United States Department of Agriculture
Agricultural Research Service
the in-house research arm of the U.S. Department of Agriculture

Research Project: Implications of Using Corn Stalks As a Biofuel Source

Location: Soil Management Research

Project Number: 3645-11000-002-01
Project Type: Reimbursable

Start Date: Sep 01, 1999
End Date: Aug 31, 2004

Project Team

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Objective:
Provide field data under relatively cool soil conditions to support development of simulation models to be used to predict the short and longterm impacts of corn stalk residue removal on soil properties (organic matter, perhaps pH, and others).

Approach:
Conduct a literature review to determine the effect of removal of corn stalk residue at different geographic locations. Establish test plots with tillage and residue variables to analyze root growth, soil physical properties and microbial activity.

What were the most significant accomplishments this past year?

D. Progress Report This report serves to document research conducted under a reimbursable agreement between ARS and the U.S. Department of Energy. Additional details of research are in the report for the parent research project 3645-11000-002-00D "Soil Carbon Cycling, Tillage and Crop Residue Management." The research will determine benefits of applying the by-product after ethanol production from corn stover to soil. The results will aid corn producers and ethanol producers in determining the feasibility of harvesting corn stover for ethanol production while maintaining soil quality. Applied to severely eroded soil, there was a significant increase in humic acid and soil stability. Data analysis continues on interaction of temperature and water availability on the effects of applying the by-product to soil. Greenhouse studies found no deleterious effects on growth of soybeans and corn grown in the presence of the by-product of corn stover fermentation. Collaboration with USDA-ARS, Brookings, SD was initiated to determine how humic acid concentration changes in field soil at different rates of stover removal. Additional collaborative field work and laboratory work is planned for FY-2004 based on anticipated funding. Annual reports have been submitted to the funding agency to aid in the overall objective of determining the feasibility of using corn stover for ethanol production. Also the information was presented to the funding agency and the other stakeholders at two workshops in 2003. Two peer-reviewed journal articles and one peer-reviewed proceedings were produced.

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JOHNSON, J.M., REICOSKY, D.C., LINDSTROM, M.J., SHARRATT, B.S., VOORHEES, W.B. RESIDUE OF CORN STOVER ETHANOL PRODUCTION AS A SOIL AMENDMENT. CD-ROM. MADISON, WI: AGRONOMY ABSTRACTS. 2002.

JOHNSON, J.M., REICOSKY, D.C., SHARRATT, B.S., LINDSTROM, M.J., VOORHEES, W.B. CORN STOVER AS A BIOFUEL. CD-ROM. ST. PAUL, MN: MINNESOTA ACADEMY OF SCIENCE. 2003.

ARS Project: Implications of Using Corn Stalks As a Biofuel Source (402790)
2002 Annual Report

What was your most significant accomplishment this past year?
D. Progress Report This report serves to document research conducted under a reimbursable agreement between ARS and the U.S. Department of Energy. Additional details of research are in the report for the parent research project 3645-11000-002-00D "Soil Carbon Cycling, Tillage and Crop Residue Management." The research will determine benefits of applying the by-product after ethanol production from corn stover to soil. Applied to severely eroded soil, there was a significant increase in humic acid and soil stability. The results will aid corn producers and ethanol producers in determining the feasibility of harvesting corn stover for ethanol production while maintaining soil quality. Current research is exploring the interaction of temperature and water availability on the effects of applying the by-product to soil. Contingent on pending funding and the availability of by-product, a field scale experiment is planned for 2003. Annual reports have been submitted to the funding agency to aid in the overall objective of determining the feasibility of using corn stover for ethanol production.

Review Publications
JOHNSON, J.M., BARBOUR, N.W. RESIDUE COMPOSITION AND DECOMPOSITION OF SHOOT AND ROOTS AMONG C3 AND C4 SPECIES. CD-ROM. MADISON, WI: AGRONOMY ABSTRACTS. 2002.

ARS Project: Implications of Using Corn Stalks As a Biofuel Source (402790)
2001 Annual Report

What was your most significant accomplishment this past year?

D. Progress Report: This report documents research conducted under a reimbursable agreement between ARS and the U.S. Department of Energy. Additional details of research are in the report for the parent research project 3645-11000-001-00D "Soil Carbon Cycling, Tillage and Crop Residue Management." The objective of the research was to determine if applying a high lignin material to soil could provide the same benefits of residue when corn stover is removed for ethanol production. In a preliminary laboratory experiment, a high-lignin analog was mixed to mimic the by- product after ethanol production from stover. The results were promising that adding a high lignin mixture to soil could contribute to the formation of soil organic matter and that this addition would help to maintain or improve soil structure and the soil's water properties. The development and duse of biofuels can help improve environmental quality, and if done wisely soil quality can also be maintained and enhanced. The results of this study were recently submitted to Soil Biology and Biochemistry for publication. Funding was provided to continue research a second year, therefore, a study using the actual high lignin by-product is being conducted during the summer of 2001. In the current study, the effect of various concentrations of by-product on carbon dioxide flux, microbial biomass carbon, soluble carbon, phenolic acid composition, moisture retention characteristics and aggregate stability is being assessed. Results of the current study will further aid corn producers and ethanol producers in determining the feasibility and balance between harvesting corn stover for ethanol production and maintaining healthy productive soil.

ARS Project: Implications of Using Corn Stalks As a Biofuel Source (402790)
2000 Annual Report

1. What major problem or issue is being resolved and how are you resolving it?
This CRIS project is subordinate to 3645-11000-001-00D. In response to a Presidential mandate to significantly increase the use of bio fuels, the U.S. Department of Energy is studying the feasibility of converting corn stover into ethanol. It is not known to what extent corn stover can be removed from the fields without causing deterioration of soil structure, and eventually, increased soil erosion. The objective of this study is to assess the effectiveness of returning the lignaceous by-product of ethanol production from corn stover to the land in an attempt to increase soil aggregation and stability.

2. How serious is the problem? Why does it matter?
There is a finite quantity of fossil fuel on the earth, and demands for energy continue to increase. The benefit of growing our energy supply (converting corn stover into ethanol) must be balanced against potential deleterious long-term effects of stover removal on our natural resources and global environment. Data show that continuous removal of corn stover will eventually negatively impact soil quality and increase soil erosion. But if the return to the land of ethanol production by-product results in positive effects on soil quality, then a combination of stover removal and good subsequent land management can result in a win-win situation where bio fuels can be a viable alternative energy option while maintaining crop productivity and conserving natural resources.

3. How does it relate to the national Program(s) and National Program Component(s) to which it has been assigned?
This research directly contributes to National Program 202 by quantifying interactions between soil biology and soil quality (Soil Biology component), identifying the extent to which changes in soil structure impact infiltration (Soil Conservation and Restoration Component, Erosion Problem Area 1), and by assessing the effect of using ethanol production by-product to improve soil quality (Productive and Sustainable Soil Management Systems Component). This project is a collaborative effort between the DOE and ARS Laboratories in Morris, MN; St. Paul, MN; Lincoln, NE; Ames, IA; Ft. Collins, CO; and Brookings, SD.

4. What was your most significant accomplishment this past year?
A: Single Most Significant Accomplishment during FY 2000 Year: See progress report in 4D. B: Other Significant Accomplishments, if Any: Nothing to report. C: Significant Accomplishments/Activities That Support Special Target Populations: Nothing to report. D. Progress Report: Reconstituted lignaceous material (based on chemical analyses of fermented corn stover by-product) was incorporated into soil cores with varying erosion histories. Methodologies were developed to measure CO2 flux and microbial activity. The net effect of this activity on changes in soil structure will be measured at the end of a 3-month incubation period, and should provide a preliminary assessment of the ability of the lignaceous by-product to improve soil quality.

5. Describe your major accomplishments over the life of the project, including their predicted or actual impact?
This research is supported by temporary DOE funding and laboratory studies were initiated in June 2000. It is expected to contribute to our understanding of how tillage and residue management contribute to soil carbon storage.

6. What do you expect to accomplish during the next year?
Contingent on DOE funding beyond FY-00: Year 1, expand laboratory study to local field conditions; Year 2, extend field study to regional sites, using corn stover by-product from ethanol plants expected to be on line by 2002; Year 3 summarize all data pertaining to microbial activity, soil carbon storage, soil aggregate formation, and water infiltration as impacted by soil incorporation of corn stover ethanol production by-product.

7. What technologies have been transferred and to whom? When is the technology likely to become available to the end user (industry, farmer other scientist)? What are the constraints, if known, to the adoption durability of the technology?
New knowledge will be transferred to DOE and other ARS scientist in early FY-01. Constraints to further transfer will be inadequate resources to thoroughly test hypothesis under field conditions.