Training professionals on sustainable agriculture for enhanced ecosystem service from the ground up

Final Report for ENC10-118

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Project Coordinator:

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Project Information

Abstract:

Understanding the role of management practices on soil health and agroecosystems is critical to improving the sustainability and productivity of agriculture. Toward that goal, we conducted a series of day-long (7-hour) multi-state train-the-trainer workshops for educators and professionals to equip them with new information, practical knowledge, teaching materials and techniques, and assessment tools to assist farmers in shifting to sustainable agricultural practices.

Fourteen workshops were conducted in Illinois, Michigan, Minnesota, Ohio, Texas, and Canada during 2011 to 2013. During these events, presentations were followed by hands-on activities (use of soil quality kit) and visualization of tools (OSU soil organic matter calculator), questions and answers, group discussions, and evaluation. More than 1100 educators and professionals (including farmers) from 18 states and Canada were trained in those workshops.

Evaluations of the training activities showed that about three-fourths of the participants had positive responses to questions about different factors in the training.

Soil organic matter was identified as the most critical soil property to sustain soil quality. A lack of knowledge/education and tradition were rated the most important barriers to improving soil quality. Cover crops, crop rotation and conservation tillage (especially no-till), together were identified as the core management components of the sustainable agriculture.

Almost 90% of the respondents were pleased with the educational materials and tools provided for teaching local farmers. In the post-workshop evaluation (after 6-month), about two-thirds of the respondents reported they are actively involved in educating local farmers.

Based on communications during and following our workshops, we expect that our

training information and tools will be shared with more than 10,000 farmers. A web page (http://southcenters.osu.edu/soil) will include our project information (results, surveys, videos and photographs, and peer-reviewed and Extension publications).

Project Objectives:

In response to strong interests shown by NC states and SARE on sustainable agriculture, the main goal of our study was to conduct a series of train-the-trainer multi-state workshops for Educators and professionals to equip them with new information, practical knowledge, teaching materials and techniques, and assessment tools to assist farmers in shifting to sustainable agriculture to improve soil health for enhanced ecosystem services. Specific objectives were:

1. Develop teaching/training materials including USB flash drive, notebook, fact sheets, and electronic media with the assistance and review from a multi-state advisory group representative of the target audience.

2. Train 200 professionals to gain knowledge and understanding of sustainable agriculture for enhanced ecosystems services. [*Note: we trained 1142*.]

3. Foster partnerships among the professionals to support and organize cooperative programs on sustainable agriculture in NC region.

The expected outcomes/performance targets will reflect the main goal and the outcomes and performance will be documented through data analytics.

Short-term outcomes

1) Educators and professionals will become aware of sustainable agricultural practices to improve soil quality, crop productivity, and farm sustainability.

2) Educators will acquire practical knowledge, learn new techniques and tools, and develop skills to teach/assist local farmers.

3) Educators will be motivated to teach sustainable agricultural practices to clientele.

Intermediate outcomes

1) Educators will train/assist farmers on sustainable agriculture related to conservation tillage, cover crops and crop rotation, manure nutrient recycling, and soil quality improvement.

2) Motivated educators will develop, organize and implement programs to assist farmers, including workshops, WebEx programs, open-house, demonstration plots, and field days.

3) Educators will assist farmers in shifting to sustainable agriculture by removing road blocks.

Long-term outcomes

1) About 20 to 30% of farmers in the NC region will adopt sustainable agricultural practices in the next 10 to 15 years.

2) Nutrient recycling (cover crops and manure) in conservation tillage will increase by 20%. As a result, chemically reactive fertilizer usage will decrease by 10% per unit of production.

3) Economics of agricultural production will be improved.

Introduction:

Human activities that influence the air, soil, and water cycles affect agricultural sustainability and ecosystems services. Conventional production agriculture produces greater amounts of food, feed, and fiber but current practices are associated with air-soil-water quality degradation and contribute to diminished ecosystems services. Frequent plowing has damaged soil quality (health) by affecting soil biology, physical structure, fertility, and organic matter content.

Erosion is causing soil to be lost at a rate 10 to 40 times the rate at which it can naturally be replenished. Every year the U.S. loses more than one million acres of land to development, land that is ideally suited to growing food. About 70% of rivers and streams and half the lakes in the US are impaired by reactive nutrients (especially nitrogen and phosphorous) and sediments in runoff, mainly from tilled fields with little or no residue cover. More than 25% of carbon dioxide, 60% of nitrous oxide, and 50% of methane as greenhouse gases are emitted from current agricultural practices.

By 2050, U.S. agricultural production may have to double, which will tend to make cropland increasingly dependent on chemicals, water, and energy. Such intensification of farming will have long-term consequences on air-soil-water ecosystems that are expected to be detrimental on ecological, economical, and social sustainability. In particular, production agriculture has affected environmental quality because of its reliance on tillage, chemical fertilization, and convenient chemical control of pests. Moreover, with rising fuel and fertilizer costs, farmers are looking for alternatives. Science-based information is needed to increase food production using sustainable agricultural practices with enhanced ecosystem services. The vision is to make soil health improvement the cornerstone of land use management decisions and promote the role of soil health in profitable and sustainable natural resource systems.

This project continued the collaboration of research and Extension professionals in Ohio and several other states. For ten years, we have been actively working with state and federal agencies, agricultural enterprises, crop consultant associations, farmer organizations, and environmental groups to promote sustainable agricultural practices by focusing on soil health.

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Education & Outreach Initiatives

Objective:

Description:

Methods

Collaboration

Organizations actively involved in organizing the workshops, in-service and field days were: Ohio State University, University of Minnesota, University of Nebraska and Michigan State University, USDA-ARS, Conservation Tillage and Technology Conference (CTTC), Ohio No-Till Council, Midwest Cover Crop Council (MCCC), Soil and Water Conservation Society, Corn Marketing Program (CMP) of Michigan, and NRCS and SWCDs in Ohio, Michigan and Illinois.

Workshops, In-Services and Field Days

A total of 14 one-day workshop/in-service/field day events were organized in Ohio (3 in Ada and Piketon), Michigan (4 in Hickory Corners, Clarksville, Owosso, and Gaylord), Illinois (3 in Mt. Vernon, Springfield and Sycamore), Minnesota (2 in Morris and Waseca), Texas (1 in Ft. Worth), and Canada (1 in Listwell, Ontario), respectively

(Picture 1). The first two workshops were held in conjunction with the University of Minnesota in 2011. Three workshops including a field day were organized in Ohio in conjunction with Ohio State University South Centers, CTTC, and Ohio-No-Till Council, 2012 and 2013. One in-service training workshop for NRCS personnel was organized at a national conference of the Soil and Water Conservation Society in 2012. A field day was also organized at a Carbon, Energy and Climate Conference in conjunction with Kellogg Biological Center, Michigan State University in 2012. Three workshops were organized in Illinois in conjunction with NRCS in 2013. Finally, three workshops were organized in Michigan in conjunction with NRCS and Michigan State University in 2013. One workshop was organized in Ontario, Canada in conjunction with Agricultural Solutions, Inc. (www.agriculturesolutions.ca/) in 2013.

Target Audience

The target audience was educators and professionals from University Extension, Natural Resources Conservation Service (NRCS), Soil & Water Conservation Districts (SWCD), Environmental Protection Agency (EPA), Crop Consultant Associations, and Farm organizations, Ag-Enterprises, Non-Government Organizations and Environmental Groups. Others invited were: young and innovative farmers, farm leaders, county officials, professors, high school teachers, and bank, credit union and farm co-op officials (Picture 2).

Workshop Speakers

Workshop speakers included: Rafiq Islam, Randall Reeder, and Jim Hoorman from Ohio State University; Dean Bass from Michigan State University; Paul Jasa from University of Nebraska; Jodi DeJong-Hughes,Jeff Vetsch and Deborah Allan from University of Minnesota; George Derringer and Mark Scarpitti from Ohio NRCS; Jerry Griger from Michigan NRCS; Donald Reicosky from USDA-ARS in Minnesota; Jill Clapperton from Montana; Steve Groff from Pennsylvania; Vinayak Shedekar, Ph.D. student from Ohio State University; and prominent no-till farmers, Bill Richards and Dave Brandt, from Ohio (Picture 3).

Workshop Materials

Workshop materials included: a teacher’s guide, a course outline, a set of Power-point presentations, handouts, CD/DVDs, and other supporting materials. The workshop materials were divided into four parts: (a) first session was to introduce the teaching materials, (b) second session was designed as an applied, hands-on exercise to give participants a chance to use the soil quality field test kit and ecosystem services calculator and any other practical assessment tools, (c) discussion and participation, and (d) response and documentation.

Topics of the teaching materials included: (1) Climate change and agricultural sustainability in the 21st Century, (2) Tillage management practices impact on carbon sequestration, soil health and water quality, (3) Conservation tillage systems approach, (4) Soil organic matter and ecosystem services calculator, (5) Ecofarming and soil health, (6) Soil quality/health tests and demonstrations, and (7) Management systems and crop production.

The demonstration and hands on activities involved in-situ and rapid test of soil health, and compaction, runoff, infiltration and slaking test demonstration (Picture 4). While the discussion and participation session was based on questions and answers between speakers and participants, the response and documentation part was based on post-workshop evaluations. Educational/training materials were prepared by the project partners and reviewed by a multi-state advisory panel.

Workshop Evaluations and Data Analytics

Workshop activities and performance were evaluated based on Pre- and Post-tests of KASA (knowledge, attitude, skills and aspiration) for participants at all events.

The professionals who attended workshops were surveyed 6 months after the workshops to collect information on conducting local workshops, providing teaching and interactions with farmers, and the number of farmers are trained. The survey data were numerically synthesized and analyzed for statistical significance by Statistical Applications Software, and presented the mean and standard error of the data in charts and figures using SigmaPlot®.

- Workshop in Minnesota – Soil quality demonstration
- Workshop in Ohio
- Workshop in Illinois
- Workshop audience in Michigan
- Workshop speaker (Rafiq Islam)
- Workshop participants using OSU soil quality field test kit in Michigan
- Workshop speaker at Michigan
- NRCS personnel using OSU soil quality test kit in Illinois
- Workshop audience in Ontario, Canada

Outreach and Publications

A web page on sustainable agriculture and soil quality is under construction, as part of the Soil, Water and Bioenergy program of the OSU South Centers website, which will be the platform for posting project results, surveys, videos and photographs, and peer-reviewed and Extension publications (http://southcenters.osu.edu/soil).

A presentation was given at the 2014 NCR-SARE Farmers Forum, held in conjunction with the Ohio Ecological Food and Farm Association (OEFFA) Conference. A recording of this can be viewed online through NCR-SARE's YouTube channel at:https://youtu.be/ATUgezk2GHo?list=PLQLK9r1ZBhhGr9RLwfvRvJLEtHJOLdXZz

Outcomes and impacts:

We are confident that the materials, information and tools provided and/or delivered in 14 workshops (ten more than originally planned) were valuable to the attendees and participants based on the turnout and follow-up responses from attendees. Our workshops and speakers attracted more than just state and regional educators, professionals and farmers, which suggests both the demand for, and the interest in, topics presented at the workshops.

Our SARE Project-related web traffic was quantified by Google Analytics to verify broader outreach of project materials. Our website is frequently visited for information on soil health, SOM calculator and agricultural sustainability (http://southcenters.osu.edu/soil-water-bioenergy/extention/som-soil-organic-matter-calculator).

We have organized 14 multi-state train-the trainers workshop field day in U.S. Midwest and Canada from 2011 to 2013 (Fig 1): two in Minnesota in 2011; one in Texas and four in Ohio in 2012 to 2013; and three in Illinois in 2013, four in

Michigan, and one in Canada in 2013. We have trained 1142 educators, professionals and farmers in AR, CA, CO, IA, IL, IN, KS, KY, MI, MO, MN, MT, NE, OH, PA, TN, TX, WI, Washington DC, and Canada attended the workshops (Fig. 2). About 123 participants attended 2 workshops in Minnesota in 2011. In Ohio, 437 participants attended 4 separate workshops/field days in 2012 and 2013. Overall, 123 participants attended our training in 2011, 212 in 2012, and 807 participants in 2013 (Fig. 3). A diverse group of professionals have attended our workshops. Among the participants, more than 36 percent with +10 percent were personnel from state- and federal agencies (Fig. 4) followed by farmers (17 percent), educators (15 percent) and crop consultants (12 percent). A few dealers and agribusiness personnel also attended. Participants from age groups have attended the workshops (Fig. 5). The most dominant age group of participants (27 percent) attended the workshop are 40 to 50-year old followed by 30 to 40-year old. About 15 percent of the participants were younger than 20, which suggests new and young farmers in the Midwest are interested to acquire knowledge or information on sustainable agricultural management practices.

Participants have shown a great interest to our workshop, speakers and the supporting materials. About 82 percent of the participants evaluated our workshops as well prepared, organized, and easy to follow, and provide new and useful information compared to 5 percent of the participants who disagreed (Fig. 6). About 82 percent of the participants agreed (including strongly agreed) that the free distribution of the USB flash drive with workshop support materials and Powerpoint presentations and soil quality field test kits were highly appropriate and ready to be used for teaching farmers workshop (Fig. 7). Only 4 percent disagreed, and 10 percent were neutral. Averaged across all sites, workshops, meetings and field days, about 69 to 89 percent of the participants agreed or strongly agreed that the workshop speakers were knowledgeable, well prepared, and informative. Less than 5 percent disagreed. About 62 to 82 percent of the participants reported that our program (workshop materials, tools, presentations and speakers) was one of the best or above average when compared with their previous educational workshops (Fig. 8). Less than 25 percent of the participants reported our workshop as average compared to previous educational opportunities. About 4 percent of the participants reported our workshop below average or one of the worst.

On average, participants stated a 21 to 25 percent increase in knowledge gain on the topics covered: (1) Climate change and agricultural sustainability in the 21st Century, (2) Tillage management practices impact on carbon sequestration, soil health and water quality, (3) Conservation tillage systems approach, (4) Soil organic matter and ecosystem services calculator, (5) Ecofarming and soil health, (6) Soil quality/health tests and demonstrations, and (7) Management systems and crop production (Fig. 9). Highest knowledge gain (29 percent) by participants was reported on *Conservation tillage systems approach - Ecofarming and soil health* followed by 27 percent on *Soil organic matter calculator and ecosystem services* and 20 percent on *Tillage management practices impact on carbon sequestration, soil health and water quality*. About 15 to 23 percent of knowledge gain was on *Soil health/quality field test and demonstration*. Eighteen percent of the participants reported positively about climate change effects and reported about 18 percent increase in knowledge gain on *Climate change and agricultural sustainability in the 21st Century*. Results also showed a variation in participants knowledge gain among the states (Fig. 10). Among the states, Illinois participants had the highest average knowledge gain (32 percent) followed by Ohio (24 percent) and Minnesota (21 percent). Michigan (19 percent) and Canadian (17 percent) participants had the

lowest average knowledge gain. In Illinois, the highest increase in knowledge gain was reported on *conservation tillage systems approach - Ecofarming and soil health* (54 percent) followed by *Soil organic matter calculator and ecosystem services* (50 percent) and lowest knowledge gain on *soil quality/health test demonstration* (13 percent). In Michigan, the highest knowledge gain reported by participants on *conservation tillage systems approach - Ecofarming and soil health* (37 percent) and the lowest increase in knowledge gain was reported on *soil quality/health test demonstration* (10 percent). In Minnesota, the highest knowledge gain was reported by participants on t*illage management practices impact on carbon sequestration, soil health and water quality* (22 percent) followed by soil quality test kit/demonstration (21 percent) and the lowest increase in knowledge gain was reported on *climate change and agricultural sustainability in the 21st century* (17 percent). Averaged across Ohio, the highest increase in knowledge gain was reported on *conservation tillage systems approach - Ecofarming and soil health* (40 percent) followed by *soil quality/health test demonstration* (32 percent) and *Soil organic matter calculator and ecosystem services* (23 percent). In contrast, lowest knowledge gain was reported on t*illage management practices impact on carbon sequestration, soil health and water quality* (18 percent) and *climate change and agricultural sustainability in the 21st century* (18 percent). Combined over other states, the highest knowledge gain by participants was reported on *Soil organic matter calculator and ecosystem services* (20 percent) and *tillage management practices impact on carbon sequestration, soil health and water quality* (20 percent). The lowest knowledge gain by participants was reported on *climate change and agricultural sustainability in the 21st century* (15 percent). In Canada, the highest knowledge gain by participants was reported on *Soil organic matter calculator and ecosystem services* (38 percent) and the lowest was reported on *conservation tillage systems approach - Ecofarming and soil health* (16 percent).

About 69 to 85 of the participants reported learning of new topic/ information and tools of soil quality after attended the workshop (Fig. 11). Thirteen percent of the participants reported they did not learn anything new from the workshop. About 9 percent of the participants were neutral. Averaged across workshops conducted, about 74 percent of the participants reportedly liked the OSU instant soil quality test kit and soil organic matter (SOM) calculator to measure variations in soil quality and soil organic matter content in response to management practices (Fig. 12). Four percent of the participants reported negatively. About 22 percent were neutral. When asked to rank the importance of the soil properties (Fig.13) to evaluate soil quality/health, about 42 to 53 percent of the participants ranked soil biological properties as 1st followed by soil physical properties (27 percent) as 2nd and the soil chemical properties as 3rd (23 percent). Similarly, when asked to identify the single most important property of soil associated with soil quality/ health evaluation, soil organic matter (SOM), cation exchange capacity (CEC), earthworms, microbes, compaction and color were identified as the important properties (Fig. 14). Soil organic matter (organic carbon) was identified as the most critical soil property to sustain soil quality and improve ecosystem services by 22 percent of the participants Earthworm population ranked as 2nd most important (19 percent), microbes ranked as 3rd most important (16 percent), and CEC, compaction and color ranked as last (14 percent).

Several barriers were identified by the participants to improve soil quality and agricultural sustainability (Fig. 15). Among them tradition was rated the most

important barrier to improving soil quality by 44 to 48 percent of the participants. A lack of knowledge/education was identified as the2nd major barrier to improve soil quality 21 to 47 percent of the participants. Finance/risk associated with transitional conservation practices was rated as the 3rd most important barrier to improve soil health by 12 percent of the participants. About 1 to 11 percent of the participants identified land leasing/land ownership as one of the barriers to improve soil health and agricultural sustainability. Cover crops, crop rotation and conservation tillage (especially no-till), together were identified as the core management components (90 percent) of the sustainable agriculture by the participants (Fig. 16). About 35 to 43 percent of the participants identified cover crops integration into the production is the most important to sustain soil quality followed by crop rotation. About 23 percent of the participants considered conservation tillage the important practice.

Long-Term Post-Workshop Evaluation

Six months after the workshop attendance, participants were asked about their activity to organize local meetings for farmers on sustainable agriculture and ecosystem services (Fig. 17 to 22). Only 13 percent of the workshop participants responded to answer the post-evaluation survey questions (Fig. 17).

Among the respondents, about 92 percent of the participants were educators (28 percent University Extension) and private companies (48 percent crop consultant) and state- and federal agencies (16 percent SWCD technicians and NRCS district specialists). About 4 percent of the respondents were innovative farmers and farm leaders (Fig. 18). About 64 percent responded positively and 30 percent responded negatively, and 6 percent were neutral (Fig. 19). Sixty four percent of the post-workshop respondents actively involved to train or educate up to 25 farmers in their local meetings and field days (Fig. 20). About 18 percent of the respondents trained more than 100 farmers in their local events. About 87 percent of the respondents reported positively (Fig. 21), with 52 percent satisfied with the educational materials and tools to organize local farmers meeting and field days, and 32 percent very satisfied. Only 13 percent were somewhat satisfied. No respondents answered negatively. About 62 percent of the respondents answered positively that they will be active to organize local meetings and field days to train and educate farmers (Fig. 22). In contrast, 17 percent of the participants responded negatively. About 21 percent of the participants were not sure.

- Outcomes and Impacts

Project Outcomes

Project outcomes:

1. Organized 14 multi-state workshops, meetings, in-services and field days
2. Trained more than 1140 educators, professionals, and farmers
3. Distributed 1200 USB flash drives containing workshop curriculum, training manuals, Powerpoint presentations, and other teaching materials
4. Distributed 1200 instant soil quality field test kits
5. Distributed more than 500 copies of OSU Soil Organic Matter Calculator
6. A web page with free access to resources (http://southcenters.osu.edu/soil)
7. One peer reviewed journal article and one fact-sheet (under preparation), and three popular articles written.

Recommendations:

Potential Contributions

Based on the questions, responses and discussions during and after the workshop sessions, we expect participants will share the training information and tools with more than 10,000 farmers, resulting in a positive synergistic impact on the adaptation of sustainable agricultural management practices in the Midwest. A blend of diverse but complementary backgrounds among our project investigators, collaborators and speakers helped us far exceed our original goals.

Recently, we submitted a Conservation Innovation Grant (CIG) proposal entitled "Developing and demonstrating a soil health assessment tool for increasing soil productivity and enhancing ecosystem services" with 7 universities (South Dakota State University, North Dakota State University, Michigan State University, Kentucky State University, Pennsylvania State University, South Carolina State University, and University of Florida) and USDA-ARS. If funded, this CIG project will help us expand and build upon the 14 multi-state training workshop experiences.

Future Recommendations

Farmers are striving to reduce their costs and increase profits which can result in the adoption of practices that produce short term yield gains at the expense of decreases in soil productivity, resilience, and soil health. Soil renaissance practices such as cover crops, increasing crop diversity, reducing tillage intensity and incorporation of manure and amendments can improve soil health while annual plowing, burning or harvesting the crop residues can reduce soil health. Farmers are willing to consider practices that increase soil health because they view them as an investment in their future. However, the long-term maintaining of these practices is complicated by benefits that are difficult to clearly identify and financial needs can influence the decision process. Easy-to-use decision tools are needed that can help farmers identify the short and long term benefits from adopting practices that

improve soil health. Educators and professionals are interested in soil health issues and want to be able to provide the needed support to guide producers in sustainable management strategies. Providing continued education and tools on soil health in response to expected climate change is essential to meet food security and sustain agricultural productivity.

Information Products

- "Rafiq Islam Cover Crop Cocktail Farmers Forum Presentation 2014 " (Multimedia)

Sustainable Agriculture Research & Education US Department of Agriculture

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