RESIDUE MANAGEMENT: 2020 AND BEYOND

Richard Wolkowski [1/]

Residue management should be a focus of every producer's crop management plan. Crop residue is known to be important for erosion reduction, supplying of organic matter for maintaining soil tilth, and as a sink for plant nutrients that are released to subsequent crops. The amount of crop residue at the surface has traditionally been linked to soil conservation programs, and it is generally accepted to be the farmer's best tool for controlling erosion. As the yield potential of crops has increased, the amount of residue has increased. This has been viewed as problematic by some, especially for corn, where the additional residue is considered to be a hindrance to tillage. The greater residue has caused some producers to "size" the residue by chopping or installing chopping heads on their combines. In many instances the crop residue is baled and removed, especially in years like 2010 when crops matured early. Furthermore, traits such as "Bt" have anecdotally been linked to slower residue decomposition and have resulted in more aggressive residue management by producers.

Producers should be encouraged to establish "tillage goals" that fit their soil types, equipment capability, and management skills. Several years ago Professor Ron Schuler from the UW Biological Systems Engineer Department outlined these goals based upon the need for conservation practices, the soil and residue condition, and the crop rotation. Tillage practices based on these goals will vary from one area to another and one producer to another. His list included:

- Quantity and type of residue and soil condition prior to tillage
- Desired final residue cover, distribution, surface roughness, and seedbed condition
- Presence of compaction or rutting
- Power and time requirement
- Planter capability
- Other management issues (e.g., fertilizer or manure incorporation, conservation programs)

Tillage Management Trends

While the forecast for residue management ten or twenty years into the future may be similar to predicting next week's weather, a sense of what might be expected can be learned by examining recent trends. The WDATCP has been able to collect limited, but useful, data through the annual transect surveys conducted in several counties. This survey uses a standard protocol to estimate soil erosion equation factors and tillage type at defined locations typically spaced at 0.5 mile increments on a prescribed driven route. The data are useful for assessing conservation programs and for future education in soil management. The state-wide data are summarized in Table 1. The presented comparison sums fall and spring moldboard and chisel tillage into one tillage category. Corn data are for corn grain systems. Soybean data are pooled for drilled, and

[1/] Extension Soil Scientist, Dept. of Soil Science, UW-Madison.

narrow and wide row planting systems. The "other" category includes tillage with disks, field cultivators, and strip-tillage. These data show several trends. First, no-till production systems are increasing for both crops, presumably because of enhanced weed control management options through the glyphosate resistant trait and improvement in planter technology that simplify no-till management. It is assumed that most no-till systems use some type of residue managing coulters. The amount of moldboard tillage has steadily decreased, most likely because of the increased time required for plowing and the price of fuel. Chisel tillage has become the full-width alternative for many producers in both corn and soybean. The increase in farm size has also likely contributed to the increased percentage of no-till and chisel systems because of the time savings associated with these practices. Finally, participation in government programs and nutrient management planning, both of which lead to a focus on farming within "T" have become increasingly important. Note that the nature of the growing season can affect tillage management. The 2009 growing season resulted in a very late harvest and therefore less time for tillage before freeze-up. This likely increased the amount of fields that were either no-tilled or chisel plowed, with a substantial reduction in moldboard plowing. The 2011 transect data may show a drop in these categories because of the early harvest and extra time that was available for tillage.

Table 1. Wisconsin tillage transect data for 1996 – 2010, (Source: WDATCP).

Tillage	1996	2000	2005	2008	2009	2010
	------------------------------------ % of fields ---------------------------------------					
Corn						
No-till	6	11	22	20	22	29
Chisel	37	39	33	52	53	58
Moldboard	52	49	43	12	12	5
Other	5	1	2	16	13	8
Soybean						
No-till	2	29	46	40	45	49
Chisel	59	39	34	38	37	38
Moldboard	28	22	19	5	7	5
Other	11	10	2	17	11	8

Expert Forecasts

Several Midwestern university faculty were asked how they felt tillage and crop residue management would change in the next 10 to 20 years. One researcher felt there would be both pessimistic and optimistic outlooks for the future of residue management that would affect farmer adoption of the various practices. Pessimism was based on the recent cool, wet springs that caused challenges with planting and increased soil compaction. Some producers are growing more corn on corn, which leads to residue accumulation and slower growth if the residue is not incorporated. Finally, he believed some are concerned with nutrient stratification in long-term no-till and weed shifts that are often encountered as tillage practice changes. Optimism for more no-till for some producers comes from an increasing awareness for the need for improved soil conservation. Recent heavy rains have resulted in significant erosion, which progressive growers won't tolerate. Other factors that enhance management in high residue environments are tillage and planting equipment that is better designed to handle more residue and hybrids that are better adapted to the early cool and wet conditions. This researcher predicts growth in strip-tillage that helps moderate some of the concerns with early growth suppression and surface compaction. Vertical tillage systems, if proven to be superior to other full-width systems like chisel, may also expand. He urges producers to make their tillage management decisions on research, not anecdotal observations and equipment company marketing.

Another researcher felt that the demand for corn grain or biomass for fuel in the Midwest would drive an effort to produce maximum yields. His concern is that this may trump conservation practice policies leading to greater tillage intensity on the landscape. More corn on corn would be expected to lead to more full-width tillage, of which most would be chisel plowing or similar practices. This year he has observed more stalk removal via baling than he's ever seen in the past ten growing seasons. Such practices that remove 50% or more of the surface residue increase the potential for erosion. There was a concern that removal of residue would lead to reduced soil organic matter and poorer soil quality in the long term.

A third regional expert believes that equipment limitations and a shortage of quality labor may limit the ability to produce crops in high residue systems. It is known that speed, soil and residue conditions, the utilization of technology such as RTK guidance, and operational costs will affect the capacity to successfully grow crops in no-till or similar high residue systems. Farmers have begun to use implements that claim to provide "vertical tillage," most likely because of their ease of operation and the fact that they can cover a lot of ground running these tools at 10 mph. The fact that these tools provide full-width tillage, size residue, and show a bit of bare soil are some of the reasons for the current high interest in their adoption. This person suggested that if society is serious about combating soil erosion and runoff then government programs that promote residue management through incentives will be necessary. The availability of significant funds for such programs in these budget times is an issue and will likely not improve in the future. Finally, many of the grain production soils in the Midwest are somewhat poorly drained necessitating tiling. Tiling these soils removes a large element of production risk, but may increase the delivery of nutrients to surface waters via the discharge in drainage water.

Climate Change Effects

Concerns regarding the effect of climate change on agriculture have been expressed as warmer weather impacts cropping management and weather patterns have resulted in more intense rains in the past decade. The effects of climate change can be argued, but the observation of the frequency of intense storms has been documented. The Soil Conservation Workgroup of Wisconsin Initiative on Climate Change Impacts (WICCI) prepared a report that outlined the current situation and considered the potential soil erosion impacts in the future. Figure 1 shows the trend for the increasing intensity of rain storms over the past six decades. There was some variation between locations around the state. An increase of up to 60% more storms of at least one inch was observed in the past 30 years at some locations, whereas others showed a decrease in recent years. In general these data show a trend for more intense rain storms in the past ten to twenty years (one only has to think of the storms of June 2008 or September 2010 to support that observation), which will lead to more soil erosion. As the trend continues, and perhaps worsens, the potential for increased soil loss is a real possibility.

Another Wisconsin agricultural trend that is apparent is the change in cropping system that has occurred as smaller dairies are closed. Larger dairies are utilizing more corn silage, which leaves little residue. Wisconsin Agricultural Statistics show that in the past 40 years production acres of corn for grain have doubled, whereas hay acres have been reduced by 50%. There are nearly 10 times as many acres in soybean production in the same time period. It is recognized that intensive tillage in a corn/soybean rotation can increase soil loss, compared to longer rotations that contain several years in hay production. Much of this shift is occurring in the Driftless Area of southwest Wisconsin, where loess soils predominate on steeply sloping land. Intensive tillage on these soils would have serious consequences.

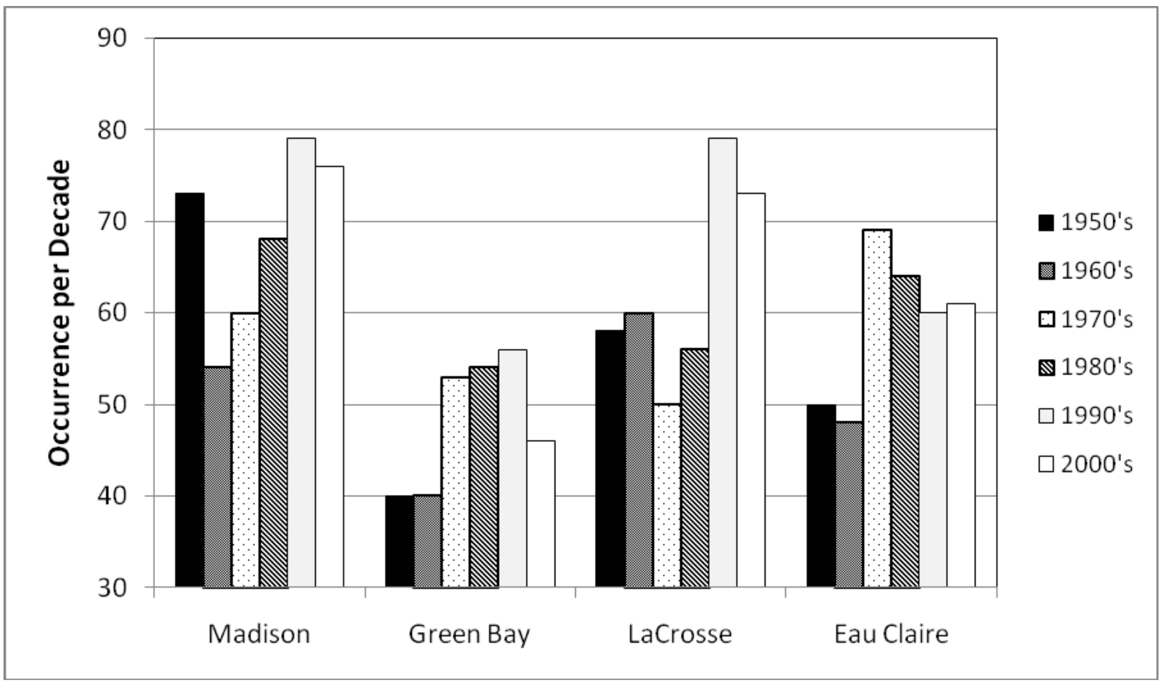

Figure 1. Occurrence of daily precipitation events greater than one inch at three Wisconsin locations. Source: WICCI Soil Conservation Working Group report, Univ. of Wisconsin Madison, 2010 (adapted from Kucharik et al., 2009).

The WICCI report suggests that there is indeed a risk for greater soil erosion in the future. The USDA-NRCS National Resource Inventory estimates that the average soil loss for Wisconsin in 2007 was 4.44 tons/acre ($\pm$ 0.25 ton/acre), which is an increase of 0.72 ton/acre determined just ten years earlier in 1997. The recent DATCP transect survey shows that about 75 % of Wisconsin fields meet “T”, which is down slightly from about 80% 10 years ago. Future modifications of factors in the soil loss equation by NRCS will modify the “T” value for some Wisconsin soils. While it is predicted that this may affect about a third of our soils, significant changes in tillage management, along with associated conservation practices and crop rotation will be needed to meet program goals in some locations.

Post-harvest Residue Management

A common practice for producers concerned with large amounts of residue from high yield corn production is to size residue, either by utilizing a chopping head on the combine or chopping stalks post-harvest. Stalk chopping has become ubiquitous on the landscape, especially in early seasons like 2010. Stalks are chopped, of course, to reduce their size and improve their flow through tillage equipment. Furthermore, removal of the chopped stalks as bales or flail-chopped materials has raised concerns about soil quality, which is made worse when manures are not returned to these fields. The consequences of stalk chopping, in addition to added equipment and fuel cost and operator time, is the fact that subsequent tillage will bury more residue compared to fields where stalks are not chopped. A recent study conducted at the Arlington Agricultural Research Station (Wolkowski, unpublished data) compared treatments with and without post-harvest flail chopping in continuous corn in either a chisel or no-till system. Surface residue measurements were made immediately after fall chisel tillage in 2010. The tillage x chopping interaction was statistically significant ($Pr>F = 0.04$). Under chisel tillage chopping reduced surface residue from 61 to 42%, whereas the change in no-till was minimal just 96 to 94%. Subsequent secondary tillage next spring in the chisel system may reduce the surface residue below 30% in the chopped environment, while it is expected to be well above that mark where the residue was not chopped. Chopping in no-till can leave a mat of residue that may keep the surface of the soil wetter, whereas some un-chopped residue will remain upright and may allow for better air circulation and drying prior to planting. This study evaluated chopping conducted in the fall of 2009, which was not found to affect the early season soil temperature, emergence rate, final stand, early season plant height, or corn grain yield measured in 2010.

Summary

Most everyone will agree that soil conservation is a very important issue and that farmers hold the key to keeping erosion in check. Conservation tillage and other factors that impact surface crop residue during the growing season are a producer's best option for controlling erosion, especially when appropriately coupled with suitable crop rotations and supporting conservation practices on the landscape. A combination of factors is expected to affect tillage and crop residue management in the future, which will become increasing challenging if rainstorm intensity and the potential for soil erosion increases as expected. Cropping system practices will change to meet current demands, whether that be biofuel production, livestock feed, or food and industrial uses. Economic consideration will drive many decisions and it is incumbent upon those in higher education and the service community to provide demonstrated alternatives that farmers can use with success. Farmers are an adaptive group who are likely to support reasonable options for practices or systems that improve productivity and profitability, while limiting environmental risk.