

## *Northwest Columbia Plateau PM<sub>10</sub> Project*

**Objective 7:** *Identify Sustainable Farming Practices for the Columbia Plateau*

**Title:** *The Effect of Wind Erosion and Control Measures on Soil Carbon, Communities, and Quality*

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### **Abstract of Research Findings**

Our overall objective is to determine the effect of wind erosion and management practices on soil organic matter, soil biological communities and soil quality characteristics. The first objective of this research is to characterize biological, physical and chemical soil quality parameters and monitor their changes over time in tillage systems of dryland farming systems. We have monitored several long-term no-till drill trials and have found that all types of no-till or minimum-disturbance drills build organic matter and improve soil quality. The major difference among drills is the distribution of the organic matter and soil characteristics within the soil horizons of the upper 10 cm. Soil organic carbon is slowly increasing in long-term no-till and approaches or exceeds that of nearby undisturbed sites. Soil organic matter can be built by reducing the number of tillage passes no matter which type of minimum-disturbance drill is used. Long-term no-till soil has a larger volume of aggregates greater than 1 mm than tilled soils. No-till soils stored a greater proportion of the carbon in the larger size aggregates, thus protecting more of the carbon from loss due to wind erosion. Our second objective is to quantify the carbon content and biological fingerprints found in wind-eroded sediments from agricultural soils. We investigated the carbon content and biological fingerprint of fractions of agricultural soil collected in Big Spring Number Eight (BSNE) sample collectors. We found that the carbon of agricultural soil collected in BSNE sample collectors at ten sites were either the same as or greater than the carbon of surrounding bulk soil. The largest percentage of material was, however, from the immediate area indicating that the sites surrounding the collectors were losing organic matter. This research provides growers and scientists with information to aid in the development of management practices.

### **Objectives**

Our overall objective is to determine the effect of wind erosion and management practices on soil organic matter, soil biological communities and soil quality characteristics. The first objective of this research is to characterize biological, physical and chemical soil quality parameters and monitor their changes over time in tillage systems of dryland farming systems. Our second objective is to quantify the carbon content and biological fingerprints found in wind-eroded sediments from agricultural soils.

### **Methods and Materials**

**Objective 1. Characterize biological, physical and chemical soil quality parameters and monitor their changes over time.**

Research is being conducted in conjunction with the ongoing wind erosion projects at various locations, such as the undercutting project; the Jirava no-till seeding study near Ritzville, WA; and the canola-winter wheat study at Lind, WA. Soils are incrementally sampled from the 0 to 15 cm depth in early spring and mid-summer to monitor soil quality changes over time. Soil quality and crop production data will be used to assess the influence of management practices on these parameters. The soil properties analyzed include bulk density; soil pH (1:1 ratio of soil:water); electrical conductivity; organic C and N (Leco Analyzer); and aggregate size distribution. The soil microbial constituents of various management systems were assessed by several different microbial methods. A study of the microorganisms in the selected plots involves soil biomass, respiration and dehydrogenase enzyme activities (Tabatabai, 1994). Soil from each of the cropping systems was analyzed using phospholipid fatty acid (PLFA) and fatty acid methyl ester (FAME) analyses (Kennedy and Busacca, 1998) to determine microbial community structure and effects of stress on the system (Ibekwe and Kennedy, 1998). The statistics used included analysis of variance (ANOVA) using Tukey's test and multivariate analyses (SAS, 1999).

**Objective 2. Quantify the carbon content and biological fingerprints found on wind-eroded sediments from agricultural soils.**

We are investigating the carbon content and biological fingerprint of fractions of agricultural soil collected in Big Spring Number Eight (BSNE) sample collectors. We will determine the amount of organic C lost to wind erosion and the impact of type of wind event, location and management on this loss. Along with the carbon content we are also interested in determining the biological fingerprint of the suspended material. It may be possible to use biological fingerprinting to determine the microsite or microaggregate origin of particles that are more erodible than others.

We are evaluating the carbon content and the community profiles of soil emissions from agricultural land collected at various heights above the soil surface. The amount of carbon found in emissions at various locations is being measured and FAME profiles of the particulates are determined and compared with adjacent bulk soil. We are utilizing particulate matter collected in BSNE samplers adjacent to conventionally tilled agricultural fields. Over a ten year period, samples from various wind events at several different locations have been collected in 0.1, 0.2, 0.5, and 1.0 m increments to 1.5 m. The soil properties being analyzed include total C and N (Leco Analyzer); and fatty acid methyl ester (FAME) analyses (Kennedy and Busacca, 1995) to determine soil biological community structure. We use a progressive approach to investigate these samples. Initially we will test height differences, then progress to location or event, and then management differences.

Data are analyzed by one-way ANOVA using Tukey's test or a multiple ANOVA (MANOVA, SAS, 1999). We will determine those characteristics that separate the samples from one another and from the bulk soil. We will also calculate the amount of carbon lost from fields and determine the changes in the soil community markers of the suspended particulate material.

The information from this proposed research will ultimately provide growers and scientists with information on changes in soil organic matter and the soil biota due to wind erosion to aid in the development of management practices. Information will be disseminated during field

days, at workshops, professional meetings, in the popular media, technical publications, and scientific journals.

## **Results and Discussion**

**Objective 1.** Over the past several years we have found that soil quality changes during the transition to no-till are less dramatic and more variable in the low precipitation zones compared to the higher precipitation zones. Organic matter increases with long-term direct seed, and these changes in organic matter may be indicating a different efficiency of soil microbial populations in the dryland regions. Long-term no-till develops complex microbial communities and increases the fungi:bacteria ratio. Soil quality parameters varied with site and tillage operation. Several soil quality parameters were similar among all management practices and varied with location. Organic carbon and microbial activity values usually increased over time in no-till compared to tilled soils. We found more of the larger aggregates in the no-till treatments and these larger aggregates contained more of the carbon in the soil.

Soil quality parameters were assessed to further define management practices that are soil building rather than degrading. Soil organic matter slowly increased in long-term no-till and chisel. The percentage of SOM in no-till research plots on a side slope at the Palouse Conservation Field Station increased from 1.9 percent to 3.6 percent in the top 7.5 inches over the course of 20 years. Soil organic matter increased to 3.2 percent when the soil was tilled with a one pass-chisel. Long-term no-till also increased the proportion of aggregates in the larger sized soil fractions. No-till stored a greater proportion of the soil carbon in the larger size aggregates, thus protecting more of the carbon from loss due to erosion when compared to nearby conventionally tilled sites. Long-term no-till results in changes to microbial communities and increases in the fungi:bacteria ratio. Data from these long-term experiments will allow us to better assess the productivity and quality of soils in the dryland cropping region of the Inland Pacific Northwest. This information will allow the identification of soil quality parameters that can be used in the development of best management practices for conserving soil quality and enhancing crop production.

We have monitored several long-term no-till drill trials and have found that all types of no-till or minimum-disturbance drills build organic matter and improve soil quality. The major difference among drills is the distribution of the organic matter and soil characteristics within the soil horizons of the upper 10 cm. Soil organic carbon is slowly increasing in long-term no-till and approaches or exceeds that of nearby undisturbed sites. We have also found that a shallow (4 inch; 5 cm) chisel pass followed by seeding with a no-till drill will improve soil quality and increase organic matter although at a slower rate than no-till drills. Reducing the number and depth of tillage passes will build soil organic matter.

### *Residue Decomposition Studies*

Cropping systems in the dryland farming region of eastern Washington state are dominated by winter and spring wheat (*Triticum aestivum* L.) and spring barley (*Hordeum vulgare* L.). Excessive levels of residue may be an obstacle in the adoption of conservation farming systems. Decomposition of cereal crop residues is associated with fiber and nutrient content, and growers have observed differences in decomposition among cultivars; however, little information exists on their residue characteristics. We found that cereal crop cultivars varied in

their nitrogen, carbon and fiber content and decomposition potential. High hemicellulose and total N can be linked to rapid decomposition, and high lignin content and high C:N ratio are associated with slower breakdown. Fiber and nutrient characteristics of residue from wheat and barley cultivars currently produced in the Pacific Northwest can be used to predict residue decomposition in cropping systems that conserve soil and water, and enhance build-up of organic matter.

**Objective 2.** Our second objective is to quantify the carbon content and biological fingerprints found in wind-eroded sediments from agricultural soils. We investigated the carbon content and biological fingerprint of fractions of agricultural soil collected in Big Spring Number Eight (BSNE) sample collectors. We found that the carbon of agricultural soil collected in BSNE sample collectors at ten sites were either the same as or greater than the carbon of surrounding bulk soil. Three of the ten sites showed less carbon in the samples compared to the surrounding soil. Carbon values were similar at all collection heights. We also found that the biological fingerprints of the suspended material were similar to the bulk soil in most cases. In four of the ten samples tested the fingerprint were somewhat different from the bulk soils indicating that soil from up-wind sites were also collected in these samplers. The largest percentage of material was, however, from the immediate area indicating that the sites surrounding the collectors were losing organic matter at a high rate. It is estimated that more than 0.01 percent organic matter can be lost from just one wind event, which can affect the long term productivity of those soils.

## References

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## Publications and Presentations

### Refereed Journal Articles

- de Luna, L.Z., A.C. Kennedy, J.C. Hansen, T. Paulitz, R. Gallagher, and E.P. Fuerst. 2011. Mycobiota on wild oat (*Avena fatua* L.) seed and their caryopsis decay potential. *Plant Health Progress*. doi:10.1094/PHP-2011-0210-01-RS.
- Collins, D., A.C. Kennedy, C. Cogger, T. Forge, and H. Collins. Selective inhibition of substrate-induced respiration to detect changes in fungi to bacteria ratio caused by cropping system. *Applied Soil Ecology* (Submitted 08/09/10).
- Lupwayi, N., A.C. Kennedy, and R.M. Chirwa. 2011. Grain legume impacts on soil biological processes in Sub-Saharan Africa. *African Journal of Plant Science* 5:1-7.

- Collins, D., C. Cogger, A.C. Kennedy, T. Forge, and H. Collins. 2010. Farm-scale variation of soil quality indices and association with edaphic properties. *Soil Science Society America Journal* 09/24/10.
- Anderson, J., E.P. Fuerst, T. Tedrow, B.S. Hulke, and A.C. Kennedy. 2011. Activation of polyphenol oxidase in dormant wild oat caryopses by a seed-decay isolate. *J. Agricultural & Food Chemistry*. 58:10597-10605.
- Pritchett, K.A., A.C. Kennedy, and C. Cogger. 2011. Management effects on soil quality in organic vegetable systems in western Washington. *Soil Science Society of America Journal*. 75 (2) doi:10.2136/sssaj2009.0294 Posted online 27 Dec. 2010

### **Published Abstracts**

- Kennedy, A.C., and T.L.Stubbs. 2010. Long-term conservation tillage and residue additions at the Palouse Conservation Field Station, Pullman, WA.
- Kennedy, A.C., T.L.Stubbs, and W.F. Schillinger. 2010. Soil quality differences among long-term no-till irrigated crop rotations to replace burning and plowing continuous wheat. Soil Science Society of America annual meeting, 31 Oct. - 3 Nov., Long Beach, CA. *ASA, CSSA, and SSSA Abstracts*.
- Schillinger, W.F., A.C. Kennedy, and T.C. Paulitz 2010. Fourteen years of diverse annual no-till cropping in Washington's winter wheat – summer fallow region. Soil Science Society of America annual meeting, 31 Oct. - 3 Nov., Long Beach, CA. *ASA, CSSA, and SSSA Abstracts*.
- Stubbs, T.L., A.C. Kennedy, G. Stephen, and J. Kuehner. 2010. Characterization of cereal crop residue in conservation farming systems. Soil Science Society of America annual meeting, 31 Oct. - 3 Nov., Long Beach, CA. *ASA, CSSA, and SSSA Abstracts*.
- Hoilett, N., F. Eivazi, N. Nkongolo, R.J. Kremer, and A.C. Kennedy. 2010. Assessment of soil microbial communities associated with greenhouse gas efflux from a secondary forest in central Missouri. Soil Science Society of America annual meeting, 31 Oct. - 3 Nov., Long Beach, CA. *ASA, CSSA, and SSSA Abstracts*.