchored." In his area, crops rarely produce more residue than his drill can seed through. When the residue is excessive, Bill still believes it is best to leave the crowns and roots undisturbed, as with flailing, so the drill can do a better seeding job.

Fertility

Bill bases fertilizer rates on soil tests and expected yields. When the soil profile is full of moisture, he typically applies 35 to 45 lbs of nitrogen (N), 10 lbs of phosphorus (P_2O_5), and 15 lbs of sulfur (S) for spring cereals, on a per acre basis. He increases the S by 5 lbs for mustard. Bill puts all of his fertilizer down in a deep-band, 2 inches below and $^1/_2$-inch to the side of the seed. "I used to think we needed to put some fertilizer with the seed and some below the seed. However, the research and other direct seeders are showing me, with the soil being disturbed under the seed by the chisel shank, by the time that little plant puts a shoot out of the ground, its roots are well into the deep-band fertilizer. So we have one tube for seed and one for fertilizer." He uses all dry fertilizer (a blend of urea, 11-52-0, and ammonium sulfate), "but I left the option open of switching to liquid if the price came down. Liquid would be a simpler form to handle, especially during damp weather."

Weed management

Jointed goatgrass and downy brome have been Bill's major weeds. "Even if we didn't want to direct-seed, we would have to spring crop right now to deal with the jointed goatgrass problem."

Late April stand of spring wheat direct-seeded after winter wheat.

Fields planted in spring crops the longest have few winter annual weeds. Under direct seeding, Bill has replaced tillage with herbicides to manage weeds. He says, "The sprayer has become the most used piece of equipment on the farm. When you can't rely on tillage to help, the Roundup (glyphosate) application has to be done just right. You have to become an expert Roundup applicator."

Bill uses one or two applications of glyphosate to control weeds and volunteer cereals between crops. He would like to put his first application on in the fall to prevent the weeds from using precious moisture and to help eliminate the "green bridge" in the spring (see "Disease management"). "In some years, winter can set in before the fall flush of volunteer emerges, making a fall application impossible. However, warm spells in the winter usually allow an application of glyphosate. In 1999, I applied 12 oz/acre of glyphosate in the first week of December, and it did a very good job." Bill uses standard in-crop herbicides, although he chooses those with short residuals to leave his options open for planting a broadleaf crop, such as mustard.

Typically, growers who raise annual spring crops trade their winter annual weed problems for spring annual weeds, especially those, such as Russian thistle, germinating late in the spring. Bill says, "We do see an increase in Russian thistle during the first couple years of annual cropping, but it becomes less and less a problem with successive years of no-tilling." He attributes the long-term decline of Russian thistle to leaving the soil relatively undisturbed and to banding fertilizer. Where Russian thistle is a problem, he uses a postharvest burndown application of 2,4-D, Roundup, or both.

Disease management

Ideally, rotation would be the foundation of Bill's disease management strategy; however, he has not yet found any consistently profitable noncereal crops. While he has successfully grown continuous spring barley, he is cautious about raising spring wheat continuously for disease reasons (see "Crops and rotation").

Given his limited rotation, Bill is aware of the importance of creating a weed- and volunteer-free period before seeding to prevent carryover of soil-borne pathogens from one crop to the next. Eliminating this "green bridge" is achieved by waiting 2 to 3 weeks between spraying the nonselective herbicide in the spring and seeding. This often conflicts with optimal timing for seeding.

"Early seeding has been critical to a good spring crop in our area. Unfortunately, by the time you can spray, it is about time to start seeding. So there's a tradeoff for us between how much we might lose to a green bridge problem and how much we might lose to late seeding." Bill says, "One reason we think we can cheat on the green bridge a little is because we are using a chisel opener that disturbs the soil (and soil-borne pathogens, such as Rhizoctonia root rot and take-all) below the seed." Placing fertilizer below the seed within easy access of seedling roots helps seedlings tolerate and outgrow root-pruning diseases. "The green bridge is a very real problem, one we are still trying to get a handle on."

Seeding strategy

Bill has increased his seeding rate for direct-seeded spring crops by 25%. He aims for 22 to 24 seeds per square foot for cereal crops. "We think we have improved our yields by increasing our spring seeding rate. When you direct-seed, you need the higher rates because not every seed makes it." Bill

Chaff spreader in operation on the Jepsen combine.

Jepsen's self-propelled sprayer. "The sprayer has become the most used piece of equipment on the farm."

GIVING UP FALLOW

When evaluating the feasibility of annual cropping on his farm, Bill had 36 years of precipitation and soil moisture data to help make the decision. His father started collecting this data in the early 1960s. Bill continues these measurements today. Figure 1 shows annual rainfall (January to December) on their farm from 1962 to 1999, and Figure 2 shows annual moisture penetration in the soil on stubble ground on April 1 from 1960 to 1999. Because Bill farms relatively shallow soils (24 to 36 inches), the soil profile is full, or close to full, in most springs. The limited ability of his soils to store moisture made Bill start to question the practice of fallowing. "When the soil profile is full, and we have a relatively wet spring, we can raise spring crops that rival winter crops grown on fallow ground."

Bill used the precipitation and soil moisture data to estimate annual spring wheat yield on his farm. The average moisture penetration in early spring is 30 inches, which translates into 5.83 inches of available moisture[1]. Add to this an average of 3.29 inches of rainfall for the months of April, May and June, to get a total of 9.12 inches of moisture available for crop growth. The average water-use efficiency for spring wheat is 5 to 6 bushels per acre for every inch after the initial 4 inches[2]. Bill could expect 25.6 to 30.7 bushels of spring wheat per acre in an average year. This seemed better than harvesting 43 bushels of wheat per acre (his average for winter wheat on fallow) every other year. Direct-seeded annual spring crops could yield even more because of the increased water infiltration and moisture conservation associated with direct seeding.

Table 1 shows estimated moisture available for crop production, predicted spring wheat yields and Bill's actual average spring wheat yields for 1996 to 2000, the years Bill has direct-seeded annual spring crops. While 1996 and 1998 yields were within the predicted ranges, the 1997 yield was well above the range. Bill attributes the greater-than-predicted yield to timely rains and optimal weather at grain fill. These first 3 years of direct-seeding spring crops were very encouraging. Then, in 1999, moisture was extremely scarce. Bill measured only 2.5 inches of moisture available in the soil profile in the spring, and his crops received only 1.5 inches of rainfall in April through June. His spring wheat yield was poor, although it was above that predicted by the water use efficiency formula (Table 1). Bill says, "The question is, would we have been any better off if we had chemical fallowed instead of cropped?" He doesn't think so. Before fall seeding in 1999, only 1.1 and 1.3 inches of soil moisture, respectively, were in the conventional and chemical fallow plots of the "Center of Sustainability" (see "Crops and rotations"). Bill says, "Conventional wisdom is once the ground is plowed in the spring, we lose all the rain plus 1 inch of soil moisture during summer fallow. It looks like that is exactly what happened." That doesn't leave Bill with much to show for one year of fallowing.

Bill is cautious about his switch to 100% annual crops. It will take many years of experience, in all sorts of weather, to fairly evaluate his new system. Direct seeding provides three main soil benefits that favor annual cropping success: increased water infiltration, decreased runoff, and decreased evaporation. "With those three, we hope to raise annual crops in most years, where we used to think we needed summer fallow to build that moisture."

Table 1. Moisture available for crop production, predicted spring wheat yields and actual average spring wheat yields for 1996 to 2000 on the Jepsen farm.

Year	Moisture available for crop production	Predicted spring wheat yield	Actual spring wheat yield
	(inches)	(bu/acre)	(bu/acre)
1996	10.36	32—38	37
1997	10.52	33—39	52
1998	11.99	40—48	48
1999	4.00	0	13
2000	8.43	12—26	25

tries to seed as shallowly as possible to place the seed in warmer soil, but still be in moisture. He also tries to seed as early as possible. "One of the keys to making spring cropping work in our area is early seeding."

ADVANTAGES JEPSEN SEES

Erosion control. "If we can make direct seeding work here, I think we will almost eliminate erosion. It will do more than all the terraces, all the trashy fallow, all the hundreds of things we have tried for years. But we have to be able to make a living at it."

Improved water infiltration. "You have standing stubble all the time, so that decreases runoff and increases infiltration. Then you have all those little pores created over the years—from roots, bugs and worms—left undisturbed. I think it is going to be hard to make no-till ground run. Even on frozen soil, the water seems to penetrate."

Improved moisture conservation. During the droughty 1999 growing season, Bill learned the importance of residue cover for conserving moisture. High winds during the winter created the potential for evaporative moisture loss. In the spring, when he measured soil moisture content in his "variety trial" test plots, Bill found an average of 2.5 inches of moisture in plots planted in barley in 1998, versus an average of 1.8 inches of moisture in plots seeded to lower-residue crops (canola, mustard, lentils, garbanzos, and flax). The barley that followed yielded only half a ton on average (it received only 1.5 inches of rain during the spring growing season), yet barley that followed barley yielded 150 to 350 lbs per acre more than barley that followed lower residue crops. "Moisture conservation was the driving force behind all yields in 1999," stated Bill. "The expected increase following an alternative crop did not happen. Instead, the yields were actually reduced after the lower-residue crops." Bill notes the 1998 crops were first year no-till and "maybe if we had direct-seeded longer, more residue would carry over so we wouldn't see such a difference in moisture conservation."

Soil structure improves. "One field we farm had a real problem with soil crusting. We were reluctant to seed a spring crop after traditional summer fallow there because we were worried the soil would

GIVING UP FALLOW Continued

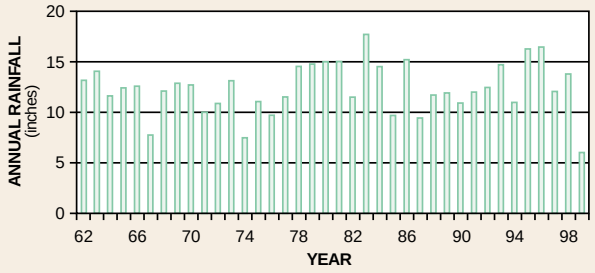

Figure 1. Annual rainfall (inches) from 1962 to 1999 on the Jepsen farm.

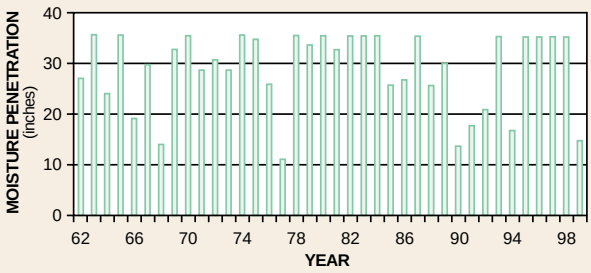

Figure 2. Moisture penetration depth under wheat stubble on April 1 from 1962 to 1999, Jepsen farm[3].

[1]Bill uses a figure of 2.33 inches of available moisture per foot of soil, which he derived from years when he had soil tests done professionally. He notes this figure can lead to an overestimation when soil penetration is shallow because the soil is usually not saturated in the last few inches of soil moisture penetration.

[2]Source: Legget, G.E. 1959. Relationship between wheat yield, available moisture, and available nitrogen in eastern Washington dryland areas. Washington Agricultural Experiment Station Bulletin 609, Institute of Agricultural Sciences, Washington State University.

[3]Moisture penetration values do not exceed 36 inches because soils are no deeper than 3 feet. Depth of moisture penetration does not consistently correlate with annual (calendar year) rainfall (Figure 1) because values are not measured over the same time interval. Factors other than rainfall influence moisture penetration: water use by a previous crop, distribution of precipitation events, frozen ground, and evaporation from the soil surface as influenced by windiness and residue cover.

crust over and the seed wouldn't come out of the ground. We don't get crusting like that anymore. The soil structure has improved dramatically; it is much mellower. At harvest, it's like walking on a carpet over a thick pad versus walking on concrete, which is what it used to feel like."

Can remove terraces. "I would love nothing more than to take a bulldozer and knock out our graded terraces. I took three out this winter where they were no longer necessary. I have miles more of them we'd like to remove because they are a weedy mess to farm around."

CHALLENGES JEPSEN SEES

Learning a new system. "When you go from conventional winter wheat/fallow to direct-seeded annual spring crops you have three big hoops to jump through. One is to go from summer fallow to annual crop. Another is to move from winter crops to primarily spring crops. The third is to replace conventional tillage with direct seeding. Those are a lot of hoops to jump through at one time."

Spring workload. "I thought about hiring somebody earlier this spring because it seemed I had 8 weeks worth of work to do in 2 weeks time. It's a real crunch time. Now, at the end of April, when I used to spend hours on the tractor making summer fallow, I am working in the shop."

Spring spraying. Waiting a full 2 to 3 weeks after spring spraying for green bridge control can be a challenge when the weather does not cooperate. If it is windy, Bill can not spray, and if it is cold, the weeds and volunteer crop do not die quickly.

Appearances. "You have to get used to your field looking like this after you're done seeding."

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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