

**Sustainable Agriculture Research and Education
2013 Farmer Rancher Grant Proposal**

Project Title: Growing With Biochar
test and teach soil carbon sequestration
prepared by: **David Yarrow**, November 2012

One Sentence Description of Project:

Growing With Biochar research & education initiative in the Lawrence, Kansas foodshed will:

- 1) assist growers to use, properly prepare and test charcoal (biochar) in soils on demonstration plots,
- 2) monitor, measure and document these early efforts to use biochar in soils,
- 3) optimize useful information and insight obtained and shared,
- 4) conduct open farms, field days and trainings to teach growers carbon-smart farming, and
- 5) draft a **Grower Manual**, instructional tools and other information on how to use biochar.

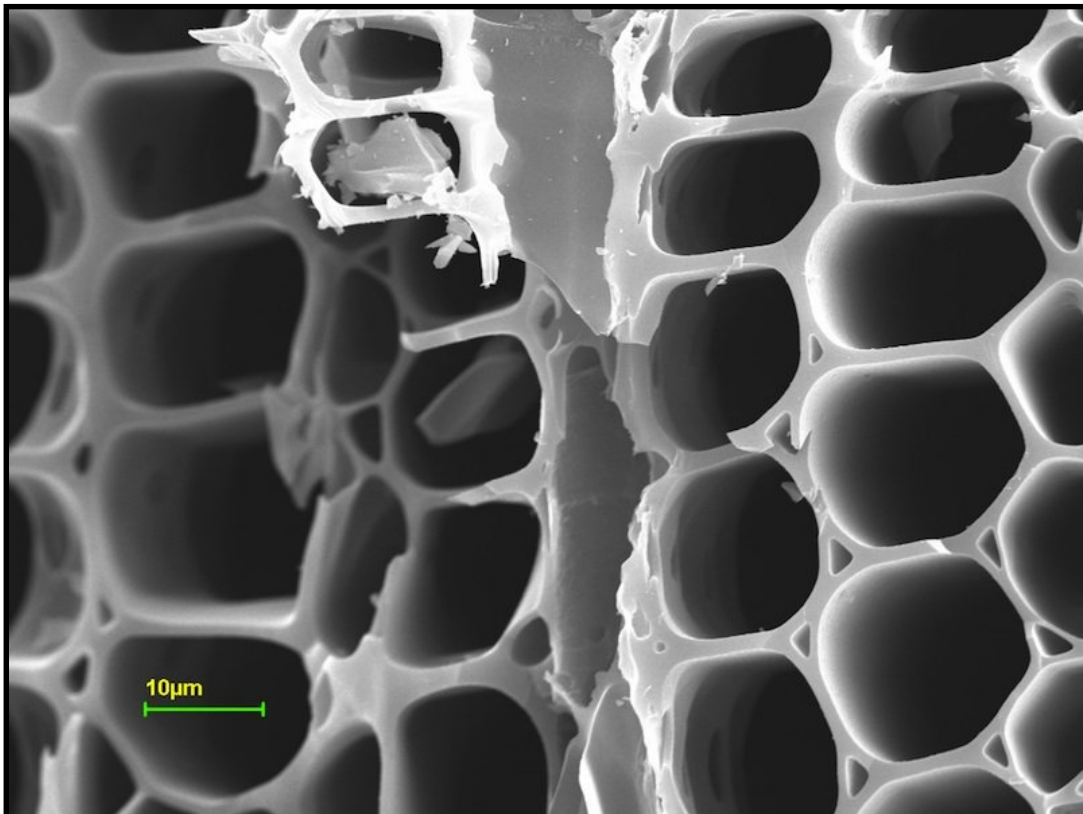
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PROJECT CATEGORY.

X Soil Management

Cedar Biochar
SEM microphoto in microns

PHOTO: Wayne Teel, James Madison University, Harrisonburg, VA



Growing With Biochar

test and teach soil carbon sequestration

Assuring Farm Productivity and Food Security in a Climate of Change A Sustainable Agriculture Project in the Lawrence, Kansas Foodshed

United States Department of Agriculture
Sustainable Agriculture Research and Education
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1) DESCRIPTION.

Hoyland Farm (Douglas Co.), **Bob & Joy Lominska** (since 1976); 40 acres of farmed out upland; bought adjacent 15 acres, then 14 acres; 2009, bought 6 acres of prime farmland in Lawrence. By organic methods, built up and intensively gardened 3 acres; rest kept as pasture or woods. Produce sold at farmer's markets to supplement elementary teachers' income. 1994, co-founded multi-farm CSA Rolling Prairie Farmers' Alliance, still going strong as main market. Bought machinery, walk-in cooler, barn converted to packing shed, expanded operation to support themselves and meet demand for sustainably-grown local food.

Vajra Farm (Jefferson Co.), **Stephen & Nancy Moring**, (since 1995); 45 acres of farm fields, woodland and reclaimed prairie, with 5 acres of vegetables, vineyard, fruit & nut orchard. Steve cultivates medicinal herbs, wine grapes, organic fruits & vegetables in edible forest garden polyculture to demonstrate permaculture design. Steve has a Kansas University Botany MA, project management skills, certified in permaculture design provides farm internships to cultivate herbs, organic produce and permaculture practice, consults on sustainable land development and alternate crop production, produces permaculture workshops, teaches through Douglas Co. Extension Service, Johnson Co. Community College and Kansas University Environmental Studies Program.

Greenman Farm (Leavenworth Co.), **Bill & Nichole Price** (new farmers); 9.2 acres, idle for some years; 3.5 acres of fruit & nut orchard, woodland trees, berries, perennial vegetables; 4.9 acres of future small-scale livestock; ¾ acre for sustainably-built home. Converting conservation terraces to swales, prairie grass to edible forest permaculture. Bill is interested how biochar benefits soil and tree growth. His goal is to demonstrate sustainable permaculture food production for home and community.

Common Ground Project (Douglas Co.), **Stuart Shafer**, Sociology Professor, Chair of Johnson Co. Community College Sustainable Agriculture (35 years organic farming); 1-acre in Lawrence of Kansas River sandy silt deposits. Produce marketed via Rolling Prairie Farmers Alliance CSA; 50% of harvest donated to Lawrence Food Bank. Drip irrigation from city water hydrant, storage shed, tillage equipment from JCCC. Quarter acre of potatoes or sweet corn

will test water efficiency of biochar treated soils.

Buller Family Farms (Douglas Co.), **Tom & Jenny Buller** (since 2006); 2010, bought Common Harvest Farms with Jill Elmers; 34 acres of vegetables, grains, orchard, and hay. They sell to two CSAs (Rolling Prairie Farmers Alliance & Moon on the Meadow), Lawrence Farmers Markets, wholesale accounts in Lawrence. They completed Growing Growers training program, with graduate coursework in sustainable agriculture at University of Minnesota.

Moon on the Meadow (Douglas Co.), **Jill Elmers**, certified organic farm in east Lawrence Kansas River bottom; 3+ acres of wide variety of vegetables, herbs and small fruit dedicated to sustainable agriculture to feed the local region. Marketed through 100-person CSA, farmers markets, local restaurants and grocery stores. April 2010, joined Buller Family Farm to buy adjacent 34-acres to add laying hens, perennial asparagus and rhubarb, and heirloom wheat for fresh ground flour.

Lulu's Garden (Douglas Co.), **Pam Bramlet**: 80 acres southwest of Lawrence overlooking verdant Vinland Valley; dedicated to grow and market aromatic, flavorful, organic culinary herbs; marketed to local restaurants, food stores, country clubs, farmers' markets; committed to sustainable, organic practices to provide wholesome food and preserve biodiversity of soil and environment; no-till organic farming to increase water, organic matter and nutrients in soil, and decrease erosion.

Lawrence Community Gardens (Douglas Co.): Test plots at three garden sites in west and east Lawrence will be used to educate gardeners about biochar benefits and use.

2) PROBLEM/SOLUTION.

Charcoal is ancient, well-known substance, but its use in soil was unknown until a few years ago. We now know "biochar" was successful in the Amazon for 6000 years to improve soils' physical and chemical properties, and enhance fertility, productivity and soil biology. Biochar also sequesters carbon in soil in a super-stable form for at least 1000 years. Biochar production from wastes can generate renewable energy as heat, hot water, gas and liquid biofuels.

Biochar is a new soil amendment, and much is unknown of its effects on Kansas soils and temperate climate crops, and less is known about methods for its proper preparation for effective use in farm operations. We are at the beginning to

explore and learn effective methods and equipment to prepare and apply biochar to soils. This lack of solid, proven methods means we are engaged in preliminary efforts to explore this new approach to soil carbon and fertility management.

Three primary barriers impede wider biochar use by farmers: 1) information on biochar effects on soils and crops, 2) instructions to acquire, prepare and apply biochar effectively, 3) education and training to teach farmers proper, effective use of biochar and carbon-smart methods.

Biochar Benefits: First, farmers need practical information and first-hand experience on biochar effects on soil, and proper ways to prepare and apply it to varied soils and crops. Currently, Lawrence foodshed doesn't have one research test plot to demonstrate biochar use and benefits. Farmers need practical "how to" information more than scientific protocols and proofs. On-farm test plots can expand our science research data on how biochar affects Kansas soils and crops, highlight biochar benefits to soils and teach farmers carbon-smart farming with biochar.

Many specific research questions can be investigated by on-farm test plots. All contribute to our emerging understanding. Individual farmers need to select research issues that are relevant to their farm operations. Growers must choose research questions to match their soils, crops and operations. Beyond individual issues, standards are needed to measure, monitor and account for soil carbon in its complexity and diversity.

Each Participant Farmer will be assisted by the Research Field Agent and Research Coordinator to define at least one specific research issue, and design a field test setup and protocol to explore the issue(s). Field test plots will be selected, in part, for their usefulness as show-and-tell demonstrations for education and training events later in the year. In January 2013, farmers will meet with the Research Coordinator and Field Agent to select their research issues and begin the test plot design and designation process.

Biochar Best Practices: Farmers need to know how to use biochar on varied soils and crops. Adding raw or unprepared char to some soils can actually inhibit crop growth the first year, although second and third year growth is enhanced. For optimum results and quick response, biochar must be processed into certain forms, blended with other materials, applied by specific protocols. Growers who do not understand and follow proper practices to prepare biochar for soil applications are likely to be disappointed by initial results. Also, some crops and field conditions require special equipment and application protocols.

Thus, growers need detailed instructions on how to select biomass to convert to biochar, and properly prepare biochar for use on specific crops and field conditions. This includes information on tools and equipment for easy, efficient spreading of bulk material, how to process biochar for easy dispersal and fast action in soil, how to inoculate biochar with flourishing microbes, and to blend with biochar with materials

that assure its optimum effectiveness. Thus, there must be pragmatic, detailed instructions made available to growers for farm-scale end use and application to soils and crops.

Biochar Education & Training: Third, farmers need information resources and education services that deliver instructions on how to make, prepare and use biochar and other carbon-smart farming methods. This includes training in selection and preparation of biomass, and fabrication of new equipment or adaptation of existing farm equipment to prepare and spread biochar. Farmers also need pragmatic training in preparation and application methods that are easy, economical, and deliver optimum, quick-response results. And growers need guidance about simple methods to evaluate the effects of biochar on their soils and crops.

3) TIMELINE.

WINTER (Jan.-March): Four workshops to teach farmers to fabricate simple equipment to make biochar. Project team meetings to formulate a year-long work plan, hire project staff, enroll more farms as research collaborators, identify test plots, design research priorities and protocols. Through winter, participants will make biochar from various local biomass. Website created.

SPRING (April-June): Soil samples taken. Participants acquire materials to prepare biochar, and fertilizers for test plots. In early spring, biochar prepared and spread on test plots. Field Agent monitors and documents test plot applications, and evaluates effectiveness of methods to apply biochar. Research protocols to gather data reviewed and tested. Growers trained in research procedures, and education events planned. Data gathered on early season crops. Initial documentation published on website.

SUMMER (July-Sept.): In peak growth season, Field Agent monitors and documents test plots. Grower meeting to plan data gathering in peak harvest. Staff and participants plan and conduct education events. Early summer is half-day open houses; late summer is full-day field day programs. Draft of **Grower Manual**, brochure and fact sheets. Website updated with events, documentation and early research results.

FALL (Oct.-Dec.): Peak harvest climaxes data gathering on yields and crop quality. Research Field Agent gathers plant samples and crop data to document biochar effects. Staff and participants meet to review progress and consider future efforts. Grower training sessions conducted, using acquired knowledge and the draft **Grower Manual**. Project Coordinator compiles **Grower Manual**. Research Coordinator compiles data and documentation, and drafts **Final Research Report**. Staff and participants draft a **Final Project Report**. Website completed with upload of these documents.

4) PREVIOUS RESEARCH.

Charcoal is ancient, well-known substance, but its use in soil was unknown until a few years ago. We now know "biochar" was successful in the Amazon for 6000 years to

improve soils' physical and chemical properties, and enhance fertility, productivity and soil biology. But how to implement this ancient method in temperate climate soils and crops, with modern farming methods, is largely unknown—a new research area.

In 2009, SARE Northeast funded a project (FNE09-673) to test biochar effects on soils and vegetable production on a small farm in Maine. Biochar was produced by Dynamotive in Ontario, Canada with “fast pyrolysis”, and was applied to soil raw without proper preparation such as inoculation and mineralization. Results first year were mixed, but significant improvement in second year after bio application.

In 2009, a USDA Conservation Innovation Grant funded North Carolina Farm Center for Innovation and Sustainability to assess biochar’s potential to improve soil conditions and agricultural productivity.

In 2010, SARE North Central funded an Iowa project (FNC10-807) to build kilns to make char added to clay. The remarkable change of “sticky” clay to “potting soil” highlights biochar potential as soil amendment.

Since 2009, several USDA soil scientists are researching biochar use, notably including David Laird (National Tilth Lab), Dr. Jim Amonette (Pacific Northwest National Lab), and Dr. Jeff Novak (Coastal Plains Soil, Water, and Plant Research Center). Initial reports are very positive and research is expanding.

International Biochar Initiative, led by Dr. Johannes Lehmann at Cornell University, was formed in 2008 to sponsor biochar research and development around the world. IBI formed a Scientific Committee to develop technical definitions and standards to identify, manufacture and characterize biochar for agricultural uses. Over 15 U.S. universities are already conducting scientific investigations of biochar.

At Iowa State University, Dr. Robert Scott has experimented with making biochar by “fast pyrolysis” from corn stover and other crop wastes, and tested it on soils and field grain crops.

At University Hawaii, Dr. Robert Antal developed high temperature, high pressure “fast pyrolysis” technology to produce bioenergy and biochar, and has limited success applying biochar to agricultural soils.

At University of Georgia Athens, Danny Day through EPRIDA studied biomass pyrolysis to produce bioenergy for over 15 years, and in 2004 began to explore the value of biochar as a soil amendment

At Virginia Tech University, experiments for three years show that inoculation of biochar with microbes by blending and aging with compost yields strong crop response at only a few hundred pounds per acre.

In Canada, several research initiatives are underway, principally by Blue Leaf in Quebec, which applied biochar to farmlands and field crops for three years, with mostly favorable results.

These research efforts are often academic scientific studies to design and test equipment and technology for bionergy production, and in the past, biochar was often a secondary byproduct. This proposal will work with growers to acquire and use biochar, create demonstration plots to show growers the benefits of biochar, and develop training methods and materials to teach growers to implement biochar strategy on their farms.

5) OUTREACH.

Demonstration Plots: participant and collaborating farms will create research test plots that display and document the proper use, effects and benefits of biochar on soils and crops.

Open Houses & Field Days: at least six half and full day public events on participant farms to present research test plots and short educational seminars about biochar.

Grower Trainings: two skill development events to teach growers to make, prepare and apply biochar.

Public Events: at least two programs for public and press on the use and benefits of biochar.

Publications: draft and distribute documents with information on biochar and its use in food production:

- **Carbon-Smart Farming with Biochar** brochure
- **Biochar Fact Sheets** 1-page papers about biochar, its proper preparation, use, effects, and benefits
- **Grower Manual on Carbon-Smart Farming with Biochar**
- **Final Research Report** summarizing results and conclusions from research test plots
- **Final Project Report** summarizing project objectives, activities and results
- **Video: How to Use Biochar** for growers compiled from footage of test plots, activities and events
- **Website: www.GrowingWithBiochar.info** will publish project documents, documentation and video

Publicity: The project must do effective outreach to recruit growers to create additional biochar test plots, and attract growers to education events. The project will use multiple ways to assure participation:

- Notices posted to www.GrowingWithBiochar.info and other websites.
- Email for Kaw Permaculture, Sustainable Action Network, KS Organic Producers, etc.
- Leaflet growers selling at the many farmers markets in the region.
- Guests on regional radio shows that feature farming, food and environmental topics.
- Press conferences and public events for news and publicity in newspapers, TV, magazines.
- Douglas County Food Policy Council and Coop Extension newsletters and public notices
- Selective ads in regional newspapers, newsletters,

journals, magazines, and other media.

6) EVALUATION.

Funds will support an initial year to develop this research and education initiative. However, biochar remains in soil for 1000+ years, and benefits increase in second and third years as microbial populations are established and increase their biomass. Thus, this project will go on many more years. The potential to expand this initiative in future years is real, so performance evaluation is important to plan for future years.

The main goal is to create biochar demonstration and test plots. Test data gathered will be solid evidence to evaluate success of 2013 plantings and biochar effects on soils and plots. Test plot observations will continue at least two more years to monitor changes to soil structure, carbon content, fertility, productivity, and biodiversity. Soil moisture, and changes in soil and plant ecology will be monitored.

Experimental methods and equipment to prepare and apply biochar will be evaluated by farmers through interviews and written assessments, and incorporated in the final **Grower Manual**.

Education events will be evaluated by several measures:

- Number of participants at events is a simple indicator of effective outreach and successful events.
- Participants will fill out simple 1-page feedback forms of their perceptions, ratings and comments.
- Results will be posted on the website.
- A success measure is the number of growers using biochar who undertake biochar test plots.

At year's end, participants, staff and collaborators meet to review activities and assess benefits, effectiveness and shortcomings. Verbal and written assessments will be included in the **Final Report**.

One extra measure of project success will be an investigation about forming a grower cooperative to own and manage a biochar production operation, and to conduct further research and education. A decision to incorporate a cooperative (or other form of organization) will indicate this project has met growers' needs, and encourages them to go forward with a more sophisticated organization to sustain the initiative.

Budget (deleted)

Budget Justifications.

Personnel: staff - Because farmers are too busy during the growing season with farming and marketing to carry out the many timely tasks required for this research and education project, four part-time staff will be employed to carry out project planning, execution and documentation: **Project Coordinator (PC)**, **Research Coordinator (RC)**, **Research Field Agent (RFA)**, **Events Coordinator (EC)**.

PC: **David Yarrow** will oversee all staff, participants, collaborators, and assist the RFA and EC. Primary task is to assure documentation of project activities to use to draft the

Grower Manual, Final Project Report, Fact Sheets, and brochure. PC will also assure photos, videos and other means to document the test plots and education events. PC is also responsible for the website.

RC: **Steve Moring** is a trained scientist skilled at design of rigorous field tests and data gathering protocols. RC consults regularly with RFA to design and implement research test plots on participant and collaborator farms, and supervises RFA to monitor test plots and gather data and documentation.

Assisted by PC and RFA, RC will draft the **Final Research Report** summarizing test plot experiments and results.

RFA: **Devin Gerling** will be the project's legs and arms to visit farms and work with farmers to design test plots based on issues identified by farmers, monitor the procedures to prepare test plots, to prepare and add biochar, monitor test plots through the growing season, and document results. RFA will assist the RC to compile research data and documentation, and prepare the **Final Research Report**.

EC: **Michael Almon**'s activities don't begin until early summer with half-day open houses after crops have grown to significant size. Full day field days will be late in summer and fall when crops are nearly full-grown. Each participant farm will host at least one open house and one field day. In early fall, farmers who decide to try and apply biochar to their farm soils can attend two full day training programs to learn the procedures and skills needed to assure success.

Staff will meet at least monthly to coordinate project activities and events.

Administration: travel – most travel expense is for the RFA, who must travel extensively to participant and collaborator farms to set up and monitor research test plots, and gather data samples, photos and other documentation. All travel will be local, within 15 miles of Lawrence, KS.

Biochar: acquisition – with simple homemade equipment, farmers will make small batches of biochar from local sources of biomass. This will need to be supplemented with purchased biochar to cover larger farm-scale areas. The project will pay up to 50% of costs, up to \$100/ton, to buy biochar from manufacturers, but since no nearby businesses make biochar yet, much of the expense is for transport.

R&E grant proposal 2014: This project is a first effort to explore the effective use of biochar, and we fully expect this effort will continue in future years. Next fall, as part of the year-end evaluation, growers will discuss how to continue with this research and exploration of this new strategy. Our expectation is that we will apply for a SARE Research and Education grant for 2014 to support further research and outreach efforts, and encourage more growers to become involved in this initiative.

X_ Robert H. Lominska, Hoyland Farm__

Signature of Applicant