Winds of Change

Controlling blowing dust in world’s driest wheat-growing region

by Tanner Ehmke
In the Horse Heaven Hills of south-central Washington State, the driest wheat-growing region in the world, farmers grow wheat on a meager 6 to 8 inches/year of precipitation.

The environment is dry and windy with sandy silt loam soils, and the region consists of about 300,000 cropland acres where winter wheat–summer fallow is the dominant rotation. The 13-month fallow period is meant to store water in the soil between wheat harvest in July and planting of the subsequent wheat crop the following year. But, if not managed properly, high winds often carry topsoil off barren fields in blinding dust storms with sometimes fatal consequences.

The nearby city of Kennewick, WA lies downwind of the Horse Heaven Hills and bears the brunt of the dust storms, according to ASA, CSSA, and SSSA member Bill Schillinger, professor and research agronomist at Washington State University’s (WSU) Dryland Research Station in Lind, WA.

“In Kennewick, some of these dust storms cause zero visibility, which often results in vehicle pileups and closed freeways,” Schillinger explains. “They call it freeway carnage.”

From 2000 to 2010, exceedances of USEPA’s air quality standards occurred 20 times in Kennewick, Schillinger points out. But with the diligent efforts of numerous wheat farmers along with university researchers like Schillinger who have spent decades studying farming practices in the region, farmers are now implementing new practices to limit wind erosion without costing farmers profitability.

Since the onset of farming in the region 135 years ago, farmers have conserved soil moisture with tillage during the spring and summer of the fallow year. Tillage implements like tandem discs and field cultivators that mix and stir the soil and bury crop residue were traditionally used. Older implements also were not equipped to apply fertilizer, which required farmers to make another trip across the field for fertilizer application. All told, farmers would till the soil eight or more times with the old tillage methods, he says.

Visibility dropped to zero in parts of eastern Washington on 4 Oct. 2009, as a large dust storm blew through. This image of the storm was captured by the Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA’s Terra satellite shortly after noon (Pacific Daylight Time). With little crop residue remaining on the soil surface and with soil clods pulverized after being tilled, high winds easily grab topsoil from fields and carry it across county and state lines. Schillinger and other WSU researchers estimate that in a 24-hour period of sustained high winds, exposed fields can lose about 80 tons/...
ac of soil. Complicating matters is the lack of structure of most Horse Heaven Hills soil. Fine dust particles of less than 10 microns, or 0.01 mm, in diameter become suspended in the air and can travel hundreds of miles before settling. In comparison, fine beach sand is 90 microns thick, and smoke particles are up to 1 micron in diameter, according to USEPA.

Because of the fineness of the soil particles, it doesn’t take much wind to cause a dust storm if there’s no crop residue or clods to anchor soil in place, Schillinger says.

“Twenty miles per hour is the threshold wind velocity. That’s where wind erosion really starts. But, it’s not unusual to get wind gusts of up to 50 mph or more,” he says. “There are stories from early days of blowing dust scouring the paint completely off the windward side of vehicles.”

Why Tillage-based Winter Wheat–Summer Fallow?

So why do farmers in the Horse Heaven Hills continue a tillage-based winter wheat–summer fallow rotation? It’s a question often asked, Schillinger says, and the topic has been thoroughly researched through the decades. Long-term field experiments document that it’s too dry most years to profitably grow any crop without a preceding year of fallow in this area, he says. No spring-planted crop so far tested has proven to be a viable alternative to winter wheat, making wheat–summer fallow the most stable and profitable rotation.

Numerous studies in the dry regions of Washington have consistently shown that for farmers to achieve the highest grain yield potential, they need to plant winter wheat early into carryover moisture in fallow in late August to early September, Schillinger explains. No other wheat farmers in the world drill deeper when seeding, he says. Farmers in the Horse Heavens drill 4 to 6 inches deep or sometimes even 7 inches deep to plant the seed into moisture to ensure germination and fall stand establishment. If the seed zone is too dry to plant early, then farmers postpone planting until mid-October to “dust in” seed at a shallow depth and then wait for the fall rains to begin.

Water loss from fallow soil, though, accelerates from mid-July through August, Schillinger notes.

“In August, we lose more seed-zone water than at any other time,” he says. “Water wants to move from where it is to where it isn’t. It also wants to move from where it’s warmer to where it’s cooler. So, we have cooling on the soil surface, and the reason for that is the days are still hot but the nights are cooling off. That’s why farmers try to plant wheat early before the seed zone is too dry.”

Plants fall with a steep penalty with grain yields 36% lower than early-planted winter wheat. And, since the summer months are dry, some type of tillage is needed in late spring to break soil capillary continuity to halt the upward movement of liquid water, thereby slowing evaporative loss to maintain water in the seed zone for early planting, Schillinger says.

No-till fallow is ideal for controlling wind erosion, he adds, but the seed zone generally dries out during the hot, dry summer months, thus not allowing early planting.

“No-till fallow is successfully practiced in many areas of the world
Controlling Wind Erosion Takes Different Forms in Different Regions

The Horse Heaven Hills isn’t the only dry and windy wheat-growing region where farmers battle wind erosion. Baca County in southeast Colorado, which was made famous for the mighty “dusters” or dust storms that raged in the Dirty ’30s, also recently struggled with dust storms.

But making direct comparisons between the semi-arid Great Plains and arid Horse Heaven Hills isn’t sound science, says Bill Schillinger, professor and research agronomist at Washington State University’s Dryland Research Station in Lind, WA.

During the epic drought of the 1930s that turned the central and southern Plains into the Dust Bowl, high winds carried topsoil from fields that lay bare from inversion tillage. Farmers adapted by implementing fallow into their rotations to save water, and by using minimum disturbance tillage implements like the Noble blade that sliced weeds’ roots below the soil surface while keeping crop residue intact to stop wind erosion.

Keith Larson, superintendent of Colorado State University’s Plainsmen Experiment Station in Walsh, CO, says the days of blowing dust are largely a thing of the past thanks to conservation tillage and no-till, which leaves soil completely undisturbed via herbicidal control of weeds.

But during the past few years, he says, intense drought returned and culminated in severe dust storms reminiscent of the 1930s and 1950s. Wind gusts reported as high as 75 mph caused blinding dust storms that closed major highways in eastern Colorado. Wind erosion even occurred on native pasture that had never been tilled.

Aside from the recent exceptional drought that set records throughout the Plains, farmers in Baca County have managed to remain productive in a region prone to drought by implementing no-till.

“We’ve gone away from a lot of the tillage. It’s residue management that’s keeping that land from blowing,” Larson says.

Farmers here have also increased cropping intensity with the additional moisture savings, Larson points out. But compared with the Horse Heaven Hills, southeast Colorado is a significantly wetter environment, receiving more than twice as much annual precipitation. Average precipitation for southeast Colorado is 16.5 inches/year compared with 6 to 8 inches/year in the Horse Heaven Hills, giving Colorado farmers a greater advantage in growing more crops and leaving more crop residue on the soil surface.

That advantage has made all the difference in cropping systems and wind erosion control. The traditional wheat–fallow rotation in eastern Colorado has largely been replaced with wheat–sorghum–fallow since no-till and minimum till became widely adopted over the past 25 to 30 years. Farmers who grew continuous sorghum on sandier soil also improved productivity and profitability with the wheat–sorghum–fallow rotation.

Meanwhile, about 1,200 miles to the northwest in the Palliser Triangle spanning southern Saskatchewan and Alberta, Canadian farmers are continuous cropping and eliminating fallow on even less moisture than Baca County with a meager 12 inches/year. However, they enjoy a less demanding pan evaporation rate of 50 inches/year compared with Baca County’s 75 inches/year, making an inch of water in Canada go a lot further in crop production.

The semi-arid region of the Canadian Prairies formerly was dominated by the spring wheat–fallow rotation with an 18-month fallow period before no-till was widely adopted in the early 1990s, says Bob Blackshaw, weed scientist at Agriculture and Agri-Food Canada in Lethbridge, AB. Fallowed acres in the Palliser Triangle—the namesake of explorer Captain John Palliser, who in the 1850s, declared the region too dry for crop production—have dropped substantially with the adoption of no-till.

“We’ve decreased fallow by more than 90% in the Canadian Prairies,” Blackshaw says. “We used to have anywhere from 30 to 35 million acres of fallow, and now we’re around 2.5 to 3 million acres. With that came continuous cropping and a more diversified cropping system.”

Now, spring canola is a major crop in the Palliser Triangle, which is commonly farmed in rotation with spring wheat and field peas. The only farmers who fallow are generally older farmers using outdated technology, Blackshaw notes.

But it’s not just fallow that has nearly disappeared in the Canadian Prairies. So have the dust storms despite the powerful Chinook winds that can gust up to hurricane force, says SSSA Fellow Frank Larney, soil scientist at Agriculture and Agri-Food Canada in Lethbridge.

But like Baca County, CO, the additional moisture that the Palliser Triangle sees compared with the Horse Heaven Hills has given growers there the benefit of producing more crops and ground cover to break the wind.

“Wind erosion has traditionally been an issue on the Canadian Prairies, but with the advent of no-till on dryland, wind erosion is quite rare now,” Larney notes, adding that the region currently is in a wet spell.

But nonetheless, he says, the threat of drought and wind erosion is always lurking in the background.
including much of the U.S. Great Plains where considerable summer rainfall is the norm rather than the exception. No-till fallow also works well on heavier-textured soils in the higher-precipitation regions of the inland Pacific Northwest,” Schillinger says. “In other areas, summer fallow has been eliminated altogether.”

Working closely with wheat farmers, Schillinger and other scientists have developed and tested two conservation management strategies that significantly reduce and/or essentially eliminate wind erosion from fields in the Horse Heaven Hills.

“There’s good news to report from the Horse Heavens,” Schillinger says.

Best Management Practices: Undercutter Tillage in the East and No-Till in the West

Spanning just 40 miles across, the region sees a 2-inch difference in precipitation from west to east, making the east and west regions of the Horse Heaven Hills worlds apart.

In the relatively wetter eastern part of the Horse Heavens, where early planting into tilled summer fallow can be achieved most years, farmers are limiting tillage to as few as two passes through the field during the fallow cycle. A low-soil-disturbance implement that combines primary spring tillage with fertilizer injection is followed with about one to three rod weeding operations later in the summer to control Russian thistle with minimal soil disturbance.

Tillage on summer fallow here is more efficient in preserving moisture than no-till, Schillinger found.

“I’ve done studies where we’ve artificially added incremental amounts of residue and we put it in these big cages,” Schillinger explains. “The more the residue better, but it’s still not as effective as creating that tillage layer. That’s why no-till fallow out here hasn’t taken off like in the Great Plains.”

Farmers who have adopted the undercutter method of wheat-fallow farming in the past 10 years have also saved cost on time and fuel with fewer field operations. Moreover, dust emissions are reduced by 70% with the undercutter tillage method versus traditional tillage, Schillinger adds.

A grant from USDA’s Natural Resources Conservation Service to the Washington Association of Wheat Growers for a cost-share program helped farmers in the eastern Horse
Heaven Hills purchase undercutters, Schillinger notes. As part of the cost-share, farmers agreed to set up their undercutter for fertilizer delivery just like was done in the research trials and to report on their experience three years later.

The new undercutter method was a very favorable experience with farmers, Schillinger says, and incidences of dust storms in the region have been reduced.

Meanwhile in the drier western region, farmers face a different challenge: There is rarely adequate seed-zone moisture for early planting, even with tillage. Schillinger advises farmers here to use no-till to stop wind erosion. Rather than planting deep in late August or early September to reach stored moisture like farmers in the eastern region, farmers here can plant wheat at a shallow depth directly into the standing stubble of the previous crop.

“If you can’t store water in fallow to plant early, there’s no reason to do any tillage at all,” he says. “So, you practice no-till fallow, and you go out in mid-October and just plant shallow into the dry soil and wait for it to rain.”

Because of the significantly lower yields in the western Horse Heaven Hills, which average 18 bu/ac compared with 32 bu/ac in the east, Farmers are cost conscious on herbicides and other inputs. No-till farmers stick to a basic herbicide package like glyphosate for weed control in fallow and 2,4-D as in-crop broadleaf weed control. Application rates typically are low early in the season when weeds are small, Schillinger points out, with glyphosate applied at rates as low as 12 oz/ac, but rates are increased later in the season and tank mixed for improved control of Russian thistle.

But the clear advantage to no-till in the west, Schillinger adds, is virtual elimination of wind erosion without hurting farmers’ bottom line.

“We can essentially eliminate blowing dust that way,” he says. “And, they can make a nice profit.”

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