2012 NC-1178 Annual Report

Report information:

- Annual Meeting Dates: 06/13/12 to 06/14/12
- Period the Report Covers: 10/2011 to 09/2012

Participants:

Members Present:

- Mahdi Al-Kaisi, IA
- Francisco Arriaga, WI
- Larry Cihacek, ND
- Mohammad Golabi, GU
- Rattan Lal, OH
- Birl Lowery, WI
- Randy Miles, MO
- Kenneth Olson, IL
- DeAnn Presley, KS
- Kurt Thelen, MI

Guests:

- Jose Guzman, IA
- David Kwaw-Mensah, IA
- Victoria Scott, IA

Brief Summary of Minutes of Annual Meeting:

NC-1178 Meeting Minutes of June 13-14, 2012 Recorded by Larry Cihacek

<u>Wednesday June, 13, 2012</u>

The meeting called to order by chair Al-Kaisi at 8:20 A.M. June 13, 2012 in the Agronomy Department Conference Room on the Iowa State University campus in Ames, Iowa. Al-Kaisi discussed administrative items covering the next days of the meeting. Administrative Advisory Report was scheduled later in the morning by N. Cavallero from USDA-CSREES if her schedule permitted. She was not able to call in.

At this time, the committee participants were introduced.

The business meeting was held with the minutes of last year's meeting in Guam being offered for approval. Cihacek moved to approve the minutes. Miles seconded. The minutes were unanimously approved by acclamation. The election of Secretary followed. Olson discussed the historical rotation of leadership for the committee between the participating states. Kansas was next in line for l leadership role and De Ann Presley from Kansas State University was elected secretary and will be chair in 2014.

The committee passed the mid-term review during this past year and discussion of the future of the committee and committee composition was brought forward by Olson. Minnesota has historically had a strong presence on the committee but currently does not have a participant. In addition, Nebraska currently does not have a participant member with the passing of Dan Walters. The general consensus of the committee members was that Minnesota and Nebraska should be contacted to inquire about the status of their members.

The term for this committee ends September 30, 2014. The committee members felt that the committee should apply for renewal based on its long history as well as continuing to be a very active committee. This means that a project renewal needs to be submitted by December 2013. A rough draft of the new project proposal needs to be ready to be finalized at next year's meeting. One general theme discussed was to orient the new project toward some aspect of soil health.

The location of Next year's meeting was discussed. Although Cihacek is willing to host the meeting in Fargo next year, Lowery extended an invitation to the group to participate in the IUSS Global Carbon conference to be held June 3-7, 2013 at the University of Wisconsin at Madison. Miles moved to recommend to the administrative advisor that the committee meet in conjunction with the Global C Conference. Golabi seconded. The motion passed unanimously.

A sub-committee for the writing of the new project proposal was proposed. The sub-committee will consist of the immediate or immediate past chairs of the committee (Al-Kaisi, Cihacek, and Presley). Cihacek was suggested as the chair of this sub-committee. Cihacek stated that he was currently chairing another regional committee that was working on a book and at this time wasn't sure about the demands on his time. Cihacek and Al-Kaisi will share chair duties as required. The sub-committee will get the original Word document from Tom Schumacher for the current project to use as a basis for the project renewal.

A discussion to list ideas for the project renewal then proceeded. Some of the ideas to be included in the new project involved building on current and past project work and included an added objective on:

1. Soil health – quality (implied)
2. C threshold levels that impact soil quality and function.

3. Relationships between soil C and crop yield
4. Indicator between soil C fraction and C sequestration
5. Cover crops/other crops in system to improve sustainability
6. Land use change
7. How much C needed to maintain soil C status quo
8. Develop a definitive statement about input levels required for soil C status quo.

State reports by Ohio, Iowa, Michigan, Illinois and Wisconsin followed.

At 2:30 P.M., the meeting closed for the day and the group toured the BioCentury Fuels Farm and ISU research plots and facilities till 6:30 P. M.

Thursday, June 14, 2012

The meeting resumed at 8:00 on June 14, 2012 in the Agronomy Conference Room on the ISU campus. State reports were concluded with reports by North Dakota, Kansas, and Missouri.

New ideas for other research were discussed. Lowery discussed work using lasers for particle size analysis. Speed of analysis, ease of analysis and lower labor costs are advantages of this methodology. Even though the advantages outweigh the disadvantages, soil scientists have been reluctant to accept this as a standard method.

Miles lead a discussion on using active C methods for evaluating soil health. Missouri is undertaking a large study in resolving issues with sampling times, sample handling, method modifications and interpretations.

The meeting was adjourned at 11:40 AM by Al-Kaisi

Accomplishments/Outcomes:

Over a 4-year period, no-till generally resulted in the highest SOC levels on severely eroded soils in Guam. Soil organic C was found to be generally higher at depth below 10 cm under all tillage systems with the greatest SOC found in the 20 to 30 cm depth for no-till, reduced tillage, and conventional tillage with a SunnHemp green manure/cover crop. This indicated very high C mineralization at the soil surface but C accumulation at deeper soil depth due to the warm moist tropical climate. (GU)

Studies on long term tillage plots showed that cover crops on these plots did not affect corn plant populations or yields over a 4-year period. Likewise, with the exception of 1-year (2006), soybean plant populations and yield were not affected, either. (IL)

After two years of corn residue removal in poorly and well-drained soil sites, there were no significant decreases in grain yield. In general, removing residue increased grain yields due to soil warming under cold and wet conditions early in the spring. In addition, there were no significant decreases in total soil organic carbon (SOC) concentrations compared to baseline year. However, potential decreases in SOC sequestration were observed when residue was removed. In the poorly drained soil site, approximately 44% of corn residue can be removed without seeing a net loss in potential SOC sequestration. In the well-drained site, only approximately 22% of the residue can be removed without having a net loss in potential SOC sequestration. Significant short term effects of residue removal on soil physical properties were observed. Increases of bulk density were observed with 100% residue removal regardless of tillage and increased N fertilization rate. (IA)

Initial results from this study indicate that stover removal for expanded uses can affect soil properties and erosion potential. It appears that negative impacts of stover removal on soil moisture, aggregate stability, and erosion tend to significantly increase at removal rates >25%. Time to runoff initiation and runoff amount were affected by stover removal because a) more of the soil surface was directly exposed to raindrop impact, causing soil particle dispersion and surface crust formation after dry runs, and b) less stover was available to intercept water flow and cause ponding on the soil surface. (KS)

Studies evaluating effects of 1) Bt trait on corn stover and cob ethanol yield, 2) environment (location) on corn stover and cob ethanol yield, and, 3) hybrid differences on corn stover and cob ethanol yield were conducted in 2010 and 2011. Composition analysis showed that there is not much variability between the glucan and xylan concentrations of Bt corn and the non-Bt corn isolines. Percent glucan levels were almost the same in both 2010 and 2011 years. Glucan conversion rate did not vary much between the Bt and non Bt isolines. (MI)

Historical evaluation of the Sanborn Field plots indicate that after long-term crop residue removal (1888-1950), return of residues beginning in 1950 required 30-40 years for SOC to be restored to levels occurring in the late 1880's to early 1900's levels with large fertilizer or manure-amendment inputs. High levels of inputs appear to result in increased SOC levels in the upper argillic horizons of the soil profile. Active C levels are being monitored to characterize effects of management inputs on soil C and soil health in conjunction with the Missouri Soil Health (MOSOHEAL) Program. (MO)

Evaluation of C:N ratios in crop residues is being used to develop guidelines for N fertilizer applications in cropping systems having rotations of two, three, four or six crops. (ND)

Removal of crop residues resulted in reduced grain and stover yields in subsequent crops at two out of three locations while soil bulk density was affected at one out of three locations when crop residues were removed. Complete crop residue removal from no-till plots subjected to simulated rainfall appeared to negate the beneficial effects of the no-till and gave runoff values similar to intensively tilled plots. (OH)

Movement of topsoil from areas of accumulation (lower slope) to areas of topsoil depletion (upper slope) increased yields 10-20 % at one location and 25-50 % at a second location. Yield increases gave increased economic returns which would allow pay-back of costs of soil movement within 7-8 years. (SD)
High corn plant density with standard row spacing resulted in lower runoff volume than standard plant density with standard row spacing at two levels of corn residue removal. However, significant differences between treatments have not yet been observed. (WI)

Impact Statements:

1. Crop residue removal can affect maintenance of SOC at some locations.
2. Crop residue removal affects maintenance of soil aggregate stability.
3. Under certain conditions, crop residue removal can influence soil bulk density.
4. Removal of crop residues may negate the beneficial effects of no-till on soils.
5. Redistribution of erosion sediments can economically improve soil productivity.
6. Management of crops, crop residues, and tillage may be influencing SOC distribution in the soil profile.

Publications:

Gao, J., L. Qian, K. D. Thelen, X. Hao, L. Costa Sousa, M. W. Lau, V. Balan, and B. E. Dale. 2011. Corn harvest strategies for combined starch and cellulosic bioprocessing to ethanol. Agronomy Journal. 103 (3): 844-850.

Golosov, V. N**,** A. N. Gennadiyev, K. R. Olson, M. V. Markelov, A. P. Zhidkin, Yu. G. Chendev, and R. G. Kovach. 2011. Spatial and temporal features of soil erosion in the forest-steppe zone of the East-European Plain. Eurasian Soil Science 44 (7):794-801.

Guzman, J., and M. Al-Kaisi. 2011. Reconstructed prairies age and landscape position effect on selected soil properties in south central Iowa. Soil and Water Cons. J. 66 (3): 183-191.

Guzman, J., and M. Al-Kaisi. 2010. Landscape position and age of reconstructed prairies effect on soil organic carbon sequestration rate and aggregate associated carbon. Soil and Water Cons. J. 65:9-21.

Guzman, J., and M. Al-Kaisi. 2010. Evaluation of soil carbon budget of newly reconstructed tall-grass prairies in south central Iowa. J. Environ. Qual. 39:136-146.

Olson, K.R., A.N. Gennadiyev, A.P. Zhidkin and M.V. Markelov. 2011. Impact of land use change and soil erosion in Upper Mississippi River Valley on soil organic carbon retention and greenhouse gas emissions. Soil Science. 176 (9): 449-458.

Stiles, C.A., Hammer, R.D., Ferguson, R., Johnson, M.G., Galbraith, J., O'Geen, T., Arriage, J., Shaw, J., Falen, A., Miles, R., and McDaniel, P. 2011. Validation testing of a portable kit for measuring an active soil carbon fraction. Soil Sci. Soc. Am. J. 75:2330-2340.

Zhou, X., M. Al-Kaisi, and M. Helmers. 2009. Cost effectiveness of conservation practices in controlling water erosion in Iowa. Soil & Tillage Res. J. 106:71-87.

Zhou, X., M. Helmers, M. Al-Kaisi, and M. Hanna. 2009. Cost-benefit analysis of conservation management practices for sediment reduction in an Iowa agricultural watershed. *Soil and Water Cons. J.* 64: 314-323.

NC-1178 (Impacts of Crop Residue Removal for Biofuel on Soils) Annual Meeting Minutes

Iowa State University

Ames, IA

June 13-14, 2012

Chair:

Mahdi Al-Kaisi

Iowa State University

Secretary:

Larry Cihacek

North Dakota State University

Secretary-Elect:

DeAnn Presley

Kansas State University

Members in Attendance:

Mahdi Al-Kaisi, IA

Francisco Arriaga, WI(Incoming)

Larry Cihacek, ND

Mohammad Golabi, GU

Rattal Lal, OH

Birl Lowrey, WI(Outgoing)

Randy Miles, MO

Kenneth Olson, IL

DeAnn Presley, KS

Kurt Thelen, MI

Members Absent:

Thomas Schumacher, SD

Diane Stott, USDA-ARS

Dan Walters, NE (Deceased)

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Jose Guzman, IA

David Kwaw-Mensah, IA

Victoria Scott, IA

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Evaluating conservation practices for agricultural sustainability and their effect on soil carbon content of degraded soils in southern Guam

Mohammad H. Golabi*, University of Guam

THE ISSUE: Among the major sources of carbon dioxide; ONE is the uncontrolled production and emission of industrial (including automobiles) related carbon dioxide into the atmosphere. In addition to carbon dioxide emitted from burning fossil fuel, there is a silent source that is less talked about, the SOIL. Soil is a very dynamic component of the environment with millions and billions of microbes living in it at any time where they produces humongous amount of carbon dioxide that can be emitted into the atmosphere as the soil is disturbed. Consequently, the impact of soil disturbances and soil degradation on climate warming and environmental deterioration has not being realized by the public. As soils degrade and desertify, as the climate warms and species disappear, and as the environment deteriorates and alters the components of the ecosystems, it will be realized that taking soils and its behavior for granted is actually the main cause of the downward spiral environmental degradation with respect to the climate change and global warming (Lal, 2011).

As burning of fossil fuels continues to pump carbon dioxide into the atmosphere, scientists are investigating ways to support soil-plant ecosystems in carbon uptake and sequestration. The Kyoto Protocol on climate change has prompted great interest in conservation tillage as a management strategy to help sequester CO_2 from the atmosphere into soil organic matter (Franzluebbers and Steiner, 2002). Ongoing research on carbon sequestration is among the priority lists for federal and state agencies and universities around the country. Carbon content and sequestration is therefore one the focuses of this study and soil carbon storage will be evaluated and reported under different tillage practices being evaluated in this project. In this study, we are specifically investigating the impact of long-term conservation and residue management based cropping systems on Soil Organic Carbon (SOC) levels and soil carbon sequestration on the tropical soil conditions of Guam in the western Pacific.

The carbon dioxide content of the soil is related to the overall soil microbial activities and plant uptake. However, once soil is disturbed by intensive tillage or other practices, the carbon dioxide is released into the atmosphere. When combined with added CO_2 released from fossil fuels and other sources of carbon dioxide emission, it exacerbates the problem of high rates of CO_2 in the atmosphere. On the other hand, it is believed that conservation practices, especially no-tillage farming restore SOC and have the added benefit of controlling erosion. Furthermore, the accelerated soil erosion threatens both the soil resource base devoted for farming and downstream environment. The challenge facing soil and agricultural scientists is therefore to develop practical strategies for agricultural productivity while restoring soil organic carbon in tropical agro-ecosystems and at the same time arresting ongoing water erosion in degraded areas of southern Guam. This study specifically examines conservation and restoration strategies that address crop production needs within a framework of increasing environmental and financial constraints of the island's farmers and ranchers. In addition to the erosion control effect of the conservation practices, the Kyoto Protocol on climate change has prompted great interest in conservation tillage as a management strategy to help sequester CO_2 to the atmosphere from the soil microbial activities. Therefore the specific objectives of this study were to: 1) Evaluate residue management and long-term conservation (i.e., no-till and reduced-till, crop rotation) based cropping systems on soil carbon sequestration on tropical soil conditions of the western pacific, also 2) Arrest ongoing water erosion in degraded areas of southern Guam and develop practical strategies for agricultural productivity while restoring soil organic carbon to these tropical agro-ecosystems.

WHAT HAS BEEN DONE: An integrated approach is designed to evaluate the effect of conservation tillage, crop rotation with leguminous crops also as green manure for organic matter build up. The residue management for soil conservation will be evaluated for re-habilitation and restoration and for enhancement and maintenance of soil productivity and quality. In order to evaluate the re-generating of soil surface that is degraded by erosion the following regimes are being practiced:

a) No-Till (NT) or zero tillage

b) Reduced tillage (RT)

c) Conventional Tillage (CT)
d) Conventional Tillage with rotation to leguminous SunnHemp (CT/SH)

These regimes represent a wide range of practices that are being evaluated as conservation and restoration techniques.

RESULTS AND DISCUSSIONS: As shown in figure1, through figure 5, the percent carbon content of the soil is generally higher in the No-Till (NT) than any other treatments throughout the experimental period since 2007. This was due to zero disturbances to the soil surface on this particular treatment during the study period. From the Reduced Till (RT) plots the percent carbon content also remained high next to the No-Till plots, mainly due to the reduced disturbance as compared to Conventional Tillage (CT) treatment plots. Also as shown in the figure 1., the percent carbon content in the CT plots are the lowest for all sampling events while the Conventional Tilled with Sunnhemp (CT/SH) rotation had higher carbon mainly due to the green manure effect that added organic matter as well as carbon to soil as the result of sunnhemp biomass production and incorporation of its biomass into the plow layer after the harvest and before the next crop production. As shown in figure 1, same trend was observed during the years of 2007, 2008 and 2009 sampling events where the NT and RT showing the highest amount of carbon content among the other treatments under study.

As explained earlier the tillage systems affect the amount of soil carbon content and hence carbon sequestration in these degraded soils of southern Guam. Furthermore, the soil organic matter as well as soil organic carbon, soil erosion, and soil water supply are all affected by tillage systems (dada not shown in this report).

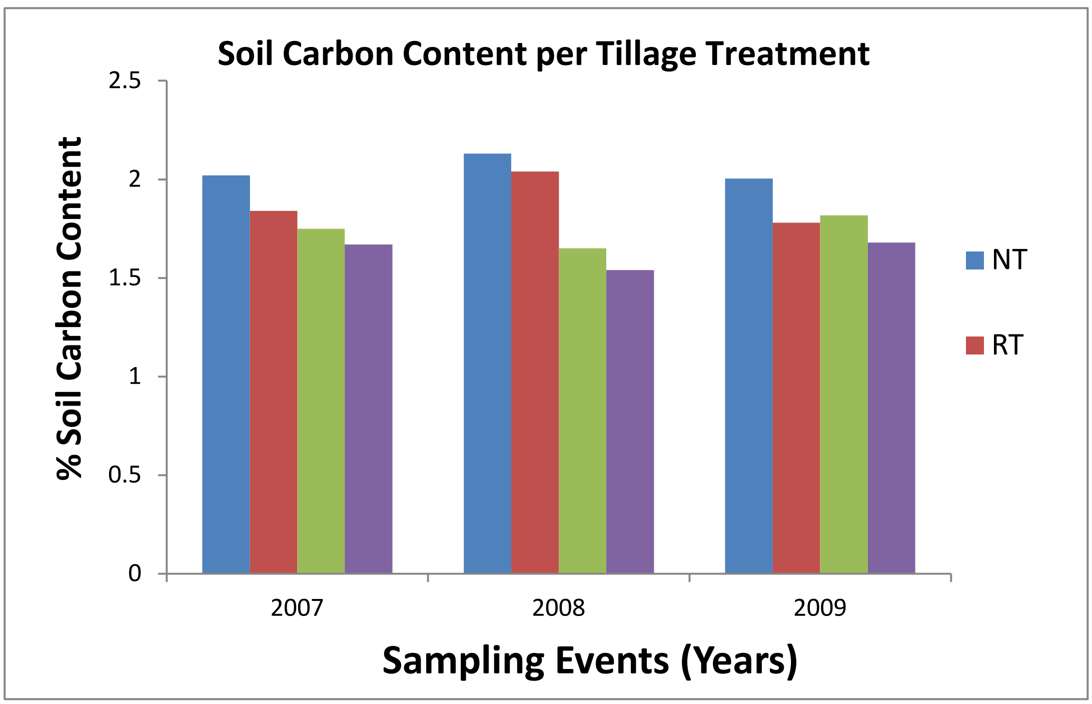

Figure 1: Showing soil carbon content for the soils under different tillage treatments for the years of 2007 through 2009 study period.

Starting in 2010 sampling was performed at different depth for carbon content evaluation as well as nitrogen content for the soils under study (Fig 2-5).

As shown in Figure 2 through Figure 5, same trends were observed in 2010 as was observed in 2007 through 2009 sampling events where, the NT and RT showed the highest amount of carbon content as compared with the other treatments under study. Also as shown in the figure 4., the percent carbon content in the conventional tilled (CT) plots are the lowest for all sampling events while the conventional tilled with sunnhemp (CT/SH) rotation had higher carbon than CT mainly due to the green manure effect as the result of sunnhemp biomass production and its incorporation into the soil following the harvest and before the next crop.

As shown in Figure 2, the carbon content of the soil is considerably higher in the lower depths regardless of the treatment however; the overall carbon content of the soil under CT is generally lower due to continuous disturbances of the soil surface and within the tillage depth. Furthermore the data illustrates that the carbon content of the soil near the surface is less than % 1.5 for all treatment regardless of the tillage practices. This could be due to the fact that the carbon sequestration potential of the soil is inadequate near the soil surface. On the other hand, the carbon content of the soil is higher at depth below the 8 inch indicating possibility of carbon release in the form of carbon dioxide or any other forms of carbon compound is relatively low in lower depth, due to the less disturbances and more stability condition at the deeper soil matrix.

Although the data was not available on time before finalizing this report, similar trends are expected for soil carbon content of the 2011/2012 data.

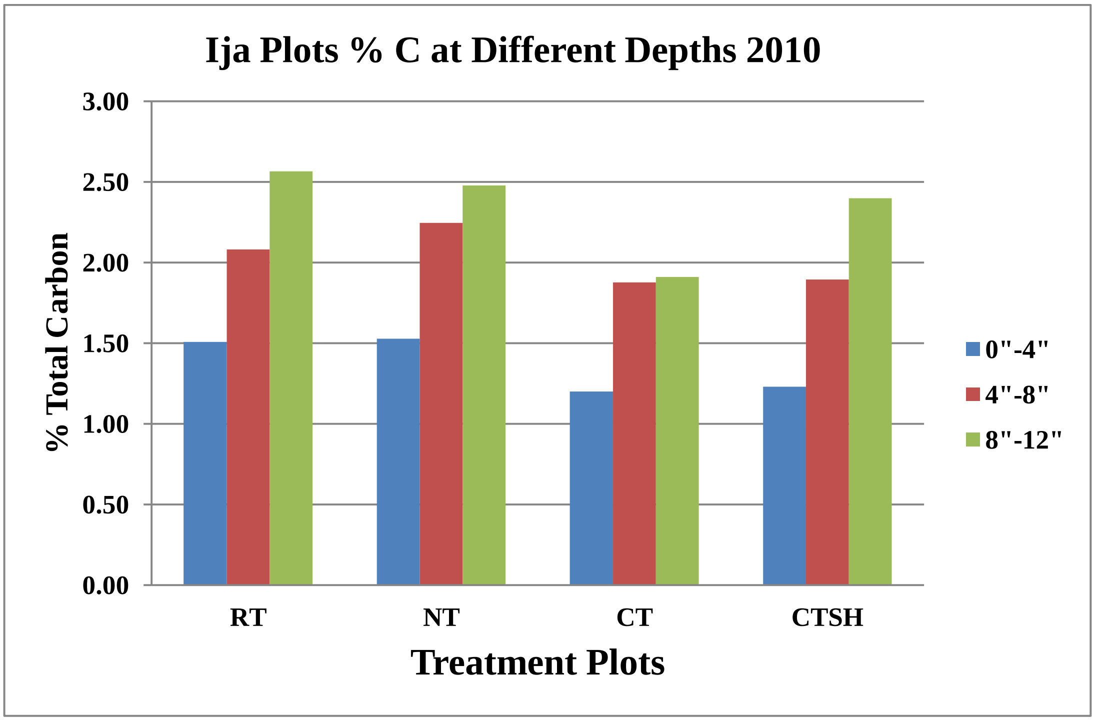

Figure: 2. Showing percent soil carbon content for different dept under different treatment for the year of 2010

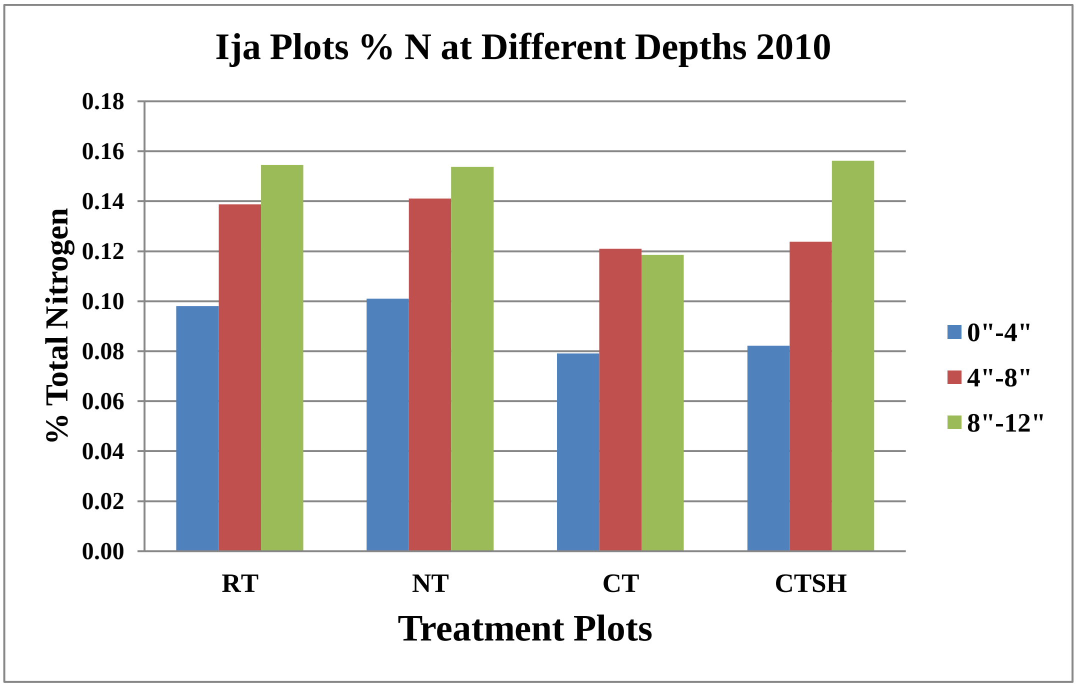

Figure 3. Showing percent soil nitrogen content for different dept under different treatment for the year of 2010

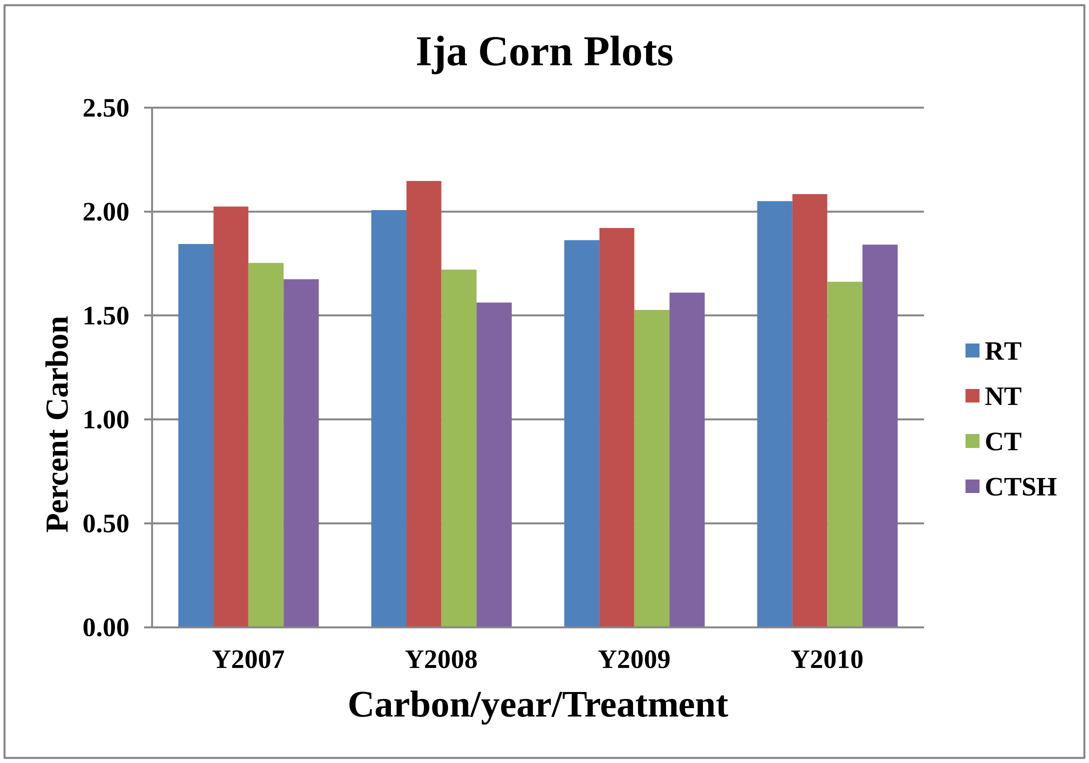

Figure 4. Showing percent soil carbon content for all years till 2010

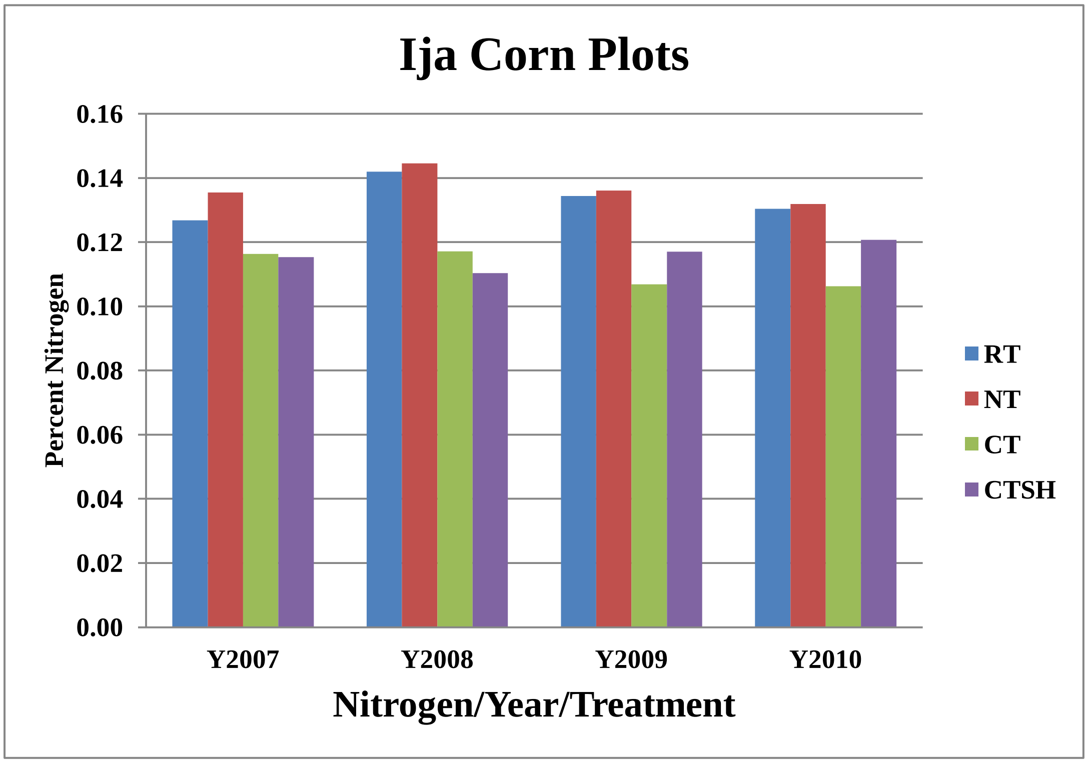

Figure 5. Showing percent soil Nitrogen content for all years till 2010

CONCLUSION:

It was shown that the higher percent carbon content of the soil under the no-tillage (NT) was due to no disturbances to the soil surface during the study period. On the reduced till (RT) plots the percent carbon content also remained high next to the no-till plots mainly due to the reduced disturbances as compared to conventional tillage (CT) practices. On the other hand, it was shown that the percent carbon content in the conventional tilled (CT) plots were the lowest for all sampling events while the conventional tilled with sunnhemp (CT/SH) rotation had higher carbon mainly due to the green manure effect that added organic matter as well as carbon to soil as the result of sunnhemp biomass production as rotating crop and its incorporation into the soil before the main crop. Same trend have been observed in the 2008, 2009, 2010, and 2011 treatment plots with NT showing the highest amount of carbon content compared to the other treatments under study. The soil organic matter as well as soil organic carbon, soil erosion, and soil water supply are all affected by tillage systems (data not shown). It can be concluded that tillage systems, affect the amount of soil carbon content hence the soil carbon sequestration consequently the carbon dioxide emission into the atmosphere.

Also, as indicated, the carbon content of the soil was considerably higher in the lower depths regardless of the tillage treatment however; the overall carbon content of the soil under CT is generally lower due to continuous disturbances of the soil surface and within the tillage depth. Furthermore the data illustrates that the carbon content of the soil near the surface is less than % 1.5 for all treatment regardless of the tillage practices. This could be due to the fact that the carbon sequestration potential of the soil is inadequate near the soil surface. On the other hand, the carbon content of the soil is higher at depths below the 8 inch indicating possibility of carbon release in the form of carbon dioxide or any other forms of carbon compound is relatively low in lower depths, due to the less disturbances and more stability condition at the deeper soil matrix.

THE IMPACT: The results of this ongoing experiment will contribute to the overall scientific efforts in understanding the role of agriculture in sequestration of carbon in soils, and the ways in which less disturbing farming practices such as zero tillage may reduce carbon dioxide emission into the atmosphere. It also provides information pertaining to the local conditions of Guam's tropical climate as relates to carbon sequestration or carbon loss in the form of carbon dioxide emitted into the atmosphere following each disturbances that occur during the tilling process.

References

Franzluebbers A.J., and J.L. Steiner. 2002. Climate Influences on Soil Organic Carbon Storage with No Tillage. *In:* Kimble, J.M., R. Lal, and R.F. Follett (editors), Agricultural Practices and Policies for Carbon Sequestration in Soils. Lewis Publishers. Boca Raton, London, New York, Washington, D.C. pp; 71-86

Golabi Mohammad H., Samir A. El-Swaify, and Clancy Iyekar. 2008. Evaluating the soil carbon dynamics under cropping rotations and conservation tillage management on severely eroded soils of southern Guam. Annual report presented before the NC1017 Multi-State Regional Project Representative. St Louis, MS. mgolabi@uguam.uog.edu

Golabi, Mohammad, H. 2008. Soil Management and Global Warming: An Impact Report - Research for Guam's Future. Annual report for the Western Pacific Tropical Research Center, College of Natural and Applied Sciences, University of Guam. mgolabi@uguam.uog.edu

Lal, R. 2011. Residue Removal for Biofuel and Soil Quality (exerts). Soil Carbon Sequestration Conference, University of Guam, Mangilao, Guam, August 3-5, 2011.

2012 Illinois Report - NC-1178

K. R. Olson

In 2001, an existing 13- year corn-soybean rotation (phase 1) under 3 treatments (no-till, chisel plow (conservation tillage), and moldboard plow) previously established on a backslope with an average slope of 6%. The 18 plots (3 treatments with 6 replications) were split with half of each plot planted with a rye cover crop in fall of 2001, 2003, 2005, 2007, 2009 and 2011 and a vetch cover crop in fall of 2002, 2004, 2006, 2008 and 2010 (phase 2). The soybean plant populations and yields for each tillage treatment with and without cover crops are provided in Tables 1 and 2. Cover crops did not affect the 4 year soybean plant populations or yields of the tillage treatments; however the 2006 CP with cover treatment had significantly lower soybean yield. The corn plant populations (Table 3) and yields (Table 4) were not affected by tillage treatment with and without a cover crop.

Tillage accelerates the erosion of sloping lands and decreases soil productivity. Surface crop residue levels were significantly higher in the NT system compared to CP and MP systems, which provided better protection against water erosion. The annual estimated soil loss during the 18-year period was 8.0(3.5), 22.1(9.7), and 30.0(13.2) Mg/ha (tons/ac) in NT, CP and MP systems, respectively.

In the fall of 2009, the third phase of this tillage experiment will be initiated. The year 2009 was a corn year and after harvest last fall the corn stover will be removed from 3 replications of each tillage and cover crop treatment. The stover was also removed in 2011. The other three replications of each tillage and cover crop treatment was left with the residue. Starting in 2010, the soybean plant population and yields are provided in Tables 5 and 6.

Refereed journal articles:

Golosov, V.N**,** Gennadiyev, A.N., K.R. Olson,M.V. Markelov, A. P. Zhidkin, Yu. G. Chendev, and R. G. Kovach. 2011. Spatial and temporal features of soil erosion in the forest-steppe zone of the East-European Plain. Eurasian Soil Science 44 (7):794-801.

Olson, K.R., M. Reed and L W. Morton. 2011. Multifunctional Mississippi River leveed bottomlands and settling basins: Sny Island Levee Drainage District. J of Soil and Water Conservation 66 (4) :104A-110A.

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Olson, K.R. and L W. Morton. 2012. The impacts of 2011 man-induced levee breaches on agricultural lands of the Mississippi River Valley J. Soil Water Conservation.67 (1):5A-10A.

Olson, K.R. and L. W. Morton. 2012. The effects of 2011 Ohio and Mississippi River Valley flooding on Cairo, Illinois area. J. Soil Water Conservation. 67 (2): 42A-46A.

Table 1. Soybean Population of Tillage Plots with and without Cover Crops at Dixon Springs, Illinois (metric)

Year	2002	2004	2006	2008	2010	5-year averages
			Soybean			
		X 1000Pts/ha				
<u>Treatment with cover crops</u>						
NT	298a+	253a	330a	270a	225a	275a

CP	380a	233a	400a	398a	226a	327a
MP	403a	245a	415a	333a	255a	330a
Treatment without cover crops						
NT	293a	240a	320a	310a	235a	280a
CP	393a	228a	363a	390a	236a	322a
MP	420a	255a	388a	360a	238a	332a

+Values with and without cover crops in the same tillage treatment and year followed by the same letter are not significantly different at the 0.05 probability level.

Table 2. Soybean Yield of Tillage Plots with and without Cover Crops at Dixon Springs, Illinois (metric)

Year	2002	2004	2006	2008	2010	5-yr average
				Soybean		
			Mg/ha			
Treatment with cover crops						

NT	2.24a+	0a	2.90a	3.10a	2.94a	2.24a
CP	1.78a	0a	2.84a	2.90a	2.79a	2.06a
MP	1.98a	0a	3.30a	3.04a	2.88a	2.24a
Treatment without cover crops						
NT	2.37a	0a	3.17a	2.84a	2.85a	2.26a
CP	2.07a	0a	3.37b	2.84a	2.53a	2.16a
MP	1.98a	0a	3.10a	3.04a	2.75a	2.17a

+Values with and without cover crop in the same tillage treatment and year followed by the same letter are not significantly different at the 0.05 probability level.

Table 3. Corn Population of Tillage Plots with and without Cover Crops at Dixon Springs, Illinois (metric)

Year	2003*	2005	2007	2009	2011	5-yr average
			Corn			
		X 1000Pts/ha				
Treatment with cover crops						
NT	61.0a+	72.0a	66.3a	68.6a	78.7a	69.3a
CP	60.0a	76.5a	67.5a	65.8a	75.0a	69.0a
MP	61.0a	68.5a	66.0a	67.6a	65.7b	65.8a
Treatment without cover crops						
NT	59.5a	70.5a	68.8a	65.0a	75.7a	67.0a
CP	61.3a	76.0a	68.5a	65.5a	67.7b	67.7a
MP	60.0a	69.5a	68.3a	64.0a	61.3c	65.5a

+Values with and without cover crops in the same tillage treatment and year followed by the same letter are not significantly different at the 0.05 probability level.

* The corn was replanted 3 times with the last 2 row being close. All of the plots had to be thinned to 60,000 pt/ha to get the crop year in.

Table 4. Corn Yield of Tillage Plots with and without cover crops at Dixon Springs, Illinois (metric)

Year	2003	2005	2007	2009	2011	5-year average
			Corn Yields			
			Mg/ha			
Treatment with cover crops						
NT	6.86a+	11.4a	6.20a	12.3a	6.10a	8.57a
CP	7.13a	11.6a	6.73a	12.6a	7.03b	9.02ab
MP	8.45a	12.0a	6.73a	14.0b	6.49ab	9.53b
Treatment without cover crops						
NT	6.67a	11.4a	6.46a	13.1a	6.13a	8.75a
CP	7.33a	11.8a	6.80a	13.6a	6.85a	9.28ab
MP	7.72a	11.4a	7.33a	14.0a	7.68b	9.63b

+Values with and without cover crop in the same tillage treatment and year followed by the same letter are not significantly different at the 0.05 probability level.

Table 5. Soybean and Corn Plant Population of Tillage Plots with and without Cover Crops and with and without Corn Residue Removal at Dixon Springs, Illinois (metric)

Year	2010	2011
	Soybean	Corn
	X 1000 pts/ha	
Treatment with cover crops and without residue removal		
NT	225a	74a
CP	226a	73a
MP	255a	60b
Treatment with cover crops and with residue removal		
NT	227a	81a
CP	231a	76ab
MP	263a	68b
Treatment without cover crops and without residue removal		
NT	235a	76a
CP	236a	78a
MP	238a	70a
Treatment without cover crops and with residue removal		
NT	237a	76a

CP	241a	66b
MP	235a	71ab

+Values with and without residue removal in the same tillage treatment and with cover crop or the same tillage treatment and without cover crop and in the same year followed by the same letter are not significantly different at the 0.05 probability level.

Table 6. Soybean and Corn Yield of Tillage Plots with and without Cover Crops and with and without Corn Residue Removal at Dixon Springs, Illinois (metric)

Year	2010	2011
	Soybean	Corn
	Mg/ha	
Treatment with cover crops and without residue removal		
NT	2.94a	6.65a
CP	2.79a	6.17a
MP	2.88a	5.91a
Treatment with cover crops and with residue removal		
NT	2.38b	5.64a
CP	2.53a	7.66b
MP	2.96a	7.10b
Treatment without cover crops and without residue removal		
NT	2.85a	6.70a
CP	2.53a	5.84c
MP	2.75b	7.70b
Treatment without cover crops and with residue removal		
NT	2.70a	5.63a

CP	2.67a	7.24b
MP	2.18a	7.00b

+Values with and without cover crop in the same tillage treatment and year followed by the same letter are not significantly different at the 0.05 probability level.

NC-1178 2012 Iowa State Report

Corn Residue Management Effects on Soil Carbon Dynamics and Greenhouse Gas Emissions

Mahdi Al-Kaisi and Jose Guzman

Department of Agronomy, Iowa State University

Study Description

The objective of this project is to establish coordinated field studies to determine the short-term and long-term impacts of different corn residue removal rates, N fertilization rates, and tillage systems on soil, air, and water resources. This study was established in fall of 2008 on the Iowa State University Agronomy Research Farm west of Ames, IA and the Armstrong Research and Demonstration Farm southwest of Atlantic, IA. The main treatment is tillage practice (no-till and chisel plow), which was split into three different corn residue removal rates (0, 50, and 100%), The N rates were the split- split treatments, varying from none to 250 lb N/acre in spring of 2009. Soil measurements were conducted in August and September, which includes soil C, N, P, K, bulk density, water infiltration, residue cover, microbial biomass, and weekly carbon dioxide (CO_2) and nitrous oxide (N_2O) gas field measurements. After harvest, crop measurements will include harvested corn for grain yield, and N, P, and K uptake. Laboratory analyses for various soil and agronomic parameters were conducted such as, soil carbon analysis, plant carbon analysis, nutrients analyses, lab incubation studies, aggregate stability analysis, and data management and analysis.

Accomplishments/Outputs

Annual field days, training workshops, and other educational events were organized in September of 2010 and June 2011 for agricultural professionals and farmers at the Iowa State University Armstrong Research and Demonstration Farm (Southwest Iowa) and at the Agronomy Research Farm in Boone County. Training sessions, PowerPoint presentations, and educational materials were presented during these events. In addition to field days, initial findings of this research were shared with other colleagues and agricultural professionals through newsletter articles, American Society of Agronomy (ASA) annual meetings, presentation at the regional committee meeting, and presentation to extension educators and other agricultural professionals during various events such as the Integrated Crop Management (ICM) conference in Iowa in 2011. The ICM conference is organized annually and approximately 1,000 agricultural professionals attended the conference.

Outcomes/Impacts

After two years of corn residue removal in poorly and well-drained soil sites, there were no significant decreases in grain yield. In general, removing residue increased grain yields due to soil warming under cold and wet conditions early in the spring. In addition, there were no significant decreases in total soil organic carbon (SOC) concentrations compared to baseline year. However, potential decreases in SOC sequestration were observed when residue was removed. The adoption of no-till and increased N rates did reduce some of the carbon (C) losses due to residue removal. However, only with adoption of no-till and nitrogen (N) rates greater than 150 lbs N per acre with very little residue removed, were there potential increases in soil C were observed. In the poorly drained soil site, approximately 44% of corn residue can be removed without seeing a net loss in potential SOC sequestration. In the well-drained site, only approximately 22% of the residue can be removed without having a net loss in potential SOC sequestration. Significant short term effects of residue removal on soil physical properties were observed. Increases of bulk density were observed with 100% residue removal regardless of tillage and increased N fertilization rate. Furthermore, decreases in soil aggregation were observed with residue removal, regardless of tillage and increased N fertilization rate. Subsequently, soil water infiltration rates were significantly reduced in the well-drained soil site. In general, the adoption of no-till over chisel plow and increased rates of N fertilization did offset some of the negative impacts of residue removal, but potential losses of SOC sequestration and deterioration of soil physical properties were still observed.

Publications

Guzman, J., and **M. Al-Kaisi**. 2011. Reconstructed prairies age and landscape position effect on selected soil properties in south central Iowa. *Soil and Water Cons. J*. 66 (3): 183-191.

Guzman, J., and **M. Al-Kaisi**. 2010. Landscape position and age of reconstructed prairies effect on soil organic carbon sequestration rate and aggregate associated carbon. *Soil and Water Cons. J*. 65:9-21.

Guzman, J., and **M. Al-Kaisi**. 2010. Evaluation of soil carbon budget of newly reconstructed tall-grass prairies in south central Iowa. *J. Environ. Qual*. 39:136-146.

Zhou, X., **M. Al-Kaisi**, and M. Helmers. 2009. Cost effectiveness of conservation practices in controlling water erosion in Iowa. *Soil & Tillage Res. J.* 106:71-87.

Zhou, X., M. Helmers, **M. Al-Kaisi**, and M. Hanna. 2009. Cost-benefit analysis of conservation management practices for sediment reduction in an Iowa agricultural watershed. *Soil and Water Cons. J.* 64: 314-323.

External Funding:

This project was supported through funding from the Agronomy Endowment at the Department of Agronomy at Iowa State University from 2008 to present in the amount of **$125,000**. This funding made it possible to support graduate student and other research needs.

2012 Kansas Report - NC-1178

DeAnn R. Presley

Project Title: Sustainability and profitability of residue removal for biofuel use in a water-limited region.

Progress update

The original plot work on two sites located near Moscow, KS concluded in April 2011. These sites were summarized in a M.S. thesis written by Nicholas Ihde and results were presented in the 2011 NC-1178 report. Work continues on three sets of plots with 0, 25, 50, 75, and 100% stover removal levels. This work was recently summarized in a M.S. thesis submitted in December 2011 by Ian Kenney. Therefore, since the work on the original site locations has concluded, I would like to modify my participation in this project to include the sites at Ottawa, Colby, and Hugoton, KS. The results presented below are for this project.

Experimental Procedures

This project was established in spring 2009 across three sites in Kansas located at: 1) KSU-Northwest Research-Extension Center at Colby, 2) a privately-owned producer field at Hugoton, and 3) KSU-East Central Experiment Field at Ottawa. After harvest, stover was removed at rates of 0, 25, 50, 75, and 100% from no-till and strip-till continuous corn plots arranged in a randomized experiment with three replicates.

Soil samples were collected throughout the experiment to determine the impacts of stover removal on aggregate 1stability and soil carbon (C) content. Additionally, soil sensors were installed to monitor changes in soil temperature and moisture as affected by stover removal. Corn was hand-harvested in the fall of 2009 and 2010. Simulated rainfall was applied in spring 2010 at rates of 7.6 cm h^{-1} at Colby and Hugoton and 9.1 cm h^{-1} at Ottawa, representing 5-yr return intervals at each site to determine the impact of stover removal on soil erosion.

Results
Soil Properties

Stover removal rates ≥75% reduced mean weight diameter (MWD) of aggregates at all sites. Stover removal did not affect C pool at Colby and Hugoton, but at Ottawa, 75% stover removal reduced C pool in the top 5 cm by 1.57 Mg ha^{-1}. Stover removal reduced volumetric water content at Colby and Ottawa, and increased soil temperature in summer and reduced temperature in winter.

Grain Yield

While stover removal had no effects on corn yield at Hugoton, it affected at Colby and Ottawa. In 2009, stover removal rates ≥50% increased grain yield at Colby, while rates ≥75% increased grain yield at Ottawa in 2009 and 2010.

Runoff and Erosion

The data obtained from the rainfall simulation study, completed in spring 2010, show that corn stover removal for expanded uses on these soils can have significant short-term (≤ 1yr) effects on runoff and soil erosion. Increases in stover removal rate caused runoff to occur sooner at all locations (Table 1). Removal rates as low as 25% caused runoff to occur over 16 min sooner than 0% removal rate during dry runs at Colby. Stover removal had no effect on runoff except at Colby where removal above 25% increased runoff. Sediment and sediment-associated C loss increased with 100% stover removal at Hugoton, and with 50% removal at Ottawa. Sediment loss also increased with 100% removal at Colby.

Table 1. Effect of stover removal on runoff initiation during dry and wet Runs. Treatments within the same site and run with the same letter are not significantly different according to the least-squares means test at $p \leq 0.05$.

Time to Runoff Initiation (min)							
	Dry Runs				*Wet Runs*		
% Stover Removal	**Colby**	**Hugoton**	**Ottawa**		**Colby**	**Hugoton**	**Ottawa**
0	30.0 a	28.8 a	15.6 a		20.0 a	13.1 ab	6.56 a
25	13.7 b	26.9 a	16.2 a		9.31 ab	19.6 a	5.37 ab
50	10.0 b	25.6 a	16.4 a		8.11 b	11.0 ab	5.08 ab

75	12.7 b	24.3 a	15.3 a		6.98 b	8.83 ab	3.81 b
100	9.15 b	15.0 b	13.6 a		4.38 b	6.47 b	3.73 b

Conclusions

Results from this short-term regional study indicate that stover removal for expanded uses can affect soil properties and erosion potential. Soil aggregate stability, water content, temperature, and erosion by water were rapidly influenced by stover removal. We hypothesize that the effects of stover removal will become more apparent in the long term. Even so, we have observed changes in soil physical properties and erosion potential during the first two years of stover removal. A soil temperature and moisture gradient is apparent between stover removal rates, and the diameter of water stable aggregates decreases with high rates of stover removal. Changes in the soil's susceptibility to erosion due to stover removal seem to be more apparent relative to other soil properties. Based upon the data collected, it appears that negative impacts of stover removal on soil moisture, aggregate stability, and erosion tend to significantly increase at removal rates >25%. Time to runoff initiation and runoff amount were affected by stover removal because a) more of the soil surface was directly exposed to raindrop impact, causing soil particle dispersion and surface crust formation after dry runs, and b) less stover was available to intercept water flow and cause ponding on the soil surface. Both of these situations will decrease the water infiltration capacity of the soil and consequently promote runoff. Losses of both sediment and sediment-associated C can be attributed to concurrent increases in runoff under low stover conditions.

It is our hope that these findings will help producers make informed decisions concerning the management of agricultural land in the future. In particular, decisions concerning the harvesting of crop residues for bioenergy feedstock need to be made with caution. Further dissemination of these results is essential to shed light upon the impacts of crop residue removal on agriculture and the environment.

Publications during reporting period:

Kenney, Ian T. 2011. Regional assessment of short-term impacts of corn stover removal for bioenergy on soil quality and crop production. (Graduated December 2011).

2011-12 Michigan Report - NC-1178

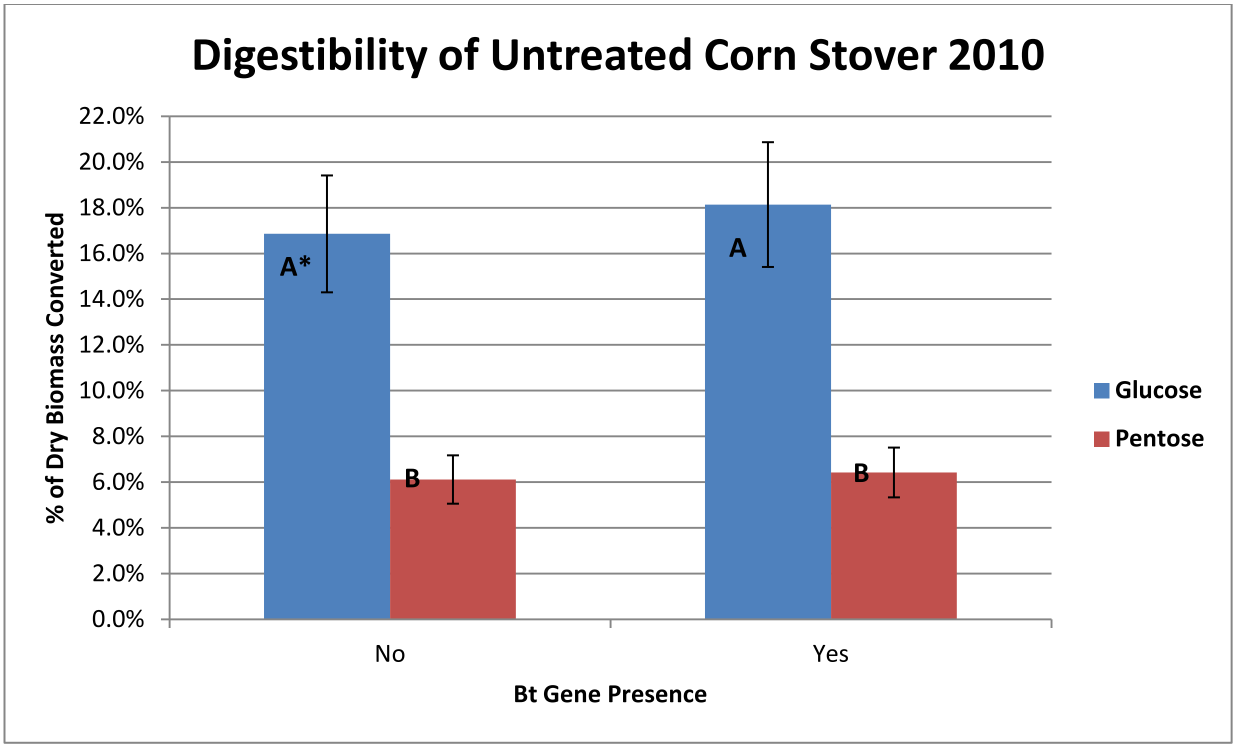
K.D. Thelen

A recent publication from Banerjee et al. 2010, reported differences in corn stover glucose release ranging from 95 to 64%. These significant differences in fermentable glucose levels would likely result in tremendous variability in bio-refinery ethanol yield from corn stover feedstock. Preliminary GLBRC analyses of corn stover (cultivar Pioneer 36H56) showed year to year (2008-2009) variability in ethanol precursors, glucose and free sugars, suggesting a significant environmental effect on stover quality.   Additionally, work published by Saxena and Stotzky (2001) showed that the lignin content, an anti-quality agent for ethanol production, was significantly higher (33-97% higher) for Bt lines compared to their respective non-Bt isoline.

The objectives of this project are 1. Evaluate the effect of the Bt trait on corn stover and cob ethanol yield. 2. Evaluate the effect of environment (location) on corn stover and cob ethanol yield. 3. Evaluate hybrid differences on corn stover and cob ethanol yield.

For the experimental design, 2 hybrid pairs (one Bt and one near-isoline relative) were analyzed giving a total of 4 hybrids. Each hybrid pair were grown at two latitudinal differing locations at the MSU Hybrid trials in four replicated plots at each location. One hybrid pair was grown in Saginaw and Mason Counties (Zones 2 & 3) and the second hybrid pair was grown in Mason and Menominee Counties (Zones 3 & 4). Total samples to process = 2 hybrids x 4 locations x 4 reps = 32 samples. At each location, the entire corn plants were harvested. Corn ears were removed from the plants and the grains were shelled from the cob. Wet and dry weights were recorded from all three fractions for each plot (stover, cob, and grain). This experiment was repeated in the years 2010 and 2011. Samples were ground and were submitted for AFEX pretreatment. Samples will be analyzed for glucose, sugar profile, cellulose, and IVTD. Samples will be fermented and analyzed for ethanol yield.

Composition analysis showed that there is not much variablity between the glucan and xylan concentrations of Bt corn and the non-Bt corn isolines. Percent glucan levels were almost the same in both 2010 and 2011 years. Once again Glucan conversion rate did not vary much in between the Bt and non Bt isolines.


Digestibility of Untreated Corn Stover 2010
22.0%
20.0%
18.0%
16.0%
14.0%
12.0%
10.0%
8.0%
6.0%
4.0%
2.0%
0.0%
% of Dry Biomass Converted
A*
A
B
B
No
Yes
Bt Gene Presence
Glucose
Pentose

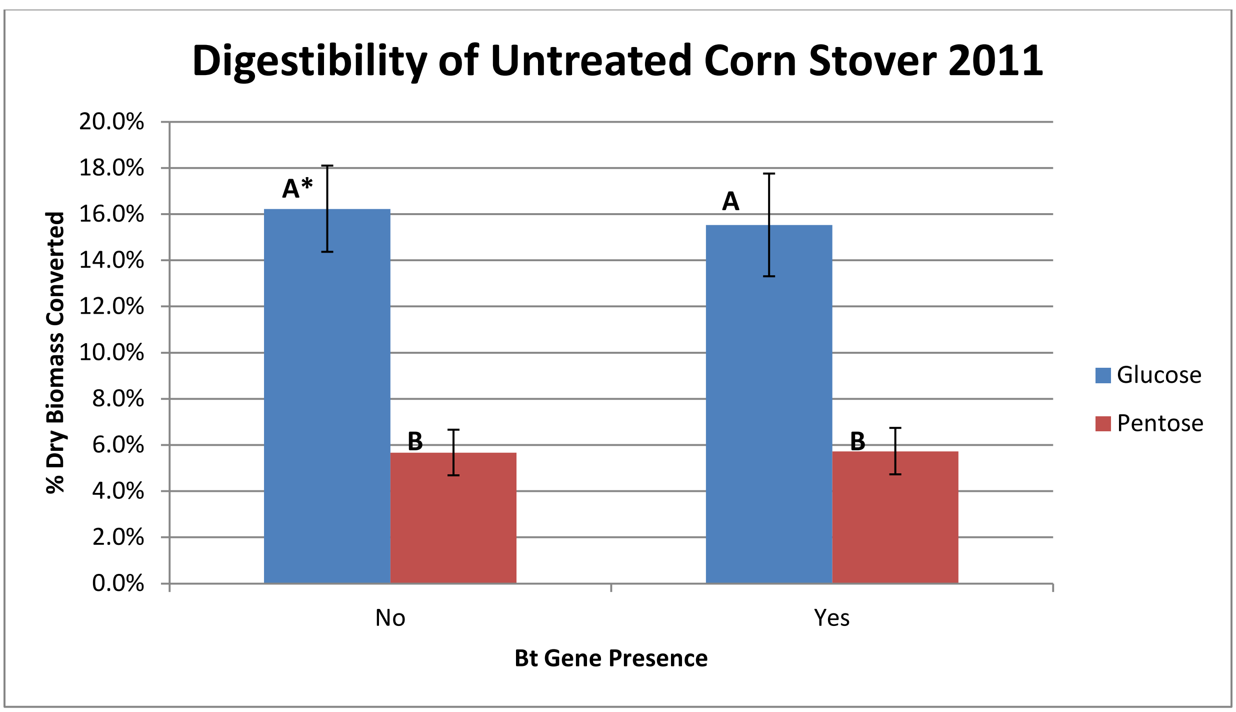
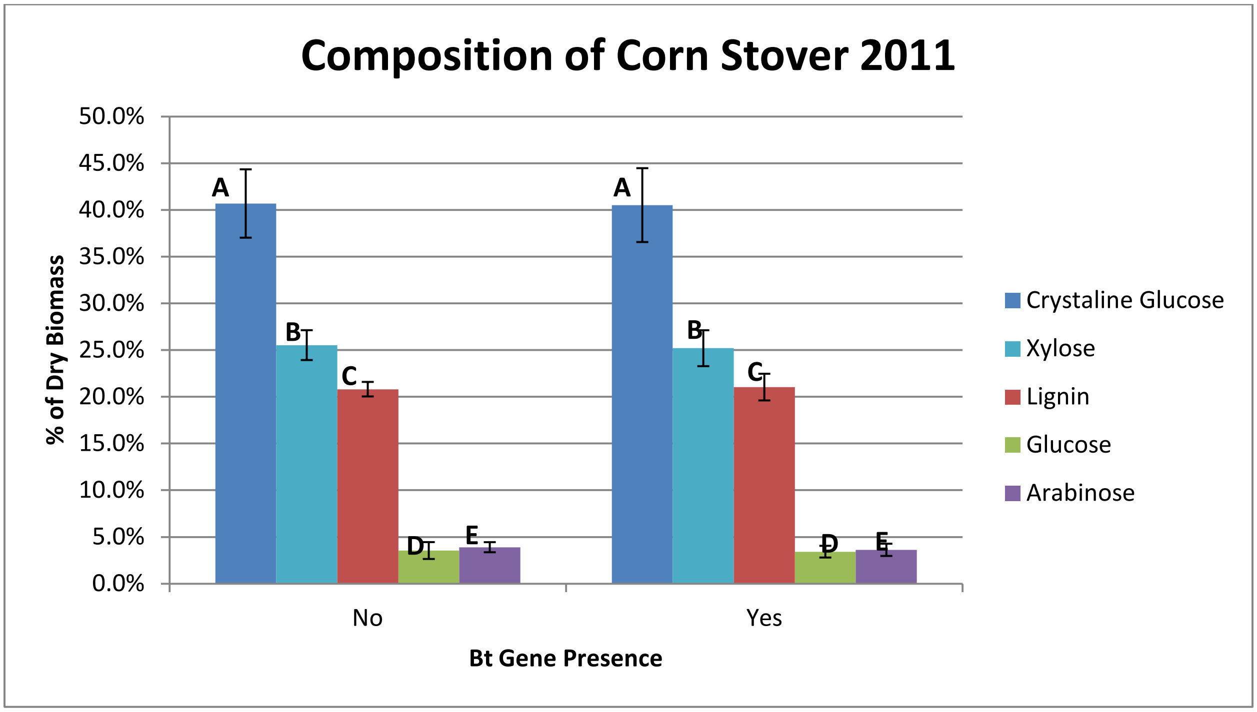

Digestibility of Untreated Corn Stover 2011
20.0%
18.0%
16.0%
14.0%
12.0%
10.0%
8.0%
6.0%
4.0%
2.0%
0.0%
% Dry Biomass Converted
A*
A
B
B
No
Yes
Bt Gene Presence
Glucose
Pentose

Fig. 1 and 2. Comparison of glucose and pentose (% of dry biomass converted) for Bt vs. non Bt corn



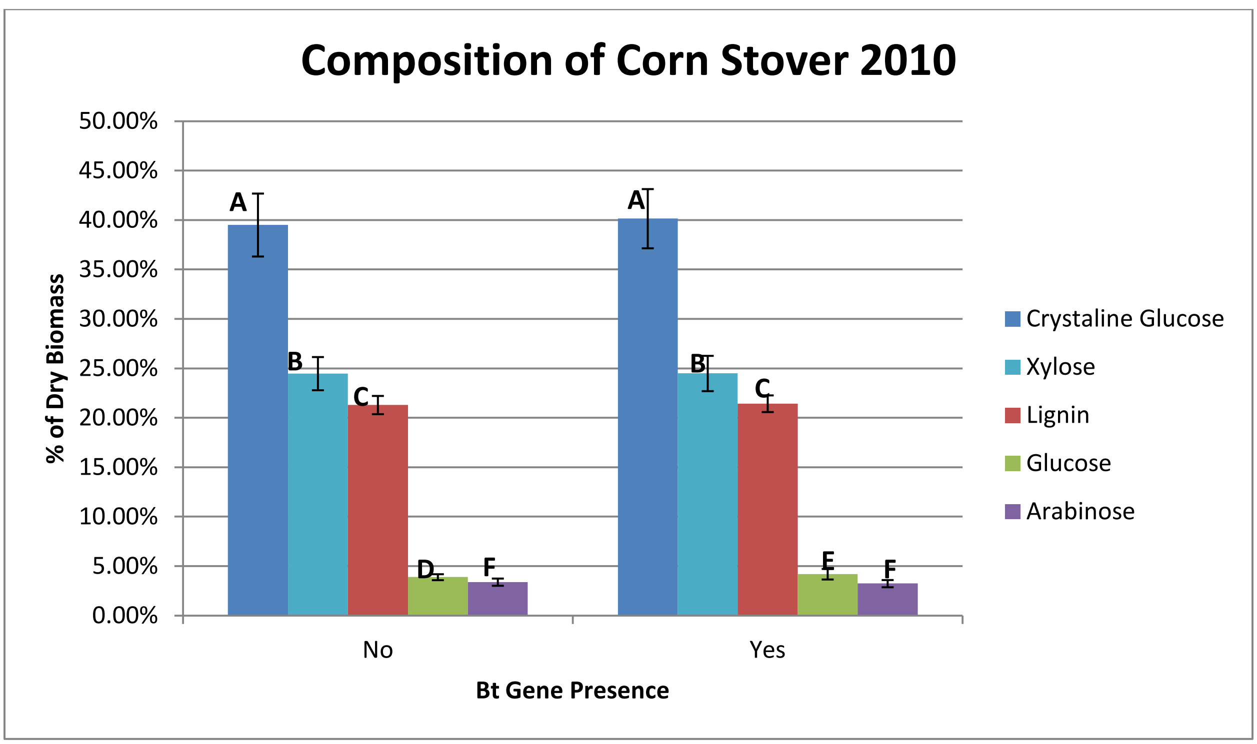
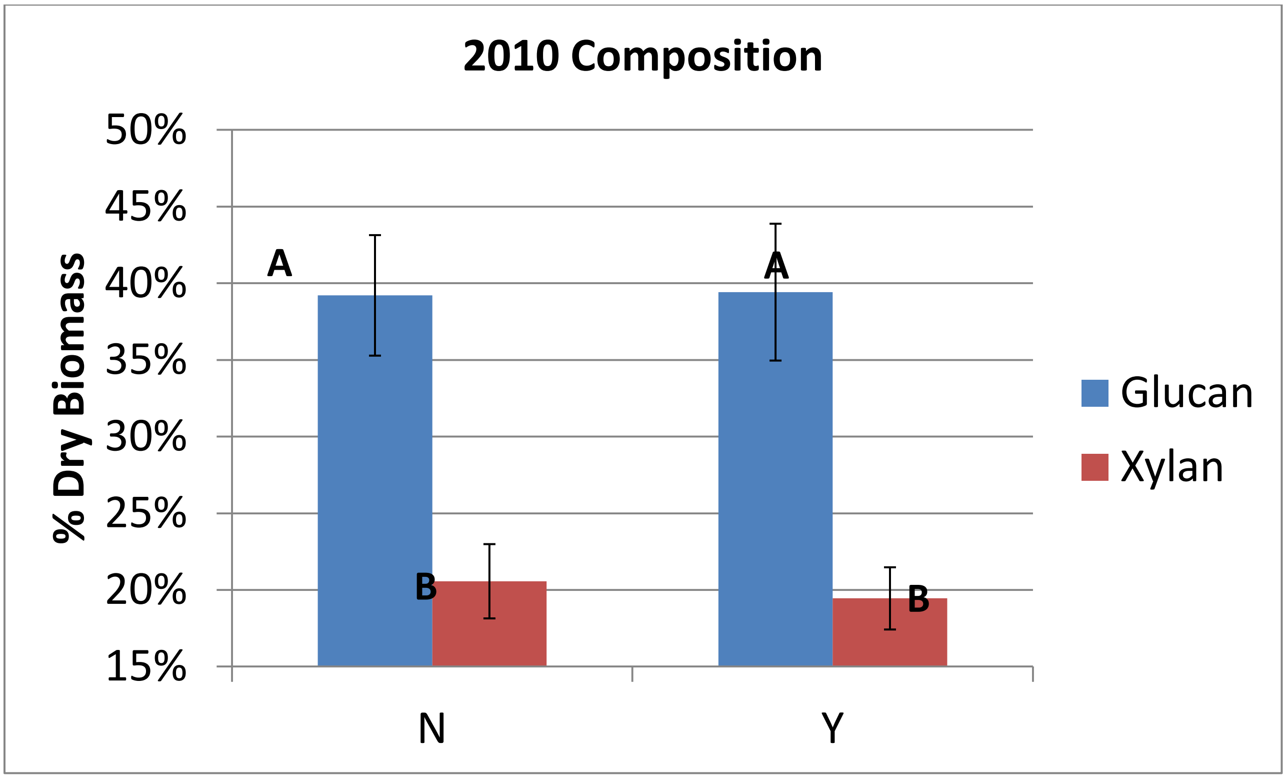


Fig. 3 and 4. Composition analysis of Bt Vs. Non Bt corn.



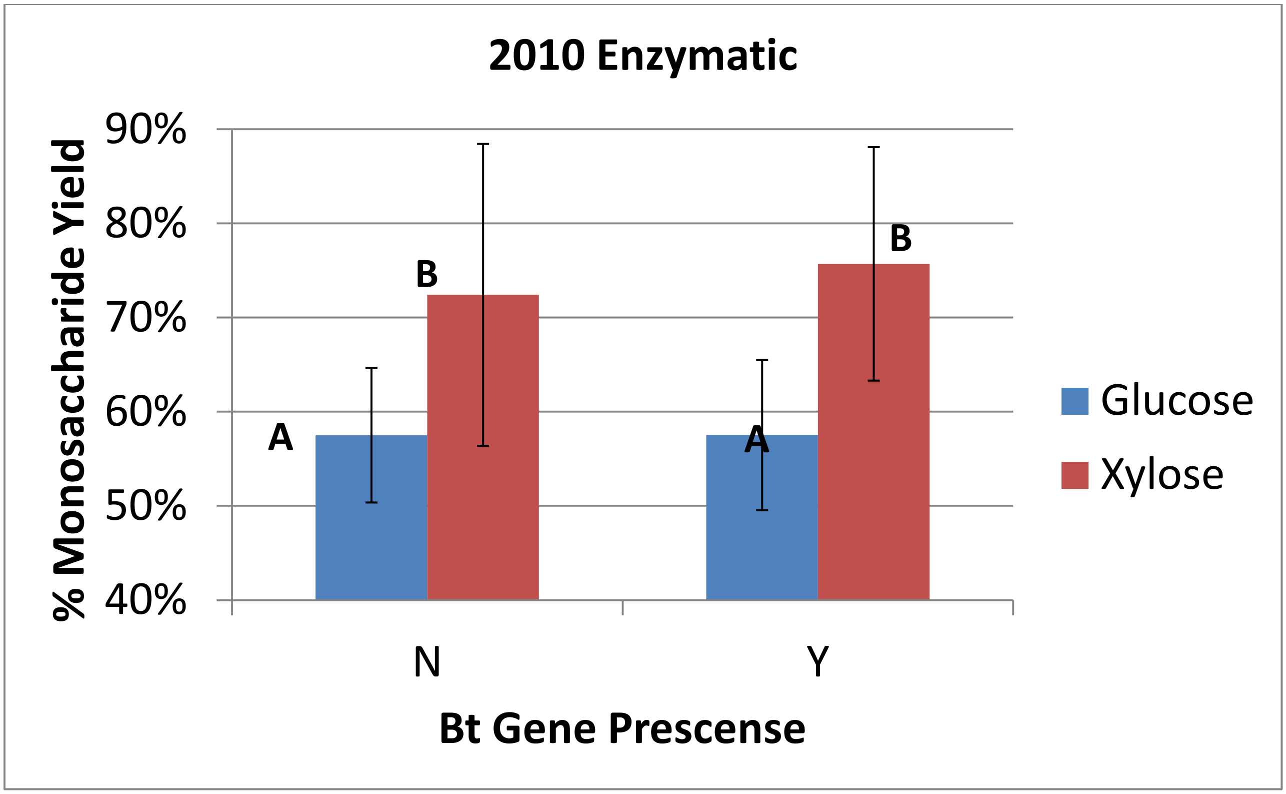
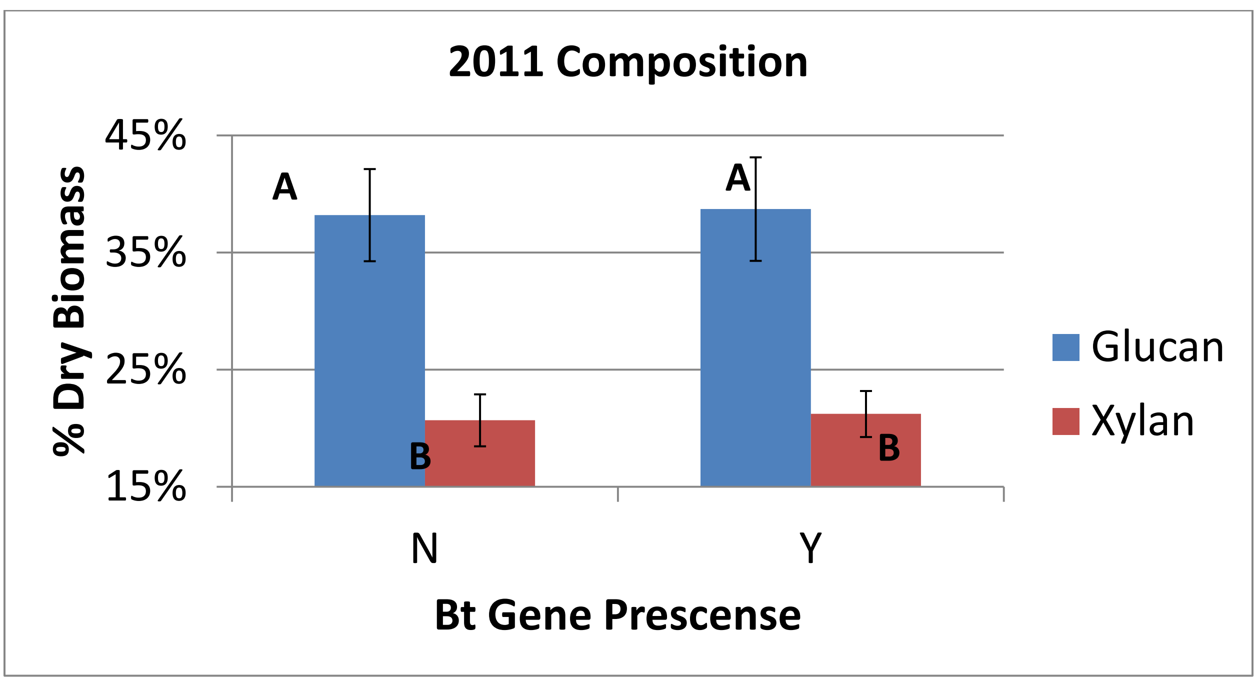


Fig. 5 and 6. Comparison of Bt vs. non Bt corn



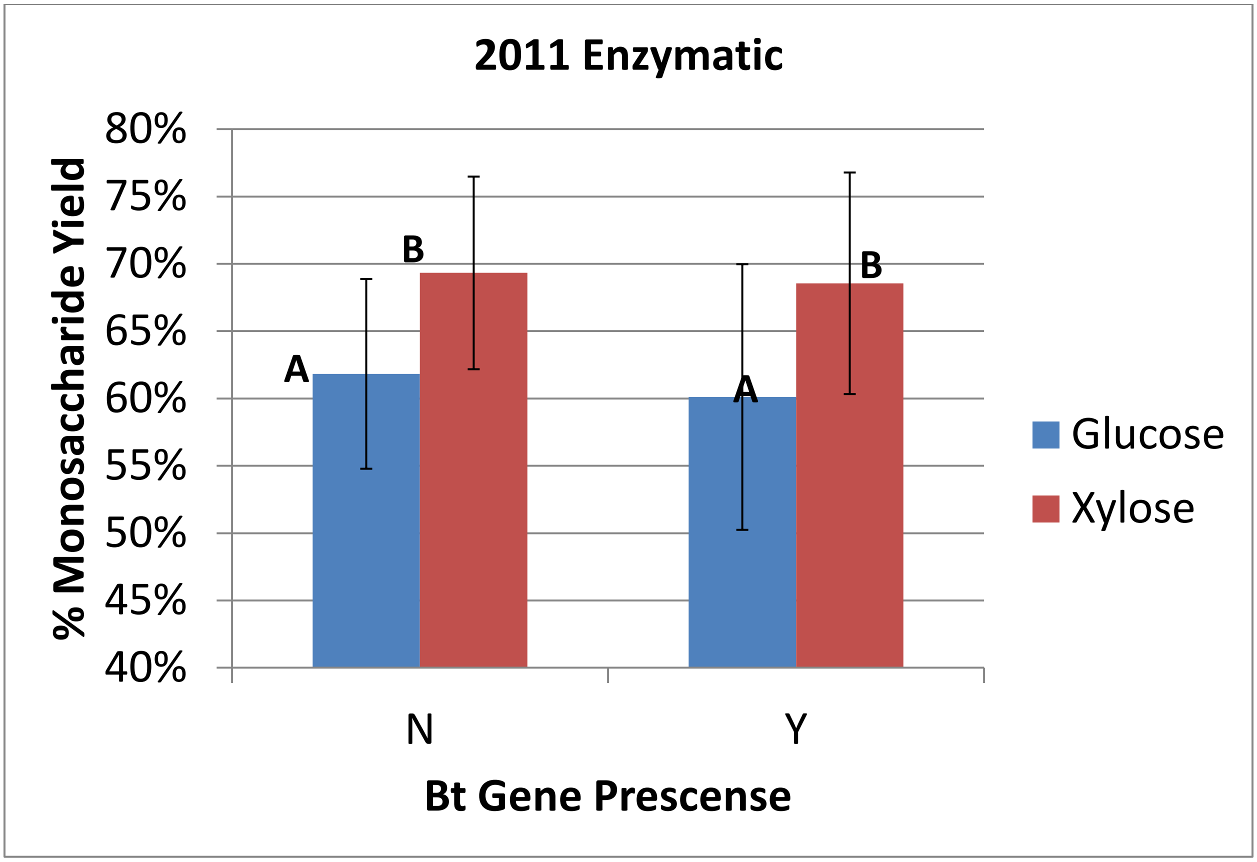


Fig. 7 and 8. Comparison of Bt vs. non Bt corn.

Conclusion:

- Preliminary data shows that there are no statistical differences between the Bt Gene and non Bt Gene isolines.
- Composition analysis showed that there is not much variability between the glucan, xylan and lignin concentrations of Bt corn and the non-Bt corn isolines.
- Percent glucan levels were almost the same in both 2010 and 2011 years.
- In terms of enzymatic digestion, there were no statistical differences among all tested monosaccharaides between the Bt and Non. Bt gene isolines.
- Future research will include analysis of latitudinal effects and varietal effects.

References:

Banerjee, G., S. Car, J. S. Scott-Craig, M.S. Borrusch, N. Aslam, and J. D. Walton (2010) Synthetic enzyme mixtures for biomass deconstruction: production and optimization of a core set. Biotechnol. Bioengineer. 106:7 07-720.

Saxena, D. and G. Stotzky. 2001. Bt corn has a higher lignin content than non-Bt corn. Amer. J. Bot. 88(9):1 704-1706.

Juan Gao,* Leilei Qian, Kurt D. Thelen, Xinmei Hao, Leonardo da Costa Sousa, Ming Woei Lau, Venkatesh Balan, and Bruce E. Dale (2011) Corn harvest strategies for combined starch and cellulosic bioprocessing to Ethanol. Agronomy journal. 103 (3): 844-850.

2012 Missouri NC-1178 Report

Randall J. Miles

Work in Missouri on impact of crop residue removal has centered on the long-term Sanborn Field plots since residues were removed from all of the historical plots from initiation in 1888-1889 to 1950 with return of residues initiated in 1950. Recent work reported by Miles and Brown (2011) illustrates that soil organic carbon (SOC) decreased with time with residue removal. After residues were returned, a minimum of 30-40 years is needed for SOC to increase to late 1880's to early 1900's levels for plots with either large fertilizer or manure-amendment inputs. Historical plots with little to no fertilizer or amendment inputs have not appreciably increased in surface soil SOC levels after return of residues. Plots with greater fertility/manure inputs also appear to have slightly increasing SOC levels in upper argillic horizons also.

Active C (AC) levels for Sanborn Field greatly flux over the growing season (Stiles et al. 2012) with largest AC occurring in the early summer time period relative to other times of the season. AC levels for management inputs that promote large organic inputs and greater fertility inputs have greater AC values relative to other management inputs over all seasonally assessments.

The Missouri Soil Characterization Laboratory role will be expanded to provide soil health analyses for the Missouri Soil Health (MOSOHEAL) program. We will be integrating the underpinnings of soil survey, pedology, and soil systems approach with soil health research. In this program soil health and Ecological Site Descriptions (ESDs) will be linked beginning with assessments of selected benchmark soils from each MLRA from natural area to areas of severe degradation. In some of these cases, severely degraded sites will be from areas of residue removal for either biofuel or silage production. We will be going back to each site at least every year to assess the EQUIP prescribed management input (cover crops, amendment inputs, etc) evaluate the practice's true input on soil properties and soil health; thus providing a standards based assessment.

Work has recently been initiated on the land application of small rural community wastewater flows to marginal lands for production of biofuel materials (Miscanthus). Assessment will look at SOC and, likely AC levels over time.

Associated Soil Carbon Work

Amber Marshaus-Steele, who completed her M.S. in 2011, was part of the NRCS national rapid carbon assessment in MLRA Region 10. Ms. Kerry Clark-Steward, Ph.D candidate is assessing Soil Microbial Response to Seven Different Organic Transition Strategies in an a compost application project for corn-wheat-soybean rotations.

Refereed Journal Articles

Hamilton, E.J., Miles, R.J., Lukaszewska, K.M., Remley, M., Massie, M, and D. G. Blevins. 2012. Liming of two acidic soils improved grass tetany ratio of stockpiled tall fescue with increasing plant available phosphorus. Journal of Plant Nutrition 35: 497-510.

Myers, D.B, Kitchen, N.R., Sudduth, K.A., Miles, R.J.Miles, E.J. Sadler, and S. Grunwald. 2011. Peak functions for modeling high resolution soil profile data. Geoderma 166(1): 74-83.

Sims, Atreyee, Horton, J., Shashikanth, G., McIntosh, S., Miles, R.J., Mueller, R., Reed, R., and Hu, Z. 2012. Temporal and spatial distributions of ammonia-oxidizing archaea and bacteria and their ratio as an indicator of oligotrophic conditions in natural wetlands. Water Research (2012), doi 101016/j.watres.2012.05.007

Stiles, C.A., Hammer, R.D., Ferguson, R., Johnson, M.G., Galbraith, J., O'Geen, T., Arriage, J., Shaw, J., Falen, A., Miles, R., and McDaniel, P. 2011. Validation testing of a portable kit for measuring an active soil carbon fraction. Soil Sci Soc Am J. 75:2330-2340.

2012 NC-1178 Annual State Report

North Dakota State University

Larry Cihacek

Introduction:

Activity 1: Two sites have been established (one in 2009 and one in 2010) to evaluate the effects of biomass removal on changes in soil organic C and soil properties. The sites are an irrigated continuous corn and corn-soybean rotation at the Oakes Research Site near Oakes, North Dakota on a loamy fine sand soil and a similar dryland continuous corn and corn-soybean rotation at the Carrington Research and Extension Center, near Carrington, ND on a fine sandy loam to loam soil. Corn residue is being removed using a plot forage chopper by removing the corn residue from none, one-third, two-thirds or all of the rows in the plots. Initial soil samples have been collected and soil samples are currently being analyzed after a delay due to our CNS analyzer requiring repair.

Activity 2: In 2011, crop residues were collected in spring and fall from seven cropping systems treatments at the Conservation Cropping Systems Project sponsored by the Wild Rice Soil and Water Conservation District near Forman, ND. These cropping systems are being managed under no-till conditions and have crop rotations with two, three, four or six crops within each rotation. These plots were established in 2001, and we have monitored two of the systems since 2006 for soil C and the remainder since 2010 for C. The evaluation of the C and N levels in the residue is a preliminary step in determining what effect long-term no-till management has on the nitrogen requirements of crops within the system. Recently, soil test information for hard red spring wheat indicates that N fertilization of the wheat can be reduced in no-till systems that have been established for more than five years. Currently, our data is being analyzed and additional residues will be collected in fall 2012.

Impacts:

1. This research will be used in models to demonstrate the C sequestration potential of soils across the region with respect to the effects of climatic gradients (both temperature and rainfall) on C accretion. In addition, the role of movement of dissolved organic C into the profile is being evaluated to with regard to its significance in contributing to long-term C storage in soils.
2. Removal of corn residue at different levels from plots will establish residue harvest levels for biofuel biomass that will sustain soil C and soil productivity.

3. Nitrogen applications for crops grown in long-term no-till systems may potentially be reduced due to N cycling from N stored in crop residues.

This information will aid in establishing more accurate carbon credits for grasslands and biofuel harvested croplands that will assist scientists, public policy makers, government and non-government agencies and land owners and operators in making land management decisions related to utilizing soils and land areas for sequestering C to mitigate global climate change.

Publications:

Thesis:

Koltes, S. 2012. Vegetation and fertilization effects on water soluble organic carbon at three North Dakota Sites. M. S. Thesis. North Dakota State Univ., Fargo, ND

NC1178 2011-12 Annual Report
Impacts of Crop Residue Removal for Biofuel on Soil Processes
The Ohio State University,Columbus,OH

Introduction:

The long-term residue management plots established at three branch stations of The Ohio Agricultural Research and Development Center(OARDC) were continued during 2011-12 with the objective of evaluating the effects of crop residue removal on soil properties and crop production. The experimental plots are located on three research farms, each with distinct soil types: Northwestern Branch in Hoytville, OH (Hoytville clay loam), Western Branch in South Charleston, OH (Celina silt loam), and USDA's North Appalachian Experimental Watershed in Coshocton, OH (Rayne silt loam). All plots are maintained under continuous no-till cultivation and continuous corn rotation. Treatments involve six levels of corn stover: 0% (complete removal), 25%, 50%, 75%, 100% (undisturbed residue), and 200% (mulch application), with three replications. These plots were established in 2004, and have been under continuous management for 8 years. In 2011, an additional set of plots with identical treatments and replication was established at the Coshocton site in vicinity of the existing plots, with the objective of comparing rates of change of soil properties under crop residue removal between the newer and longer standing plots.

Grain and Residue Yields:

A. Coshocton Site: Agronomic data were collected in late 2011 on grain yield, stover production, and harvest index from all experimental plots. Results from the plots on the sloping, Rayne silt loam soil at Coshocton demonstrated the most consistent trends associated with residue removal. Corn grain yields from the complete residue removal (0%) plots in the long term experiment at that site indicated a 15% reduction in yields compared with plots under all other residue levels. There was also a strong effect of residue removal on stover production (p=0.02) with 0% plots producing only 60% of the stover as from the mulch (200%) plots, which had he largest quantities of stover. Plant height at the grain filling stage was also measured on all plots and data indicated a significant effect from residue removal (p=0.01). Plant height increased linearly with increasing residue application from the 0% (233cm) to 200% (250cm) residue retention treatment. In comparison,the plots established in 2011 at Coshocton did not demonstrate any differences in grain or stover yield. **B. South Charleston**:In 2011 the plots at South Charleston were planted to soybeans ,and were not fertilized. Data collected in those plots indicated a trend of decreasing crop yields with residue removal. Plots receiving 0% of residue mulch had the lowest grain yields and the highest yields were observed in the 100% and 200% residue retention. Residue removal had a significant effect (p=0.05) on harvest index at South Charleston with values increasing linearly from 0% through 200% residue retention treatments.

C. Hoytville : Data collected from the plots in Hoytville in 2011 did not indicate any significant effects of residue removal on crop yield parameters.

Soil Properties:

Soil samples were collected from all plots at all sites in 2011 following the grain harvest and the application of the residue treatments.

A. Coshocton : Residue removal had a significant effect on surface (0-10 cm) bulk density values in the soils at both the 2004 (p=0.01) and 2011 (p=0.001) plots at the Coshocton site (Table 1). In the 2004 plots, bulk density values increased with decreases in crop residue from the 200% (1.32 g cm^{-3}) through the 0% (1.50 g cm^{-3}) residue retention treatment. In the 2011 plots, soil bulk density under complete residue removal (1.49 g cm^{-3}) was significantly than that under the undisturbed 100% residue retention treatment (1.33 g cm^{-3}). This trend in soil bulk density suggests that soil compaction can occur rapidly (<1yr) in the surface of soils where crop residue is removed completely.

B. South Charleston and Hoytville: Significant residue treatment effects on surface bulk density were not observed in samples collected from the Hoytville and South Charleston sites. Previous studies at these sites have also indicated a stronger effect of residue removal on soil physical properties at the Coshocton site compared with the Hoytville and South Charleston sites (Blanco-Canqui and Lal 2009, Blanco-Canqui et al. 2006, 2007). The Rayne silt loam soil at the Coshocton site occurs on sloping (10%) land and has a silt- dominated texture. Both of these factors make this soil more susceptible to physical degradation than the Hoytville Clay and Celina soils which occur on very flat land (<1% and 2% slope, respectively) terrain and contain larger quantities of clay. Laboratory analyses on the 2011 soil samples are ongoing and include measurement of available water capacity and measures of labile soil organic C.

Simulated Rainfall Runoff Study at Coshocton:

During April 2012, a field experiment was conducted on the long term residue removal plots at the Coshocton NAEW site to determine their susceptibility to erosion and runoff from significant rainfall events. The hypothesis being tested is that increased levels of crop residue removal lead to increased runoff, sediment levels in runoff, and losses of SOC during large rainfall events. A field rainfall simulator (after Humphry et al. 2002) was utilized to apply rainfall at an intensity of 7 cm hr^{-1} to a 4 m^2 area of each plot, according to the SERA 17 rainfall simulation research protocol (sera17.ext.vt.edu). Briefly, rainfall was applied to each plot until measurable runoff reached the outflow, at the low point of the plot, and the time until runoff was recorded. The rainfall was then stopped for exactly 15 minutes. After the rest period, the rainfall was applied for 30 minutes and all runoff and sediment were collected. Total suspended solids were measured gravimetrically from representative samples of the runoff. The rainfall was applied to plots with complete residue removal (0%), 50% residue, and undisturbed residue (100%), as well as from a set of recently tilled plots.

A significant treatment effect was detected in the total runoff measurements (p=0.0001) (Table 2). Complete residue removal resulted in 5 times more runoff (22.09 mm) than plots with full residue (4.39 mm). Complete residue removal on no-till plots also resulted in significantly larger quantities of runoff (22.09 mm) than the tilled plots (12.81 mm), suggesting that complete residue removal can negate some hydraulic benefits associated with no-till soil management. The 50% residue plots had a total runoff of 13.26 mm, which was similar to the tilled plots and suggests that intermediate crop residue removal may also lead to decreased soil hydraulic functions and water quality.

Complete residue removal also had the lowest time to incipient runoff (5.50 min), while that for 100% and 50% residue treatments was 8.20 and 6.23 min, respectively (Table 2). The time to incipient runoff in freshly plowed plots was 14.26 min, which was significantly higher than that of the no-till plots (p=0.0001). The total suspended solids (TSS) were the highest in the tilled plots (8870 mg L^{-1}) (p<0.0001). The no till plots demonstrated decreasing TSS values with decreases in residue removal. The sediment load was 5970 mg L^{-1} in plots with 0% residue retention, and 1730 and 1500 mg L^{-1} in plots receiving 50% and 100% residue retention, respectively. The trends in TSS suggest increased risks of TSS and non point source pollution with increasing quantities of residue removal from sloping lands and soils of high erodibility.

Laboratory analyses for this experiment continue and will result in measures of nitrate, dissolved organic C, and total P in runoff, as well as total C, N and P of runoff sediments and surface soils. Further research is being conducted into the microbial activity and availability of C in the eroded sediments. This research will result in valuable outcomes of increased knowledge of the basic effects of erosion on C and macronutrient cycling, as well as improved understanding of the effects of residue removal and tillage on these processes.

References Cited:

Blanco-Canqui H, Lal R, Post WM, Izaurralde RC, Owens LB (2006) Corn stover impacts on near-surface soil properties in no-till corn in Ohio. Soil Sci Soc Am J 70: 266-278.

Blanco-Canqui H, Lal R, Post WM, Izaurralde RC, Shipitalo MJ (2007) Soil hydraulic

properties influenced by corn stover removal from no-till corn in Ohio. Soil Tillage Res 92: 144-155.
Blanco-Canqui H, Lal R (2009) Corn stover removal for expanded uses reduces soil fertility and structural stability. Soil Sci Soc Am J 73: 418-426.
Humphry JB, Daniel TC, Edwards DR, Sharpley AN (2002) A portable rainfall simulator for plot-scale runoff studies. App Eng Agric 18: 199-204.

Outputs:

Presentations:

Beniston J, Dungait J, Dayton E, Jones S, Shipitalo M, Lal R. Corn stover removal for cellulosic ethanol production: Effects on soil and water quality. 2012 Public Land-Grant Conference on Energy Challenges: The Next 50 Years. The Ohio State University. April 30, 2012.

Lal R. Opportunities and challenges in producing biofuel feedstocks. Biofuels and Sustainable Energy Forum, Center for Applied Plant Sciences. The Ohio State University. February 27, 2012.

Table 1. Soil bulk density values from residue removal plots at Coshocton, OH (NAEW) site during Fall 2011.

	Bulk Density (g cm^{-3})			
Residue Level (%)	**2004 Plots**		**2011 Plots**	
0	1.50 (0.04)	A	1.49 (0.04)	AB
25	1.50	A	1.37	BC
50	1.42	AB	1.45	ABC
75	1.44	AB	1.54	A
100	1.42	AB	1.33	C
200	1.32	B	1.36	BC

	Bulk Density (g cm^{-3})	
Residue Level (%)	**2004 Plots**	**2011 Plots**
Treatment Effect	p=0.0112	p=0.001

- Letters indicate mean groupings according to Tukey's HSD test (α=0.05) and numeric values in parentheses are standard error of the means.

Table 2. Runoff parameters from simulated rainfall experiment conducted in Spring 2012.

Treatment	**Total Runoff (mm)**		**Time until Runoff (min)**		**Total Suspended Solids (mg L^{-1})**	
100% Residue - NT	4.39 (1.45)	C	8.22 (1.21)	B	1500 (1506)	B
50% Residue - NT	13.26	B	6.23	B	1730	B
0% Residue - NT	22.09	A	5.50	B	5970	AB
Tillage	12.81	B	14.26	A	8870	AB
Treatment Effect	p=0.0001		p=0.0001		p<0.0001	

- Letters indicate mean groupings according to Tukey's HSD test (α=0.05) and numeric values in parentheses are standard error of the means.
- Rainfall was applied at a rate of 7 cm hr^{-1} and a pressure of 34.5 kPa. Total rain applied=3.5 cm over 30 minute period.

NC1178 Report

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Replacing translocated topsoil increases productivity. Movement of topsoil from areas of accumulation (lower slope) to areas of topsoil depletion (upper slope) may be one approach to increase the overall productivity of eroded landscapes. We established two on-farm sites, one near Morris, MN and the other near Sisseton, SD to provide information regarding the impacts of intra-landform soil movement on soil properties, crop production, weed populations, economic returns, and herbicide fate. At both sites, soil was removed from the lower slope and added to the eroded upper slope (15-20 cm depth). These rehabilitated plots were compared with adjacent plots that remained in their eroded condition. The experiments extended through six growing seasons in Morris and four seasons in Sisseton.

Yield in areas of soil addition at the Morris site were 25 to 50% higher than those in eroded plots. The Sisseton site is less severely eroded, and yield increases in areas of soil addition averaged 10-20%. Yield was reduced at both sites in areas of soil removal; this is at least partially an artifact of the plot layout. Plots are located adjacent to each other, and surface water sheds from undisturbed plots to neighboring rehabilitated plots, causing excessive moisture (drown out) in areas of soil removal.

Approximate increased returns in areas of soil addition were calculated based on local grain prices at the time of harvest. These yield gains are achieved only through soil movement (no additional inputs). The full cost of soil-landscape rehabilitation was estimated at $800/acre, consistent with contractor charges. On severely eroded land, the pay-back time for soil movement is 7-8 years (Table 1). This analysis assumes no yield loss in areas of soil removal.

Table 1. Increased yields and approximate increased returns in areas of soil addition at a severely eroded site near Morris, MN.

	Soybean		
	2006	2008	2010
Price ($/bu)	$6.00	$9.00	$9.70
Increased yield (bu/ac)	6.5	7.8	10.1

Increased return ($/ac)	$39	$70	$98
	Corn		
	2007	2009	2011
Price ($/bu)	$3.50	$3.25	$6.00
Increased yield (bu/ac)	36	48	38
Increased return ($/ac)	$125	$150	$230

Next step 1: Using manure instead of soil to rehabilitate eroded land. Field plots described above were divided in half after 2011 harvest. Manure was applied to half the plots at a rate of 18 tons per acre (35,720 lbs/acre). The manure consisted of the solids pressed from manure following methane digestion. It had a relatively high C:N ratio of 15. We applied about 410 kg ha^{-1} N (96% was organic N), 180 kg ha^{-1} P, and 150 kg ha^{-1} K. Our plot design allows comparisons between (a) no soil added (eroded condition), (b) soil added in 2005, (c) manure added in 2011, and (d) both soil and manure added.

The primary purpose of this study is to evaluate productivity differences achieved by adding manure relative to those achieved by adding soil. Yield will be monitored annually for four years. Soil nutrients will be measured annually, and other properties will be monitored as resources permit.

Next step 2: Evaluating response of differing depths of soil addition/removal. A new site was established in fall 2011. Plots are on Buse soil (highly eroded) and Barnes soil (moderately eroded). Soil removal plots (Darnen) are in a swale where soil accumulates through water and tillage erosion. At least 12 inches of soil has been deposited throughout the swale. An area of bulk soil removal (Blue Earth) was located in a depression about 0.5 km distant from the addition plots.

Treatments for soil addition are: No soil added; 8 cm of soil added (all from depression); and 30 cm of soil added (20cm from depression, 10 cm from swale). Only the swale will be monitored as an area of soil removal, with treatments: No soil removed; and 10 cm of soil removed.

Yield will be monitored each year for 4 years after soil movement. Our expectation is that crop yield will increase with increasing amount of soil added. Soil samples will be collected each year to investigate relationships between soil properties and crop yield.

Publications pertinent to this project:

Schumacher, J.A., Papiernik, S.K., Schumacher, T.E., and Reitsma, K.D. Identifying Conservation Hotspots Using Tillage Erosion Modeling. In: Mueller, T.G. et al., editors. GIS Applications for Agriculture, Vol. 4, Conservation Planning. Submitted

Papiernik, S.K., Young, R.A., Schumacher, T.E., Westgate, M.E., Dabney, S.M., and Wilts, A.R. Factors affecting water runoff and soil loss during simulated rainfall in wheat–sunflower and corn–soybean rotations. J. Soil Water Conserv. Submitted

NC-1178 Report, 13-15 June 2012

Soil Erosion, Carbon and Chemical and Physical Properties as affected by Crop and Reside Management

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Objectives:

1. Assess management effects on carbon sequestration and soil productivity including the impacts of crop residue removal on soil organic carbon and erosion.

2. Determine spatial carbon distribution and dynamics in soils of eroded landscapes for better quantification of erosion impacts on soil carbon loss and sequestration.

In addition to the two NC-1178 objectives we have the following two objectives specific to Wisconsin:

3. Assess the impact of variable corn row width and population, and two levels of residue removal (zero and 90%) on soil erosion, carbon distribution, fertility, and selected soil physical properties.

4. Compare possible differences between corn residue removal and switchgrass harvesting on soil erosion, carbon distribution, fertility, and selected soil physical properties.

Methods:

The research site is located at the Arlington Agricultural Research Station on Griswold silt loam soil, 6% slope. Research plots were established Spring 2012 with switchgrass and no-tillage continuous corn. Continuous corn plots consist of four treatments: (1) two crop residue management systems, high (90% removal) and no removal, (2) two row spacing, conventional (76.2 cm) rows and narrow (38.1 cm), and (3) two seed density treatments, standard and high. The four treatments were established in a split-block design, with three replications each. Switchgrass was planted using drill-seed method. Mini-runoff/erosion plots (50x100 cm) are installed in each plot. The 12-row wide by 19.8-m long plots have two residue removal treatments imposed at harvest, zero (no removal) and high (90%). The 90% residue removal was based on cutting height at harvest for the corn plots last fall. The crop residue removal constitute a split-plot design to the overall randomized complete block design. No-tillage is used to remediate the impact of residue removal on soil quality (organic matter/carbon and physical properties). The plots are setup as continuous corn and switchgrass, thus plots will not be rotated.

Results:

Lowest corn yield average was 10.91 Mg/ha (174 bu/ac) in standard row, high density, and greatest 11.48 Mg/ha (205 bu/ac) in the narrow row, standard density. Runoff volume for the growing season was consistently greatest for corn at standard row spacing standard density ranging from 1.36 to 0.15 L, and lowest for standard row spacing and high density ranging from 0.87 to 0.09 L. Runoff volume average was 0.85 L for switchgrass during establishment period but decreased near the end of the growing season, averaging 0.05 L. Sediment loads and nutrient losses have not yet shown a significant difference between treatments. With various new management practices for biofuel, surface runoff was reduced and grain yields maintained in the first year of the study, but to fully assess benefits continued monitoring for several more years is necessary.

Publications:

Published abstract
Andreucci, S., Ruark, M.D., and Lowery, B. 2012. Biofuel and Crop Management on Surface Runoff and Nutrient Retention in Southern Wisconsin. Wisconsin AWRA Annual Conference. American Water Resources Association. Wisconsin Dells, WI, 2012.