Project Summary

Title: Sustainable Agroecosystem Science on Diversified Farms Producing for Local Food Systems

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This integrated, standard grant addresses both SAS LTAP program goals and all agency mission areas. New farmers are appearing throughout the country, operating small and diversified farms, that are part of a growing trend towards relocalization of food systems. The goal of this proof-of-concept proposal is to lay the foundation for robust long-term agroecosystem research, extension and education about a fundamentally different structure for agriculture in densely populated regions of the US – a structure that supports sustainable production, processing and distribution of high-quality and healthy foods for local communities. A transdisciplinary team of research and extension scientists in partnership with a unique group of farmer educators propose to create a long-term network linking existing research and education farms that will be used to build a new agroecosystem science for local food systems. The farms represent a range of points in their transition to diversified production and are geographically dispersed in the rural-to-urban landscapes of major metropolitan areas in Ohio, typical of lands surrounding major cities throughout the Midwest and Eastern United States. The research will use soil, biodiversity, and market data to test the hypothesis of self-reinforcing feedbacks between diverse demand and production for local markets, increased capacity for systems thinking among land managers, and increased capacity of soils to sequester carbon, recycle plant nutrients, and further support diversified agriculture. Education and extension via the network will be enhanced with an academic conference, curriculum, development of internet networks among the farms and between the farms and schools.

Project Narrative

Sustainable Agroecosystem Science on Diversified Farms Producing for Local Food Systems

Introduction

The goal of this proof of concept proposal is to lay the foundation for robust long term agroecosystem research, extension and education about a fundamentally different structure for agriculture in densely populated regions of the US – a structure that supports sustainable production, processing and distribution of high quality and healthy foods for local populations and communities. A transdisciplinary team of research and extension scientists in partnership with a unique group of farmer educators propose to create a long term network of research and education farms that will be used to build a new and strong agroecosystem science of local food systems. The farms are distributed throughout a region characterized by glaciated soils in the rural to urban transitional landscapes of major metropolitan areas in Ohio, typical of lands surrounding major cities throughout the Midwest and Eastern United States.

Demand for locally produced food far outstrips supply in most places, so there is plenty of opportunity for existing farmers to shift their production to meet that demand and for new farmers as well. New farmers are beginning to appear throughout the country. The 2007 Census of Agriculture documented a 4% increase in the number of US farms and the operators of those farms have become more diverse in the past five years. The new farms are small and diversified, and many if not most are part of the trend towards relocalization of food systems and economies.

Much of our existing agroecosystem science has been built around more conventional agriculture, based on larger scale and relatively simplified cropping and socioeconomic systems. A new agroecosystem science of local food systems must be able to deal with diverse and complex ecological and socioeconomic networks. Long term integrated research on educational demonstration farms, and not just one but several of them, can play valuable roles in demonstrating the possibilities for working, transitioning and beginning farms, and in developing a new agroecosystem science that truly integrates all the disciplines needed to support the complex networks of environmental, economic and social factors involved in diversified local food systems .

The scientific focus of this proposal is to seek an improved understanding of both biophysical and socioeconomic processes in diversified farming systems, and use that understanding to better interpret how those processes can improve the land, support farmers, and strengthen ties between farms and communities. Socioeconomic processes of interest include the market demands and cultural preferences that shape what farmers decide to produce and sell in local and regional markets. These market demands evolve and shift over time, requiring farmers to adapt and nimbly shift production to meet them. Diversification and an ability to connect these shifting markets with production are hallmarks of successful farms, for which demonstration farms provide an example. Of particular interest in comparing these farms are the biogeochemical cycles that link above-ground diversity in plant and animal communities with the below-ground diversity of soil communities and how this biodiversity impacts soil carbon dynamics. To better manage soils and production in such settings, we require shared knowledge on how local markets drive decisions on what is produced, how production diversity leads to biological diversity and economies of scope on farms, how farm biological diversity leads to soil organic matter profiles that reflect the biological diversity of their plant and animal origins, and the impact of such soil organic matter profiles on ecosystem services such as carbon sequestration, ground water percolation and nutrient cycling. **Our overarching hypothesis is**

that the diverse production required to meet demand in local markets over time leads to increased capacity for systems thinking among land managers and increased capacity of soils to sequester carbon, recycle plant nutrients, and further support diversified agriculture. The bidirectional and positive reinforcement between economic diversity and biological diversity, manifested through a multifunctional agriculture with greater understanding and awareness of food systems among both farmers and consumers, is a long term transition that is needed in the United States. It is this long-term hypothesized feedback loop of diversified production, between the socioeconomic conditions surrounding farms to the biogeochemical conditions in the soil and back to the community in multifunctional benefits at landscape scales, that we are proposing to research over many years or decades.

Key research questions about the biogeochemical aspects of soil systems in diversified farms include: 1.) the relationships among aboveground biodiversity, belowground food webs and decomposer communities, and the composition of soil organic matter; 2.) the change in carbon balance of soils with transition to diversified production systems and plant communities; 3.) the relative importance of various organic soil amendments to crop productivity and soil carbon sequestration capacity; 4.) the impact of chemically diverse detrital biomass produced in diversified farming systems on soil processes associated with carbon sequestration; 5.) how soil health resulting from diversified farming systems varies over time and across rural to urban landscapes; and 6.) how can we develop a science-based policy that supports diversified farming systems and the ecosystem services they promote.

Key research questions about the social and behavioral aspects of managing such diversified farms include: 1.) how the new relationship between producer and consumer in local food systems translates to diversity in production of food and ecosystem services, in both spatial and temporal terms; 2.) how farmers acquire and develop the information, skills, and technologies necessary to manage diversified multifunctional enterprises producing and marketing local foods and ecosystem services; and 3.) how experience in dealing with complex market demands and diversified production systems enhances farm management from a more holistic systems perspective.

Key research questions about the emerging relationships at the watershed, community, and rural-urban level include: 1.) how changes at the farm and consumer level translate/aggregate to changes at the level of watershed, community, and regions; 2.) the temporal and spatial dimensions of these changes; 3.) how we can tailor markets and/or payment systems for ecosystems services from diversified farms; 4.) what indices of ecosystems services such as carbon credits can be developed that can be monitored, verified, and exchanged; and 5.) the potential for including carbon credits in local food system transactions, particularly so that credits accrue to both producers and consumers, tightening the bond between them.

Key research questions about the opportunities for education and outreach include: 1.) how we can train students to conduct transdisciplinary analyses of the natural and human components of farming systems, from soil to society; 2.) how we can create sequential threads in thesis and dissertation projects around long-term integrated agroecosystem studies on demonstration farms; 3.) how land managers' experiential understanding of soil organic matter and carbon management in diversified farming systems can be formalized to spread through peer networks; and 4.) what experiences and on-farm experiments make soil C an observable outcome of farm management practices.

The network of farms we propose includes land-grant university owned and managed; local government owned and managed in parkland; non-profit NGO-owned farms associated with various educational, civic or religious organizations; and farms that are operated in a national park. They range from very typical rural farms to a "remnant" urban farm in a primarily African American and Jewish community. They range in land management decision-making but share a focus on education, to assist and influence practicing farmers. They each operate in tight partnership with practicing farmers and focus on the best opportunities for diversified farms in serving local food markets. Therefore, this network provides an excellent and seamless flow from research to education to practice for our integrated research and education project. Furthermore, this network of farms has an assurance of remaining in operation throughout a long-term project because of the government or NGO commitment behind them. Such longevity is difficult to assure in the private sector, particularly for the relatively new farms producing for local food systems. In fact, the demonstration farms themselves represent different points in the transition from conventional commodity agriculture to the diversified farming systems described above, an additional advantage for our research and education network. Although all focus on diverse production and education, note that each is at a different point in a transition away from conventional production for commodity markets, providing opportunity to study changes over time in the soils and in participating farmers.

Aullwood Audubon Center and Farm was created in 1962 by the National Audubon Society as one of the first educational farms in the country. Aullwood's organic farm consists of nearly 70 acres of alfalfa hay, spelt, pasture grasses, croplands, sugarbush, herb and vegetable gardens. Sustainably and/or organically raised beef, pork, lamb, turkey goat, chicken and eggs are sold locally to members, visitors or restaurants. Aullwood conducts many long-term citizen science projects on farm and sanctuary land and teaches by example using active learning techniques. Children learn that their food originates, in Ohio's rich soil.

Transition Farm at Conneaut Creek Park is in the process of ownership transfer to the Center for Ecological Culture in partnership with the Ashtabula County MetroParks. The park contains approximately 90 acres of woodland, scenic trails, and creek access, twenty-five arable acres and a two and one-half acre pond. In recent history, a portion of the land has been operated for hog production, conventionally farmed hay, corn and soybeans. New activities planned for 2010 when the Metropark acquisition will be completed include agroforestry, agritourism, edible perennial production, fuel crops, and small-scale grain production. Its unique characteristics in the farm network are that this publicly held parkland will be managed by a neighboring non-profit, Center for Ecological Culture, which will conduct extension activities in the areas of ecological literacy, sustainable farm design/management, training, and internships to the Ashtabula county community.

Crown Point Ecology Center's Mission is: "To demonstrate the practical applications of ecology and to connect spirituality, social justice, and environmental protection." Crown Point is green space that matters – a biologically diverse living laboratory that serves to demonstrate the practical applications of ecology. The 130-acre property in Bath, Ohio is a regional model for sustainable agriculture and environmental education. The farm's managers believe that ecological land stewardship encourages structural and social well-being through the four principles of community, justice, spirituality, and sustainability.

Farms in the Cuyahoga Valley National Park (CVNP): Cuyahoga Valley National Park (CVNP) was established in 1974 to preserve and protect the "historic, scenic, natural and recreational values of the Cuyahoga River and adjacent lands of the Cuyahoga Valley" including its rural landscape and character. The Cuyahoga Valley Countryside Conservancy (CVCC) – was created in 1999 to help conceptualize and manage a program to rehabilitate and revitalize the old farms within park boundaries. The *Countryside Initiative*, is now considered the most ambitious and innovative agricultural operation in the National Park Service – and is viewed an important model for other units of the Park Service having agricultural resources. Eleven farms have been rehabilitated, and four more are in progress. CVCC and CVNP are now working with other partners to establish three additional learning and demonstration farms: a small (6 acre) organic farm linked to a k-8 school and it's curriculum, a "residential farm school" for 3-4 day programs, and an Entrepreneurship Center, which will include demonstration, food processing facilities, small farm incubator sites, internship and structured educational programs (workshops, classes, conferences).

George Jones Memorial Farm and Nature Preserve: This 70 acre farm is owned by Oberlin College and leased to the New Agrarian Center (NAC), an independent non-profit organization that works to facilitate sustainable regional food system development. The farm transitioned from corn and soybean production in 2001 to a combination of small-scale vegetable and free-range meat production and nature preserve. The farm is operated by beginning farmers and mixes research programs in sustainable agriculture and restoration ecology with a variety of demonstrations The farm offers a liberal arts college connection and outreach programs including the City Fresh farms-to-urban neighborhoods program, documentary film making, a K-5 learning curriculum for public schools and a high school apprentice program, local and regional food policy efforts, and a variety of workshops and programs for a wide audience.

Greenwood Farm was established as a farm in 1908 by the Phypers family. In 1912 the Ohio Agricultural Extension Service recommended a design for providing the best yields and proper drainage for the farm. The farm had a variety of livestock including cows, chickens and Tarnworth boars. As the area became more urbanized it ceased operating as a farm in the late fifties. In August of 2004 the City of Richmond Heights purchased the remaining 16.62 acres of Greenwood Farm for park and nature conservation purposes. A portion of the acreage will be devoted to community gardens and farming to educate an urban community about sustainable farming practices and to broaden their knowledge of local food production and how it contributes to a healthier environment.

The OSU-OARDC Mellinger Farm: This 300 acre farm near the Wooster campus of OARDC is in the process of being donated to The Ohio State University by the Quinby family, the original homesteaders who established the farm in 1816. It is currently rented for no-till corn and soybeans while the transfer of ownership is being completed. New enterprises envisioned when the transition begins in 2010 include horticultural crops, organic sheep and goat dairy, agritourism, agroforestry, and diverse agronomic crop rotations. It's unique characteristics in the network are that it will be operated by a major land grant University agricultural research institution, OARDC, and provide hands-on educational opportunities for students in a 2-year associate degree programs at the adjoining Agricultural and Technical Institute.

The Stratford Ecological Center, a private 501(C)(3), maintains 236 acres including an organic farm, a privately owned State Nature Preserve, forests, a prairie, pond and waterways that all serve as the stage to provide experiential, appreciation based agricultural and environmental education. Annually over 3,000 children come to learn where there food comes from and the potential synergistic relationships between agriculture and nature. The farm follows an eight-year crop rotation (corn, spelt, oats, sunflower, buckwheat and hay), a multispecies livestock operation including beef and dairy cattle, sheep, goats, hogs, chickens and a llama that serves as a guardian for the small livestock, two greenhouses that produce greens and other vegetables/herbs/flowers year-round, an orchard, children's garden, brambles, asparagus, strawberries, and 1-2 acres of field grown vegetables, a maple sugar bush and wood-fired sugar shack, beehives for honey, and shiitake mushrooms. Stratford offers internships in Sustainable Agriculture and Environmental Education, experiences for children, programs for families and adults in a wide range of farm-related topics.

Sharing knowledge and opportunities in diversified production to meet the demands of local food systems is the central theme of this set of Ohio demonstration, education and research farms, part of a national and international trend that is gaining recognition in the literature.

Background

Local food systems have received a great deal of interest over the past decade and even more so as rising fuel and energy costs make transportation over large distances economically less efficient. Besides potential energy savings, however, local food systems have been associated with a wide range of benefits including social justice (Wilkins 2005), better connection between urban and rural populations (Francis et al. 2005) and between farms and rural communities (Hultine et al. 2007), sustainable agriculture (Campbell 1997), and rural economic development (Marsden et al. 2000, Marsden and Smith 2005, Renting et al.2003, Ernst et al. 2007). Economic benefits of local fruit and vegetable production and marketing have been demonstrated in a number of studies (Brown 2002, Gale 1997, Otto and Varner 2005, Swenson 2006). Furthermore, through helping farmers stay in business, farmers' markets indirectly contribute to the preservation of open space and farmland (Brown 2002).

Just as diversity in farm enterprises brings economic benefits to farms and farm communities, the biological diversity associated with more diverse farming systems can lead to ecological benefits. Multifunctional agriculture is a term used to describe the combination of environmental, social and economic benefits that can accrue from diversifying agriculture (Latacz-Lohmann and Hodge 2003). Boody et al. (2005) documented environmental benefits in improved water quality, fish health, carbon sequestration and reduced greenhouse gas emissions. Proposed mechanisms and the specific ecosystem services that are enhanced vary somewhat among studies. The ecological literature has documented a convincing case for greater biomass production resulting from plant diversity (Cardinale et al. 2007). One mechanism, attributed to both crop and animal species diversity, is more efficient use of natural resources through increased nutrient cycling (Carrol et al. 1990). But diverse crop mixtures also have been associated with reduced losses to pests and diseases (Hajjar et al. 2008, Holling et al. 1995, Folke et al. 1996), and maintenance of an even wider range of ecosystem services including pollination, soil nutrient processes, and carbon sequestration (Hajjar et al. 2008). Biodiversity is expected to increase with a shift to more diversified farms producing for local food systems (Bengtsson et al. 2005). Farms that produce for local food systems are more diverse in terms of scale, production, and the farmers themselves, than those that produce for the global food system (Lyson and Green, 1999). In a meta-analysis of literature on the effects of organic farming, characterized by more diverse rotations and less pesticide and inorganic fertilizer use, species richness was 30% higher compared with conventional farming systems. The net result of crop diversity is resilience and sustainability in agroecosystems (Collins and Hawtin 1999).

Based on this body of evidence in the literature, we used a measure of biodiversity as one of six key natural/physical and social/economic variables describing agroecosystem health (Vadrevu et al. 2008). This innovative model also integrates soil health, farm and land economics and social organization into the index, which can be mapped to provide a landscape scale analysis of agroecosystem conditions. Local food systems would be expected to increase the index through positive reinforcement among each of these variables. Therefore, our proposed research will test some of the key hypotheses behind the index.

From an economic perspective, diversification allows farm households to avoid the economic centrality of commoditized agriculture that favors off-farm sectors and/or grow a business to accommodate multiple generations (Shucksmith and Hermann 2002). Lobley and Potter (2004) found diversification allowed farmers to continue farming when traditional approaches left them in a price-squeeze. Rising interest of producers in local food systems can be attributed to the continuous pressure on farm incomes in global commodity chains (Renting et al. 2003). Given competition in global commodity markets is based on low-cost production, farmers need to invest continuously in the newest technology and exploit scale economies to stay competitive (Renting et al. 2003). This 'technological treadmill' is particularly devastating for smaller farms that cannot produce enough to offset large capital investments. Adaptation to market conditions via diversification involves changes in the farm enterprise, labor, business structure, tenure, and size (Munton 1990). Increasingly, such farmers are looking for alternatives to the commodity system in diverse and multifunctional forms of agriculture and innovative marketing strategies that connect them with the local community and restore the economic viability of their operations (Renting et al. 2003).

Farm households finding ways to grow up, not out are turning to direct marketing (Shucksmith and Hermann 2002, Walz 2004), counter-industrial marketing and production (Guthman 2004), short commodity chains or local branding (Suryanata 2002; Allen et al. 2003; Renting et al. 2003; Winter 2004), alternative networks that reconstruct the commodity chain to the advantage of the producer (Whatmore and Thorne 1997; Winter 2004), and diversification (Barbieri et al. 2008). Clark (2009) found that the greater the extent to which farmers engage in diversification, the greater the potential for future business growth. Diversification was the second most important factor to farm success next to their business trajectory in the previous five years. These adaptation techniques imply an important relationship with the local community. Local residents may be important providers of labor, key inputs, and other services. Value-added processing, storage, transportation, and other activities may also create opportunities for local businesses and local employment. By considering agriculture to be part of local economic development strategies, communities can benefit by keeping more dollars circulating in the local economy and protecting more of local farmland resources.

In the past 15 years, consumer demand for organic, natural, and locally grown food has grown substantially (Dimitri and Greene 2002). Important motives for purchase of such niche food products include health and food safety concerns, environmental concerns, and a desire to support local, small scale agriculture and local rural communities (Williams and Hammitt 2000; Underhill and Figueroa 1996; Batte, et al. 2004). Consumers associate diverse positive attributes with buying local food (Darby et al 2008). A study of consumers shopping at farmers' markets revealed support for local farmers and locally grown foods is a key customer motivation (Feagan et al. 2004; Ernst et al. 2007). Farmers who seek reduced input costs based on low external inputs and scope, rather than scale, economies rely on ecosystem services and have been called "economical farmers" who often seek improved prices in local markets (Van der Ploeg 2000).Loureiro and Hine (2002) suggest that commodities with "locally grown", GMO-free, and organic labels all can command premium prices. Research by Sharp (2003) found that 81 percent of Ohioans prefer to buy foods produced locally whenever possible. Batte et al. (2004) found shopper race, gender, and those who elected to shop in a whole food/health specialty store to be significant variables in the explanation of willingness to pay for locally produced foods in Ohio. They also found health and safety concerns to be important determinants of food selection decisions.

Against this backdrop of price premiums for organic or local products, is the concept of green outputs, which are valued but would be un- or underpriced, and therefore underproduced, in a free-market world. In this section, for brevity, we denote these various outputs as "green outputs" and their prices (real or virtual) as "green prices". Optimal green production requires an appropriate structure of green prices or payments. The right green prices are contextual, particular, and richly detailed. There is a multiplicity of non-commodity outputs, each of them is multidimensional, and value at the farm level involves variety, quantity, quality, location, and availability of substitutes and complements. All of this places a substantial burden on the design of a structure of green payments: some fine distinctions must be made, in terms of amenity type, quantity, quality, and accessibility to demanders; and the valuation framework must be consistent as we move from single to multiple amenities, and from local to national spatial scales, and back again; and farm-level monitoring is needed to connect green payments with green production.

Randall (2007) has outlined a framework for a consistent valuation and pricing framework for green outputs. Several authors have explored the production relationships between commodity and green outputs (Blandford, et al. 2003, Gatto and Merlo 1999, Randall 2007). A substantial literature has emerged, estimating green values and/or benefits of European (Hanley et al. 1999) and US agriculture (Randall et al. forthcoming). Scarcity and substitution/complementarity relationships are, among other things, spatial in nature and systematically affect values and potentially prices for green outputs (Schläpfer and Hanley 2003). Efficient green-pricing involves the interaction of supply – which reflects at the local level the direct and opportunity costs of producing green outputs – and demand. One objective of this project is to explore how diversified producers of food and ecosystem services can participate in ecosystem service markets. We will begin with carbon markets, addressing design issues and field-testing the feasibility of measuring and verifying carbon credits. Eventually we will consider the potential of markets in suites of multiple ecosystem services, again addressing design and measurement issues.

Economic assessments of the potential for agriculture to help mitigate net greenhouse gas emissions by sequestering additional carbon in soils suggest that 30 – 170 million tons of CO_2 may be sequestered every year for \$5-\$30 per ton CO_2 (Murray et al., 2007; Lewandrowski et al., 2007). To a large extent, the potential for carbon payments rests on future policies, such as the proposed Lieberman Warner Climate Security Act of 2008 (s.2191), or the more recently proposed Waxman-Markey bill being considered in the US House of Representatives. Both bills would give clear pathways for agricultural landowners to be compensated for sequestering carbon in their soils. Of course, there already are myriad voluntary opportunities for landowners to be compensated, such as with the Chicago Climate Exchange (CCX), but the compensation levels in these voluntary programs are substantially lower than the future legislation may provide.

Despite potential for sequestering carbon in agricultural soils, the difficulties of doing it right are well recognized, if not yet solved (Murray et al., 2007). One issue, of course, is "additionality", which is the problem of establishing what a farmer would have done in the future without the payments for carbon sequestration. From the perspective of the atmosphere, only actions that reduce future net emissions should be compensated, but knowing which farmers would and would not have managed their land with conservation tillage in the future is a difficult task indeed. Another issue is measuring, monitoring, and verifying whether the carbon is indeed sequestered and stored in the future if it is contracted. While some work has begun on this issue for large industrial farmers (e.g., Antle et al., 2003), it's not yet clear what contracts would best work with smaller landowners, nor is it clear what measurement and verification systems can be put in place for the wider landscape. If small landowners growing diverse crops are to be involved in carbon sequestration in soils, entirely new measuring and monitoring systems will have to be developed and established to verify the carbon gains.

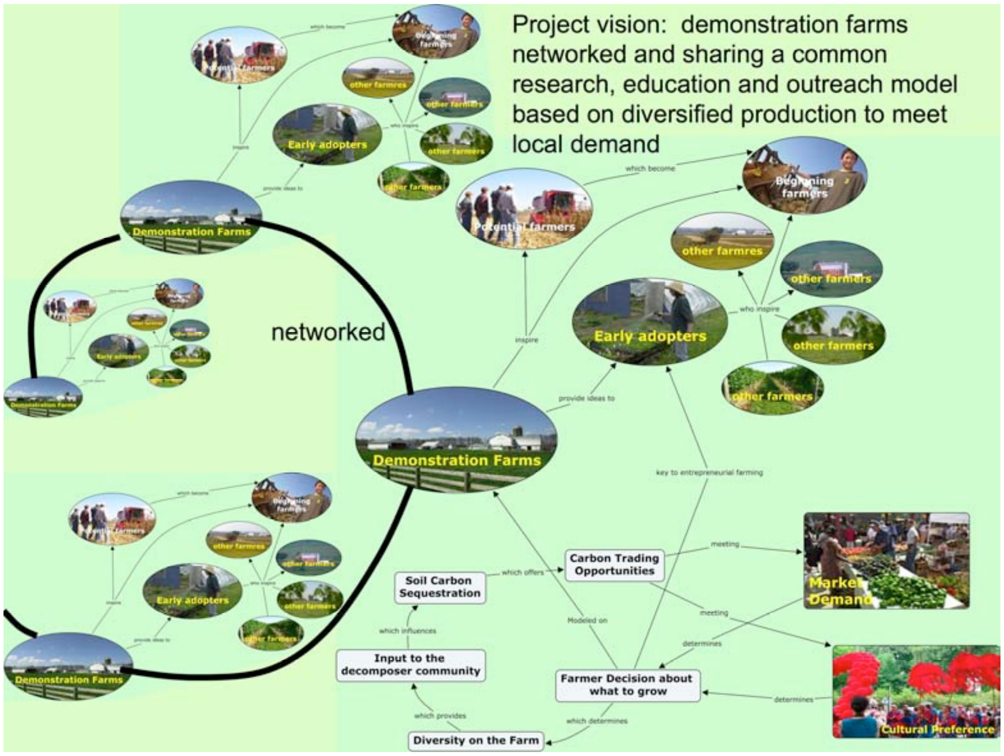
Perhaps most importantly, studies have shown that social interaction is an important determinant in the decision of both consumers and farmers to participate in farmers' markets (Brown 2002). It is these attributes of connection between consumers and producers, among producers, and between producers and others in the food value chain, that our network of demonstration farms cultivates. In fact, the concept of value webs (Block et al. 2008) is more useful as a way to describe the network we envision. Value webs go beyond value chains to include the multidirectional connections formed by linking demonstration farms more broadly to communities. Value webs can produce value both of the web, for example new market opportunities for producers, and value in the web, for example a more cohesive farm community with equity between producers and greater inclusion of farming in the food, art and musical culture of the community.

Rationale and Significance

The research, education and extension described in this proposal will 1.) build a network of farms that represent diversified food production for local food systems, 2.) establish and refine a data collection, management and analysis system to research long term changes in both farmers and soils leading to multifunctional benefits of farms, and 3.) set in place the educational and extension programs that will increase the capacity of an extended network of such farms to contribute maximally to local food systems, economies, communities and ecosystems. The unique combination of organizations that are connected in this proposed work include land-grant universities, liberal arts colleges, NGO's, and municipal, county and national parks. Each has education and outreach missions for private landowners and farmers, resulting in an extremely rich collaborative network for scientific and cultural exchange. The scientific framework centers on a hypothesized self-organizing feedback described in brief as: diversity in markets and culture ⇔ diversity in farm production ⇔ biodiversity on farms ⇔ diverse organic matter profile in soils. This system of feedbacks is hypothesized to, over long time periods, increase the capacity of both farmers and soils to maximize the multifunctional benefits of agriculture including: diverse and secure food production to meet community needs, holistic management of farmlands that maintain ecological integrity and ecosystem services, increasing capacity of soils to sequester carbon and to support increasingly diverse and abundant production of food.
Innovative components of this proposal include:

- An transdisciplinary network of researchers, collaborating institutions, and farmers linked in an internet-based, regional, dynamic and collaborative knowledge system. This system will build upon existing efforts within the network that focus on social networking, digital media, and holistic support of local food systems.

- A unifying conceptual framework and a detailed strategy for integrating the ecological and biogeophysical processes impacting soil carbon with the socioeconomic and cultural elements behind soil management.
- An experimental design that takes into account shifting market demands for farm produce over time, shifting products and diversity of production on farms that seek economies of scope, and both the levels and forms of diversity.



- An approach for scaling from grid sampling within farms to farm-level analysis to regional analysis across the entire network of farms within Ohio.
- A deliverable product in enhanced education and extension capacity among these unique research and education oriented demonstration farms during the proof of concept phase.
- A conceptual model capturing the dynamic interactions among ecosystem, farms, watershed, and community.
- Initial runs of the model parameterized with empirical data where it can be generated during the project, and numerical best-guesses for additional key variables.
- Proof of concept and a detailed proposal for the 10-year project.

Approach

This integrated proof of concept project includes a set of research, education and outreach objectives, consistent with the mission of the demonstration farms represented. Although these activities will be integrated in the project, they will be discussed separately below for clarity. The integration among component activities will take place through the management plan, which includes a well-organized approach to networking and collaboration among farms. Key to this integrated system is an internet-based connection between the farms and their education and outreach constituents that provides rapid access to project data and results to all collaborators in an expanded network of demonstration and working farms.

Research activities
Methods to be used in carrying out the proposed proof of concept project include a baseline resource inventory, a set of monitoring programs that demonstrate what can be carried out over the long term, and the infrastructure to coordinate and maintain the research as a collaborative activity.
During 2010, we shall establish a **baseline resource, management and marketing inventory** for each of the farms in the proposed network. The baseline inventory will include the following (described in more detail below): 1. History of the farm including production, people, soils, and outputs, Guiding principles of the farm decision maker(s) , 2. Market structure for local products, 3. Current farm production including output and yield information for the preceeding 5 years, if available, 4. Complete soil quality and soil organic carbon assessment including biological, chemical and physical quality analyses and calculation of soil carbon sequestration indices.
During 2010 and 2011 we shall 1. collect weather and soundscape data over the entire year using sensor platforms; 2. Analyze and scale the soils data to compare farms, place them on a transition trajectory and scale the results up to regional scales using EPIC/Century models; 3.Collect survey data on farm and community aspects of local foods; 4. Develop the design features to accommodate diversified farms in carbon markets, and evaluate the feasibility of their participation. 5. Build a simple dynamic model, parameterize it with the empirical data and simulate the dynamic interactions over long time frames at farm, community, watershed, and regional scales.

Monitoring toolkit: To ensure that consistent samples and measurements are being taken on each farm, we will develop a farm monitoring toolkit for each farm that includes:

- Weather monitoring equipment - relatively inexpensive weather monitoring kits for each farm, with wireless connectivity for real time data access and entry into the network for across the network.
- Sound and sensor platforms with wireless connection to the farm office will be used to measure diel, seasonal and annual variation in biodiversity based on the soundscape. The soundscape provides a means of documenting and analyzing diversity particularly for insects, birds and amphibians, over time and space. The acoustic habitat sensor platform that we plan to use was developed by Gage et al. This technology is being developed in ongoing research at the OSU Mellinger farm (Hoy) and at Michigan State University and the Kellogg Biological Station LTER site (Gage). The hardware components of the sensor platform comprises a processor, a power supply to convert AC input (from farm building with battery power backup) to 5v output, an acoustic sensor (microphone), a web camera, a USB hub for additional sensors, a 2 GB flash card for local storage (additional backup), a wireless communication card (802.11b), and a waterproof case. The processor operates using Linux and requires relatively low power (~3w). These units will be established at the border of the farmsteads next to fields, with outdoor electric cable for power supply. The USB hub will provide flexibility to allow for additional sensors to be added if needed. A web service module with wireless internet connectivity has been developed by Gage et al. to manage and operate large sensor arrays with real-time data access. We will use parts of this interface and laptop servers with standard wireless routers to manage sensor functions in the field, including: time, recording interval, sensor parameter settings, location on server for data capture; log files, and starting/restarting the sensor platform. Each sensor platform will be identified via its IP address and an identification code and a

time/date stamp will be attached to the sensor files transmitted to the laptop. These files can be made available for educational use by the network of farms (discussed below) as well as in analysis of biodiversity. Examples can be found at the Remote Environmental Analysis Laboratory at Michigan State University (http://www.real.msu.edu/). Of particular importance is the experience of the Gage lab in data stewardship that will be brought to bear on this project (see http://www.real.msu.edu/overview/datasteward.php).

- Soil sampling equipment and supplies including soil corers, sieves, and sample bags and containers.
- Data forms to record market conditions, farm decisions, inputs and yields/outputs.

Data, analysis and interpretation: The baseline inventory will establish where each farm stands in a transition from previous patterns of land use to the current level of diversification. Farms will be compared over time based on their own historical data and to each other to gain an initial estimate of their stages in transition and the point each farm represents on the timeline for this transition. **Our overall hypothesis is that farms will vary in both soil organic matter composition and in systems thinking capacity for farm-level decision making according to the number of years in transition to diversified production systems.** Testing this hypothesis and placing the farms on a trajectory consistent with diversification will require a series of hypothesis tests. The series of hypotheses to be tested are consistent with our conceptual model for the feedback established between local markets, farm managers, farm enterprise diversity, biodiversity, and soil organic matter profile:
H1: Farms in localities with more diverse market demands, including those in communities with greater cultural diversity, will diversify more quickly and to a greater degree than farms with less diverse market demand. We will adapt a farm survey instrument developed for a USDA grant-funded project on agricultural economic development to the needs of this project. Key variables in this instrument include: type and level of interaction with public, level of decision-making retained on the farm, community support/community infrastructure, any local products sold, identifying locally or regionally engaged farms, farm management changes over time, consumer demand (currently measured every two years with a survey of rural and urban Ohioans, "The Ohio Survey of Food, Agricultural, and Environmental Issues"), changes in the farm's balance sheet, and market opportunities for the farm over time.

Full-season diversified crop production systems are already in place on the demonstration farms. Data collection protocols will be developed for measurement of all inputs and outputs of the production process for each crop in the system. Production will be valued at appropriate market prices given alternative output market structures, i.e. supermarket chains, neighborhood grocer, farmers' markets, pick-your-own, and community-supported- agriculture ventures. Quality differences sufficient to impact product price will be reflected in the analyses. All variable inputs will be measured and valued at their market or opportunity prices. For inputs not purchased from the market, opportunity cost concepts will be used to value the input. Land will be valued at the cash rental rate in local markets. Labor will be valued at a rate consistent with local labor or migrant labor markets.

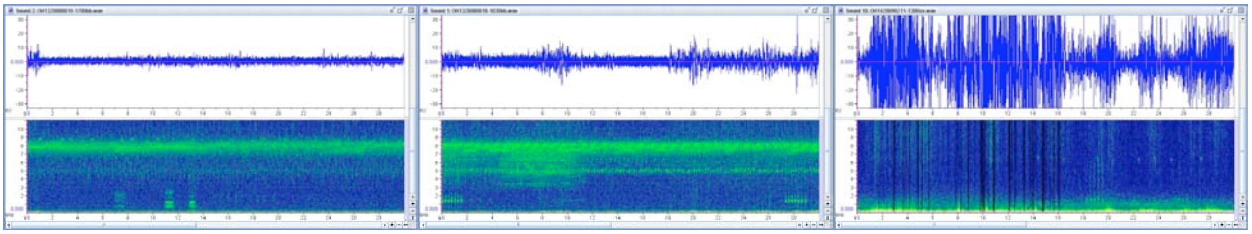
The fixed costs of machinery, equipment, and other durable capital are important and an appropriate set will be identified and catalogued. This equipment will be priced using new or used equipment market values. Per acre costs of fixed assets will be calculated for the demonstration farms involved. In any other cases a commercial-sized farm enterprise will be assumed based on Ohio averages.

Thus, local/regional data needs will be measured by a survey of local farmers administered with the assistance of the farm managers. On the market-side, the product price each crop garners in the marketplace over time, under each market structure; the quantity and price associated with variable inputs such as seed, fertilizer, pesticide, and labor hours, for each crop type; wage rate information from the farm and local/migrant market; transportation and fuel costs for the community/region; assessed values within the property market and rental rates for land; prices for each type of capital equipment employed on the farms (either new or suitably discounted).

On the community-side, distance from each farm to nearest rural community, urban center, and type of output-market structure; population size, age and income distribution; business structure, tax rates, and property rights regimes will be calculated from readily available US Census data. Of additional interest will be qualitative (quantitative) descriptions (measurements) of amenities and services available within or by the community. Consumer profiles in the output markets will be generated. These would include distributions on age, income, sex, ethnicity, job type, household size and composition, level of education, and demand for environmental services in the northeast Ohio region, both at the rural community level and within the urban center. Regional/State/National Data Needs will be necessary for the meta-system analysis. This includes data on all of the above variables (in the form of national averages, and/or distributions, as well as descriptors on the political structure and any ensuing changes through law or mandate pertinent to the analysis.

Net present value (NPV) analysis will be used to estimate system profitability. The investment period for many of the crop species to be produced could be substantial. For instance, certain species may produce over multi-year periods, and there is a substantial differential in the timing of cash inflows and outflows over this period.

H2: Farms with greater enterprise diversity will have greater biological diversity, measurable via the soundscape over the growing season. We are currently using a technique proposed by Sueur et al. (2008) described as rapid acoustic survey for biodiversity assessment. The sonogram for a particular place and time is decomposed according to acoustic entropy. The Acoustic Entropy Index, H, is computed as the product of the temporal entropy, H_t, and Spectral entropy, H_f. Each of these is a measure of the "evenness" of an amplitude value across its domain, over time in the case of H_t and over the frequency spectrum in the case of H_f. The entropy index H is computed as the product of both temporal and spectral entropies. H will tend towards 0 for a single pure tone, increases with the number of frequency bands and amplitude modulations, and tends towards 1 for random noise. Sueur et al. (2008) tested and found evidence for the hypothesis that H increases with the number of species contributing unique signals to the soundscape. We have tested this algorithm and have found that signal processing to maximize signal to noise ratio needs to be carefully considered. Background noise such as wind, rain, water, etc. reduces sensitivity of H in measuring biodiversity and we are, therefore, developing signal processing algorithms that will improve this statistic. However, we found that H does, in general, increase with greater variation in bioacoustic signal and will serve as a useful measure for this project. For example, in data collected at the Mellinger farm, H was 0.9027 and 0.9079 for two sonograms containing various insects, crows and either sheep or light wind (left side) whereas it was considerably lower at 0.7089 for one with wind and crows only (right side). These differences demonstrate how the acoustic entropy index can distill from a complex signal a measure of biodiversity (in this case the added insect signals). The sound monitoring system has the added advantage of offering a means of automated sampling of diel, seasonal and annual



variation in these biodiversity measures, which would not be feasible through more traditional direct observation and trapping.

H3: Farms with greater enterprise and, therefore, biological diversity will have higher soil organic matter (SOM), soil organic carbon (SOC), overall greater soil quality, biologically, chemically and physically, and will sequester more carbon. Field boundaries on each of the farms will be digitized from aerial photographs available from county offices. We have soil survey maps at 1:12,000-1:31,000 in an existing GIS. These data will be combined with the National Agricultural Statistical Service (NASS) crop data layer, digital elevation models (DEM) and any additional information (eg: yield maps) available from farm managers to classify homogenous sampling zones for directed sampling (Pocknee et al., 1996; McCann et al.,1996; Fleming et al., 2000). Permanent sampling areas within 25 individual sampling zones at each farm will be established by GPS (GARMIN$^{@TM}$,15-25 cm accuracy). Re-sampling will be from the same locations in subsequent years. Within each sampling zone, soil samples will be collected from at least 10 different locations through random sampling and these subsamples will be mixed into one composite sample. Soil samples will be collected in early spring and fall at 0-15 and 15-30 cm both within and between rows. The soil cores will be 2-mm sieved and homogenized to keep under short-term (7 d) incubation at room temperature to stabilize microbial activity. Microbial biomass analysis will be performed within 15-d of soil collection and processing. Air-dried samples will analyzed for selected chemical and physical properties as follows: 1.) Total microbial biomass C and N will be determined by microwave soil extraction (Islam and Weil 1998). Soil biological activity and ecophysiological stress indices will be measured and/or calculated as basal and specific maintenance respiration rates, urease and dehydrogenease enzyme activities, and earthworms (Anderson and Domsch 1990, Tabatabai 1994, Islam and Weil 2000, Islam et al. 2002). 2.) Soil bulk density (compaction), water infiltration, macro- and microaggregate stability, and aggregate associated C and N pools will be measured (Kempers and Rosenau 1986, Islam and Weil 2000, Islam et al. 2002). 3.) Total, passive and active C and N fractions, cation exchange capacity, and humification indices will be measured and/or calculated (Islam et al. 2002, Stinner 2008). 4.) The inductive additive approach based on normalization, summation, and average of selected core biological, chemical and physical properties will be used to generate a single integrator of soil quality (Islam 1997, Islam 2006, Stinner 2008). Data for each individual soil property (X_0) measured or calculated will be transformed on a 0-1 scale relative to the maximum value (X_{max}) of that X_0 ($X_i = X_0/X_{max}$) in the data set. Transformations of pi will be done to normalize the data sets for reducing heterogeneous variances of the errors and to simplify the relationship between random errors influenced variables. Equal weight will be assigned to each X_i on a 0-1 scale, normalizing the final soil quality index.

Mathematical and statistical models will be used to project expected changes in soil C sequestration under various anticipated conditions. Because soils are not able to sequester C indefinitely, we expect that C sequestration will eventually achieve an equilibrium level but that this level will be higher on diversified farms because of their more complex soil organic matter

profile. The following approaches will be used to calculate and validate soil C sequestration in farm ecosystems.
(i) Traditional approach: The calculated biological, chemical, and physical C and N stocks measured separately or sequentially at each depth and within the soil profile using *concurrently measured ρb* (variable compaction effect) will be regressed over time to calculate C and N sequestration rates. Parameters for the Polynomial model in linear, quadratic, and cubic forms; Hyperbola model; Exponential model (rise to maximum), and Power model will be estimated to select the best fit.
(ii) Modified approach: To account for artificial variation in soil mass from using concurrently measured ρb among and/or between samples, "equivalent soil mass" will be used to convert concentrations of C and N fractions into mass per unit area for a fixed depth. The biological, chemical, and physical C and N stocks measured separately or sequentially at each depth and within the soil profile will be regressed over time to calculate C and N sequestration rates. Parameters for the models used in the traditional approach will be estimated.
(iii) Proposed New Inductive Additive model for Soil C Sequestration Index: Because soil organic matter is thermodynamically unstable, the net balance among the basic processes of primary production, biological transformations of organic residues and physico-chemical protection largely determines the temporal variation in qualitative and quantitative aspects of soil C equilibrium in response to management practices. To calculate various C sequestration indices, we will use the mean value of C fractions to integrate their respective effects. The individual C fraction datum (C_i) at any time (T_i) will be normalized on a 0-1 a scale by dividing the amount of C in any particular pool (C_0) at the time of the experimental initiation (T_0), C_i-Index = $C_i(T_i)/C_0(T_0)$. C_i-Index values greater than 1 in any pools will be considered to be a sink C, lower than 1 will be considered to be a source of C, and equal to 1 will be considered in equilibrium. Using this method of computation, it is possible that a single key C fraction, as an early and sensitive indicator of total C, could predict the complex nature of C sequestration.

Upscaling Farm Level Carbon Data Modeling approaches will be needed to integrate the data from many farms across the region and project how regional carbon dynamics would be influenced by a shift towards the style of agriculture practiced on these farms. We will adapt a recent version of the Erosion Policy Integrated Climate (EPIC)-CENTURY model (Williams, 1990; Trevor and John, 1995; Parton et al., 1987; Izzurralde et al., 2006), to analyze the impact of diversified crop rotations and management practices on short-term and long-term carbon dynamics within and among the demonstration farms in our network. The EPIC model is capable of assessing the impacts of such processes as climate, landscape characteristics, soil conditions and management schemes on a number of soil parameters (Williams, 1995) including tillage effects on crop residues and bulk density, wind and water erosion, hydrology, soil temperature and heat flow, C, N, and P cycling, fertilizer and irrigation effects on crops, pesticide fate, and economics. The recently updated version of the model includes modifications for handling soil organic carbon dynamics by a process similar to that in the Century model (Izaurralde et al., 2006). The model operates on a daily time step and can execute long-term simulations (hundreds of years) from the site level to catchments to regions. The revised EPIC model has been successfully tested and adapted to a wide range of different sites (Easterling et al., 1997; Binder et al., 2004; Gassman et al., 2004; Potter et al., 2004; Allison et al., 2005; Izaurralde et al., 2006; Niu et al., 2009).

The main inputs for the EPIC model include meteorological data, soils data, crop rotation and management practices. As noted above, these data will be collected for the individual farms in the network and will be used for calibration of the model in year one. Adjustments will be made to the crop and soil parameters of the model, such as harvest index, maximum crop height, maximum potential leaf area index, soil carbon, nitrogen pools, etc., to reflect the more diversified nature of cropping systems and site conditions. Although, the model simulates a variety of outputs, we will focus on soil organic carbon (SOC) dynamics. We plan to further develop the SOC subroutines to relate SOC dynamics to more complex soil organic matter (SOM) profiles. The resulting simulations from EPIC relating to SOC dynamics are expected to provide valuable information on system behavior with respect to carbon sequestration and explain variation both within and among farms.

The validation process will focus primarily on: a). testing the EPIC crop yields against observed crop yields on farms, b) compare simulated with historical yields, particularly for years with the highest and lowest yields, c) simulated vs observed short-term soil organic carbon change during the 2 year proof of concept phase, d) additional comparison of simulated and observed nitrogen pools. Standard statistics such as mean square deviation and goodness of fit regression measures, between simulated and measured values (yields, SOC, nitrogen pools), will be used to evaluate the predictive accuracy of the model outputs against measured data. After testing the model across the range of demonstration farms in our network, the model will be used to simulate soil organic carbon changes on similar farms, at regional scales. Modifications to upscale the site-specific results will include improved EPIC model simulations including land use, soils, and climate data in a geographic information systems (GIS) framework. Level of farm diversification and crop cover will be identified using the latest National Agricultural Statistical Service (NASS) cropland data layer obtained from AWiFS satellite data. Farms with local market sales will be determined through registerations on Ohio Market Maker the major agricultural organizations in Ohio (Ohio Ecological Food and Farming Association, Innovative Farmers of Ohio, Ohio Farm Bureau, Ohio Produce Growers and Marketers Association). Site-specific soil properties analyzed from our soil test data on farms within the network, will be integrated with the county level soil survey georeferenced database (SSURGO). Daily weather variables will be obtained from the network of farms as well as university and government meteorological stations within the study area. Data on fertilizer rates and soil nutrient management, tillage practices, and residue management representative of the network farms will be incorporated into the model simulations for quantifying SOM dynamics and carbon sequestration at the regional level.

The result of these comparisons will be detailed estimates for how soil carbon dynamics would change under a long-term shift in farming practices from relatively low-diversity commodity production systems to diversified crop and animal mixtures. These estimates would have two years worth of comparison data as proof of concept. The more complex model for how the farmers' market-driven decision making leads to more diverse production, more diverse SOM and then new levels of SOC, will be tested empirically against these predictions over the long term monitoring project.

An additional scaling analysis will employ the agroecosystem health index described above (Vadrevu et al. 2008). Using the data for the demonstration farms generated in the study for social organization between these farms and surrounding communities, state level soils maps and the simulation results described above, and the crop data layer, we will calculate and map the agroecosystem health index for the demonstration farms and farms within a 20 km radius. Our hypothesis is that the agroecosystem health index will be relatively high for the demonstration farms compared with the surrounding landscape. Furthermore, we expect that over time the index will increase in the surrounding landscape through the impact of these farms.

For an additional comparison in long-term studies, each farm will be expected to establish a relationship during the proof of concept project with a neighboring conventional less specialized commodity production farm nearby and secure the cooperation of this farmer to provide a pairwise comparison for each farm in the long-term study. These pairwise comparison farms will provide a standardized set of controls for the analysis of changes taking place on the diversified farms in transition. Comparison farms will be expected to be similar in terms of size, age and education of the farmer, and landscape characteristics including soil types within the farm. Differences on the comparison farms will be that they are not diversified and do not focus on local markets, rather they specialize in relatively few commodity crops, corn and soybeans being the typical cropping pattern for Ohio.

Examine the feasibility of local-foods-oriented diversified farmer participation in carbon markets. With satisfactory measurement of carbon sequestration performance, participation in carbon markets can be explored. If small landowners growing diverse crops are to be involved in carbon sequestration in soils, it is clear that measuring and monitoring systems will have to be refined and established to verify the carbon gains. We will undertake the following analyses. First, we will assess the economic and financial feasibility of these farms participating in standard carbon markets. Second, we will examine design and performance issues in carbon markets to determine whether they can readily be adapted to accommodate small and diversified producers. Third, we will undertake two approaches to the emerging question of markets in multiple ecosystem services. (1) We will draw upon on-going NSF-funded research to develop a measurable, verifiable, and marketable index for a suite of multiple ecosystem services. (2) We will explore a bundling approach. Given adequate measurement and monitoring of on-farm output of soil carbon credits, water quality improvement, and biodiversity across diverse landscapes, the different services can be sold to different demanders. For example, the water quality gains may be sold in watershed-level water quality trading programs, the carbon gains may be sold off in the carbon market, and the ecological gains may be sold as conservation easements to public agencies or NGOs. This approach is consistent with other markets, and circumvents the need for an index.

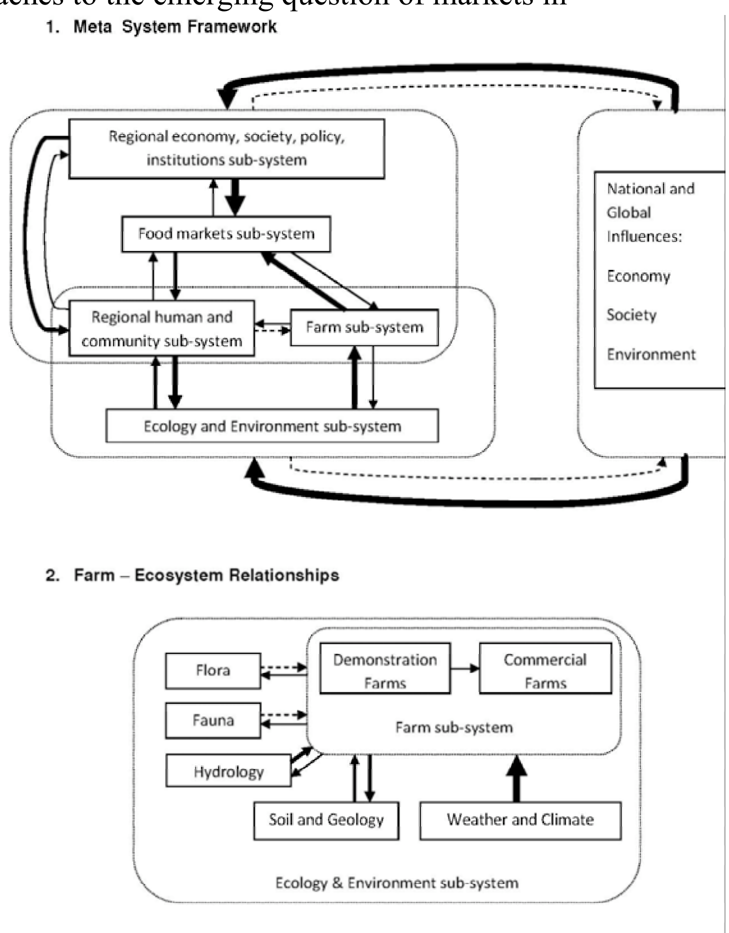


Figure. Concept for modeling system dynamics: (1) the meta system including the Ohio local food oriented diversified farm sector, and (2) the ecology and environment and farm sub-systems expanded

Develop, a conceptual and preliminary simulation model of the dynamic interactions among agroecosystems, markets, and communities, i.e. a model of agroecosystem function. The Figure at right provides a framework, at a highly aggregate level of how our ecosystem, farms, markets, and community interact, and how they fit into the larger national and global scene, and (2) an expanded view of the relationships between the farm and ecosystem sub-models. We will use this framework to build a relatively simple stylized dynamic model of this system and explore system behavior with exploratory runs of the model with numerical data generated during the project, secondary data as appropriate, and numerical best guesses where necessary. Results will provide insights and hypotheses useful in further research, education, and extension, while serving as a valuable proof of concept exercise for the project.

Expected outcomes: We expect demonstration farms to differ in soil organic matter profile and SOC sequestration according to the length of time in transition from more simple and conventional cropping. Management capacity to be enhanced both by the experience of diversification and functioning in a network of farms. Results will be used to expand the network to the farms and farmers served by demonstration farms, creating better understanding of new opportunities in local markets and the multifunctional benefits that accrue. Potential pitfalls and limitations are primarily a function of the level of sampling feasible in a large and complex project. If based on the analysis during year one we find that additional samples are needed to resolve the level of variation inherent in soils on diversified farms to make areawide and long-term comparisons, then our commitment is such that we would find a way to increase the sampling for the proof of concept work in year 2. Limitations to the research is that market demand, and the diversity of production to meet the demand, is expect to change over time. Based on current trends, both level and diversity of demand will increase in local markets as consumers gain experience with an increased variety of seasonal farm products. Therefore, our analysis will be restricted to the impact of diversity itself, and not a specific controlled level or composition, which would be artificial and contrived anyway. Activities related to the project are not expected to be hazardous to personnel, in fact the food associated with the project is expected to be quite healthy.

Education activities

The farms in this network provide opportunities for students from k-16 to graduate levels. To engage students, teachers and educational institutions in the project we will accomplish the following during the proof of concept phase:

1. Each of the farms in the network currently engage k12 or k16 students in their programs in various ways. The network established among farms will be enhanced by sharing curriculum offerings for farming, nutrition and health, gardening, nature and environmental programs among the participating farms. Farm managers and staff will be encouraged to attend educational programs at other farms in the network without registration fees, in exchange for assistance with the programs, learning the curriculum through this involvement.
2. The internet connection among farms will provide narrative, video, and sensor data including both weather and soundscapes, and an opportunity for social networking between students in Ohio public schools and the demonstration farms. Classrooms that visit on field trips will be given instruction in the research taking place and how the students can participate in monitoring progress of the study. Students will be provided an opportunity to revisit the farm throughout the school year via a website that serves these data. Students will be offered the opportunity demonstration farms will be via the internet connection between schools and farms.
3. A guided journal exercise, to be conducted by students, will be initiated to document seasonal rhythms on farms. Students will be asked to document using sound, video, still pictures and their own written descriptions the changes taking place on farms, including the life in the soil.

4. In year two of the study, we will host an academic conference to assemble the best practices in curriculum and student engagement on demonstration farms. Students and faculty from k-12, undergraduate and graduate programs will be invited to participate in the conference. It will include:

- Symposium and poster sessions - sharing the current innovative programs taking place on demonstration farms in formal presentations
- Workshops on target areas such as linking activity in school gardens and student farms with demonstration farms, pre-and post field trip lesson plans, graduate courses with land lab elements, habitat and soil restoration, etc.
- Planning sessions - graduate students and faculty will develop proposed student-centered graduate program focus areas that would include graduate research as well as courseworkbased on resources available through the farm network.

Outreach activities

Each farm is in place to share and demonstrate a vision for what is possible on working farms in the region. The existing connections between the demonstration farms and their surrounding commercial and beginning farms and farmers will be strengthened by a number of extension activities that focus on the farms:

- Field days and tours – although these are conducted on the farms at various times, a coordinated series of such field days and tours that draw expertise from across the network will be established and advertised. Pasture walks are a well received example in current programs and can be offered as a series.
- Extension team engagement – OSU Extension is organized into various commodity- and issue-focused teams that can be engaged to assist with this project and for whom this network of farms provides a valuable resource. The most relevant teams include the sustainable agriculture team, vegetable, small fruit, poultry, beef, sheep and forage.
- Student internships and beginning farmer mentoring - students funded by this proposal as well as through mentorship and internship opportunities offered by collaborating farm organizations will have an opportunity for placement through the network.
- The farms as a collaborative network plan to offer to policy makers a series of opportunities to experience the farms and share a tangible vision of what is possible in Ohio agriculture.

The opportunities available on the demonstration farms will be advertised through promotional displays at regional farm conferences. Furthermore, we will build connections between farms and communities through social network facilitation among demonstration farms, between demonstration farms and working farms in the community, and between farms and non-farming community members. Social networking is the focus of an existing USDA SCRI grant to Hoy et al. and can easily be adapted to serve the network and their collaborating working farms.

Evaluation: Throughout the project we will assess the level of engagement with the food system among those participating in demonstration farm activities. Furthermore, in both formal programs and mentoring relationships we will track the co-learning that takes place between less experienced and more experienced farmers. Evaluation will be by the level of participation in local food markets among farm visitors, as measured by their purchases (described above).

The detailed timeline for the activities above is provided in the Management Plan.

Budget Justification

Personnel

Funds for personnel are to ensure that samples are collected consistently across farms, to provide direct support for educational and outreach programs, and to ensure expert support for the data management, statistical analysis and upscaling to regional scales.

The labor for this project will be provided primarily by students. Funds are requested for one graduate research assistant, for 3 quarters, to oversee data collection and entry and conduct much of the analysis under the guidance of project faculty and other participants for the duration of the 2 yr project. Funding is requested for 3 seasonal undergraduate assistants to provide additional support for data collection and educational programs.

The personnel budget includes funding for one month's salary for a research scientist, Dr. Krishna Vadrevu, with remote sensing, GIS, and biogeochemistry background to conduct the statistical analysis including temporal and spatial scaling of the data.

The personnel budget includes consulting fees for Dr. Stuart Gage, Professor Emeritus at Michigan State University, to compensate for support on the sensor network and liason with similar work being conducted at the Kellogg Biological Station LTER site, and Mr. Mic Miller, sound engineer and technical support for the current sound monitoring program at the OARDC and Mellinger farm.

Equipment

None, we have the available computing, statistical and GIS software as well as the laboratory analytical capability required for the proof of concept project.

Materials and Supplies

Supplies budgeted in year one are primarily for the monitoring toolkit required for each farm. Components of the toolkit will include the sensor platform including microphone, video camera, soil and air temperature, solar radiation, anemometer, and rainfall guage. Sensor platforms will be constructed to run on AC power close enough to a farm building to run wiring to the unit. Each will have a processor and wireless card so that data collection can be timed and controlled by the unit and data can be sent to a computer at the farm where it will be accessible to the entire network for both analysis and educational use (e.g. providing k12 classrooms access to the sound and video in real time). We will build these units from relatively inexpensive component parts, none of which cost more than a few hundred dollars mostly much less. Additional sampling supplies for the field include soil sampling probes, pH test kits, and soil moisture probes. Supplies for gathering market structure and farm input and output economic data include data forms and any software required to ensure consistent record keeping across farms. Total budget for the monitoring toolkits is $1500, 1 kit for each of 8 farms = $12,000.

Supplies for year 2 are primarily the resources needed for an academic conference of participating and potentially participating academic institutions, including both k12 and higher education participants. We estimate the total cost for this 1-day conference, including facility, lunch and facilitation supplies for poster sessions, proceedings, breakout group sessions to be $8,000.

The supply budget includes $3200 in year one and $2000 in year 2 to support the soil analytical laboratory that will process the soil samples (2 sampling times x 40 sample sites in year 1, 25 in year 2 x 8 farms x $5 per sample).

Additional supplies for each year, $2000 in year 1 and $1500 in year 2, are the office supplies needed to administer the project and report on results.

Travel

In-state travel will be extensive throughout the project for establishing the monitoring program and collecting the initial two years worth of data. We estimate 32 trips totaling over 6400 miles, and have budgeted mileage accordingly. Additional funds are budgeted for travel support for quarterly meetings of the project participants, which will rotate among the participating farms and provide one meeting at each of the locations in the project.

Other direct costs – purchased services

We have budgeted funds for establishing the internet infrastructure needed to connect the farms and provide internet access to the farms and the project data. We envision using the OSU-OARDC server and adding a page that will provide the necessary linkage for data management and web-based outreach/education programming. Access will be geared primarily to educational audiences.

Budget breakdown by function

Although in an integrated project research, education and outreach are usually quite interwoven we have estimated the budget breakdown for adherence to the guideline of ≤ 2/3 budget devoted to one area. We estimate the graduate assistant's time will be spent 2:1 on research : education/outreach programs, and the undergraduate students and travel will have a more even 1:1 ratio as they will be assisting with educational efforts on the farms during each visit. The remaining personnel costs are primarily for research. Half the value of the monitoring platforms will be attributed to their use in education, linking classrooms to farm soundscapes and weather in real time. Half of the office supplies and all of the funding for the academic conference and web access development will be for education/outreach. Totaling these expenses (including fringes, tuition and fees) gives 63% of the direct costs primarily for research and 37% primarily for education and outreach.

MICHIGAN STATE
UNIVERSITY

20 April 2009

Dr. Casey Hoy
W. K. Kellogg Endowed Chair in Agricultural Ecosystems Management
The Ohio State University
Ohio Agricultural Research and Development Center
Agroecosystems Management Program
Wooster, OH 44691
United States of America

Dear Casey:

I am very enthusiastic about being involved as a consultant in the proposed project "**Sustainable Agroecosystem Science on Diversified Farms Producing for Local Food Systems"**. I think your local-regional-network focus is excellent as is your emphasis on monitoring changes in system level characteristics. As you know I have been a Co-Principle Investigator of the Kellogg LTER since it's inception in 1987. I have contributed to that initiative in three major areas: insect biological control (long term-high resolution monitoring of native and invasive species); regionalization of crop-climate interactions (scaling from plot-to-site-to region); and development of autonomous sensors to monitor biological change (use of the microphone to automatically record and analyze biological and human created mechanical sounds). I can and will gladly contribute my knowledge and understanding of any of these areas.

Our ongoing collaboration on adopting and using sensor technology to record the soundscape at regular intervals in different agricultural operations is beginning to provide new insight on the degree of biological diversity associated with varying degrees of human disturbance. I believe this is a very important and useful method to aid us to understand the value of balancing human impact on the landscape. We have recognized that new sensor technology can provide major benefits including simultaneous multiple-scale monitoring. This can have huge economic savings as well as increasing our measurement resolution and intensity as we can monitor at multiple locations at all times of the day using our advanced sensor technology. In addition, we now have the technology to deliver biological observation in near-real time (www.real.msu.edu). This has major implication regarding outreach and public engagement. Our sensor deployment at the Kellogg Biological Station had a significant impact on monitoring biological diversity at KBS as well as encouraging establishment of a wireless communication system that enables transmission of observations made in the field directly to remote servers. We are currently testing long distance communication by transmitting field observations in near real time from a site in Brisbane, AU to our servers at Michigan State University.

I am excited about being associated with your proposed initiative and look forward to continuing and enhancing our long-term collaboration through being involved with this multi-fasceted proposal: "Sustainable Agroecosystem Science on Diversified Farms Producing for Local Food Systems".

Sincerely

Stuart H. Gage

Stuart H. Gage
Professor Emeritus

DEPARTMENT OF ENTOMOLOGY

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April 22, 2009

Dr. Casey Hoy
Professor and Kellogg Endowed Chair in Agricultural Ecosystems Management
The Ohio State University,
Ohio Agricultural Research and Development Center
Ohio State University Extension
1680 Madison Avenue, Wooster, OH 44691

Dear Dr. Hoy:

I am glad to collaborate on your proposal to the USDA Sustainable Agriculture Systems Long Term Agroecosystems Project Proof of Concept proposal. If funded, the Soil and Water lab at Ohio State University at Piketon under my supervision will provide all kinds of support to sample, process and analyze soil samples associated with the project.

Sincerely yours

(Rafiq Islam, Ph.D.)
Program Director
Soil and Water Resources
islam.27@osu.edu

United States Department of the Interior
NATIONAL PARK SERVICE
Cuyahoga Valley National Park
15610 Vaughn Road
Brecksville, Ohio 44141-3097

IN REPLY REFER TO:
L3217

April 23, 2009

Casey Hoy
Professor and Kellogg Endowed Chair in
Agricultural Ecosystem Management
The Ohio State University
Ohio Agricultural Research and Development Center
Ohio State University Extension
1680 Madison Avenue
Wooster, OH 44691

Dear Casey:

I am pleased to offer Cuyahoga Valley National Park's support for your current grant application to the United States Department of Agriculture's Agriculture and Food Research Initiative. Darwin Kelsey, of the Countryside Conservancy, explained that, if funded, you will be doing research on the environmental, social, and economic consequences of various farming practices – and that your research will involve some of the farms located within CVNP's boundaries.

We welcome any insights such research may offer for managing the farms here in the Park. We believe our farms will have an important educational impact in the years ahead. CVNP is visited by more than 2,500,000 persons annually – most of whom are interested in environmental as well as health and wellness issues related to food. Moreover, CVNP's innovative agricultural program is well regarded within the National Park Service – and serves to encourage similar projects elsewhere around the country.

In short, we hope you are successful in the grant application process – and that we will have the opportunity to work together on this project.

Sincerely,

John P. Debo, Jr.
Superintendent

Documentation of Collaboration

Countryside Conservancy

Reconnecting Land, Farming, Food and Community

2179 Everett Road • Peninsula, Ohio 44264 • P **330.657.2532** • F **330.657.2198** • **www.cvcountryside.org**

April 23, 2009

Casey Hoy
Professor and Kellogg Endowed Chair in
Agricultural Ecosystem Management
The Ohio State University
Ohio Agricultural Research and Development Center
Ohio State University Extension
1680 Madison Avenue
Wooster, OH 44691

Dear Casey:

On behalf of the Countryside Conservancy, I want to express support for your grant application to the USDA's Agriculture and Food Research Initiative. I believe the proposed research focus addresses significant and complex environmental, social and economic issues. We look forward to collaborating both on the basic research, and the subsequent interpretation and dissemination of research findings.

As we discussed, the several farms operating within CVNP offer both high-quality research opportunities, and effective venues for public education. First, we have eleven small diversified farms in the park now operational, and another four in various stages of rehabilitation. We have two "school" farms in planning or development: The first a small (6 acre) organic farm linked to an innovative sustainability curriculum at the only private/public school (K-8) located in a National Park. Second, is a "residential farm school" intended to bring some 25-30 kids per week, for 3-4 day programs, to the park – reconnecting them to consequences of where and how food is produced.

Finally, and perhaps most significantly for this grant application, we are conceptualizing and developing an Entrepreneurship Center (EC) focused on local community-based farming and food systems. It will include 100+ acres of crop and livestock production areas, food processing facilities, small farm incubator sites, internship programs, and "formal" education programs (classes, workshops, conferences). It seems important to note here that much of what the EC is being created to do will be closely related to the research and education focus of your grant application.

Good luck on the application. I look forward to working with you on this project should a grant be awarded.

Sincerely,

Darwin Kelsey
Executive Director

farmland *farmers* *food* *community*

Documentation of Collaboration

CROWN POINT Ecology Center

renewing earth and spirit since 1989

Dr. Casey Hoy April 21, 2009
Agroecosystems Management Program
The Ohio State University, OARDC
Wooster, OH 44691

Dear Dr. Hoy:

I am pleased to collaborate on your proposal to the USDA Sustainable Agriculture Systems Long Term Agroecosystems Project Proof of Concept proposal.

This research project will help us to better understand the ecosystems at work in our farmland soils, riparian areas and edges, as related to our organic production methods. We are committed to sharing the results and process with other area farmers in northeast Ohio.

Crown Point is pleased to work with the university students and faculty in this project. We have on going relationships with recent college graduates through our farm apprentice program. Including university researchers will enhance our collaborative learning and formalize our study. We look forward to the data gained by the weather monitoring system and sharing that data with the other farms involved in the project. Maintaining that system here will be a priority, as will other related data collection methods, such as the automated sensor system you mentioned.

Our farm apprentice program is one of our educational programs, but we conduct several programs throughout the year. Our Community Supported Agriculture program has hosted many growers over the years and several CSAs have started because of our shared experience. Our public programs at the OEFFA conference, Summit and Akron public libraries, Green Energy Ohio, Summit County Food Policy Coalition and Northeast Ohio Food Congress are other venues through which area farmers, students and general public are impacted by our existing programs. Yet I feel this project will add a depth of understanding and learning for our own practices, that will enhance our educational programming concerning our 13 years of organic production.

In addition, the opportunity to engage in research with other educational farms in Ohio is a value adding proposition to us. It has long been a concern to me that education farms seeking to model sustainability must tackle both smart land use and engaging public programming that is unlike what universities or farms are called to do. To share in the agro-ecosystems research with the other farms, will open the pathways to other collaborations and shared learning, ultimately benefiting our local constituents.

I look forward to long term support and engagement of this research and earnestly endorse its full funding.

Sincerely,

Christopher Norman, Director

PO Box 484 • 3220 Ira Road • Bath, OH 44210 • 330.668.8992 • Fax 330.668.9176 • www.crownpt.org

A Ministry of the Sisters of St. Dominic, Akron, Ohio

Greenwood Farm

264 Richmond Road

Richmond Heights, Ohio 44143

April 21, 2009

Dr. Casey Hoy

Agroecosystems Management Program

The Ohio State University, OARDC

Wooster, Ohio 44691

Dear Dr. Hoy:

I am pleased to collaborate on your proposal to the USDA Sustainable Agriculture System Long Term Agroecosystems Project Proof of Concept proposal.

The opportunity as a beginning urban farm to interact with established local farmers and receive training and support from them is an exciting possibility. We would, of course, cooperate with all procedures and protocols to make for a successful research project.

It would greatly enhance our mission to bring together our diverse urban population in innovate and productive ways. As they become more involved in the local produce system they reconnect with farming and become better consumers.

In the long term this will be of great benefit to the farm and the community and we look forward to building a solid relationship.

Sincerely

Cheryl E. Goggans,

Board Member

New Agrarian Center

PROGRAMS
City Fresh
George Jones Farm
Cross-Learning Web

OFFICE
MPO Box 357
Oberlin, OH 44074

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440-935-3106

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April 20, 2009

Dr. Casey Hoy
Agroecosystems Management Program
The Ohio State University, OARDC
Wooster, OH 44691

Dear Dr. Hoy:

On behalf of the New Agrarian Center (NAC), we look forward to collaborating on your proposal to the USDA Sustainable Agriculture Systems Long Term Agroecocystems project proof of concept proposal.

The NAC manages and operates the George Jones Farm and Nature Preserve, a 70 acre farmstead owned by Oberlin College. The NAC combines applied interdisciplinary learning and research opportunities utilizing the farm in addition to a variety of outreach programs to urban residents, area farmers, and youth.

Through our affiliation with the college's Environmental Studies, Biology, and Geology departments, we have developed some capacities for long-term monitoring of soils, critical habitat areas, and energy performance of experimental strawbale buildings (walk-in cooler, office, greenhouse) on the farm. The proposed collaboration with the OARDC will add value to our current monitoring efforts. Simultaneously, we look forward to upgrading our monitoring efforts to synchronize with a larger state-wide network among learning farms. John Petersen, chair of the Environmental Studies Program at Oberlin, has received national recognition for his pioneering data monitoring systems at the college's Lewis Center for Environmental Studies.

This data, in combination with data collected and shared among partnering sites, will provide critical feedback as to the ecological and financial effects of different systems on the farm. This will help to enhance management decisions, education for college and high school students, and training workshops for area farmers. We will work in collaboration with the college to maintain regular maintenance of monitoring equipment and data tracking. We already have experience with five years of wetland monitoring that includes standardized annual community ecology surveys, water quality sampling, and organic matter accumulation. We can advise the development of a larger, internet-accessible monitoring site for the various learning farm sites.

The NAC has a variety of outreach programs that involve a network of urban and rural farmers, both of whom will benefit from this program. Through a program called City Fresh, we work with about 25 rural farmers to support the distribution of locally grown produce into inner-city neighborhoods in Cleveland, Lorain, and other impoverished cities in Northeast Ohio. These farmers visit the farm and also host students and others at their farms for learning and mentoring programs. We also collaborate with OSU Extensions Cuyahoga County program to augment urban market garden training programs through hands-on learning workshops at the farm. We have involved about 70 urban growers over the past three years in learning programs at the farm site. Additionally, the farm hosts over 400 Oberlin College students annually through a combination of volunteer opportunities, summer and school-year internships, Environmental Studies courses on organic farming, field labs for science and Environmental Studies courses, and applied research projects. We also host about 900 local school children at the farm each year as well from Cleveland and Lorain County public schools. The monitoring program will also enhance our educational outreach for K-16 students.

This proposed program takes an important step in the direction of fostering deeper collaboration and cross-learning between learning farm sites across the state of Ohio. Learning farms are uniquely positioned to aid in the transition to more sustainable and local food systems. Through outreach to young people and beginning farmer opportunities these sites can play an important role in training the next generation of farmers while educating the general public about the importance of local food systems. Additionally, these learning farms have more flexibility to experiment and test alternative growing and management methods. Area farmers have less ability to take risks, so learning farms can provide important spaces for testing new approaches and deploying successful strategies to area farms.

We look forward to building this important collaboration and growing Ohio's role as an innovator in local food systems development.

Sincerely,

Brad J. Masi, M.S.U.S.
Executive Director

Fostering an Appreciation for the Land

April 21, 2009

Dr. Casey Hoy, Kellogg Endowed Chair
Agroecosystems Management Program
The Ohio State University, OARDC
Wooster, OH 44691

Dear Dr. Hoy:

It is with great enthusiasm that the Stratford Ecological Center looks forward to the opportunity to collaborate with OARDC/AMP on your proposal to the USDA Sustainable Agriculture Systems Long Term Agroecosystems Project Proof of Concept proposal titled ***Sustainable Agroecosystem Science on Diversified Farms Producing for Local Food Systems.***

The public need and demand for projects like this, synergizing the resources of a state Land Grant and non-profit demonstration farms, is much greater than the supply. From local food accessibility and security, to education on how to grow one's own food, from applied to basic ecological research, to understanding the role of carbon management to promote biological diversity, which in turn can enhance economic diversity, redundancy and resiliency of local farms, all of this within the context of an economy that requires all of us to do more with less, the idea of gathering like-minded entities together couldn't be more timely.

Our demonstration farm, which has been certified organic since 1995, has both an education and research mission. Carbon management, or maintenance of soil organic matter, has been at the heart of our management choices and decisions. The dynamics of carbon cycles go beyond or abilities to measure and monitor the farming system component in a timely and comprehensive manner. With assistance from OARDC/AMP, and the luxury of long-term data sets from other farms in our region, this project will give us a much clearer picture as to what actually is happening on our farms, giving us a powerful management tool to make more timely market and farm/soil health decisions. We have a history a working with students with on-farm research and look forward to doing the same with OSU's students for the soil sampling portion of this project. We also look forward to adding and assisting to maintain the weather and automated sensor system, and ensure that the data is accessible to the rest of the network via the internet.

Stratford's programs are primarily designed for children, but also reach families and adults, including farmers and farmer organizations. Annually Stratford has about 5,000 visitors. Our message is primarily about food, where it comes from, how it is produced, and the connections between agriculture, nature and our environment. This project will enhance what we do as new opportunities will emerge to demonstrate and discuss carbon cycles and sequestration, especially as it relates to organic and sustainable agriculture, and to the choices producers and consumers have that potentially impact our environment and quality of life. We see opportunities to engage our sustainable agriculture and environmental education intern as students, educators themselves and research assistants. We also see opportunities to provide a venue for extension personnel, teachers, farmers, farmer organizations and policy makers to provide them with real-world demonstrations on the function of organic farming systems, both biophysically and socioeconomically.

Much of our decision making process around production and marketing is a reflection of what has worked with other farmers in the region. Creating even more intimate connections and interaction with other demonstration farms and farmers in the region will only enhance our ability to exchange information,

STRATFORD ECOLOGICAL CENTER

Fostering an Appreciation for the Land

including crop production and marketing trends. This in turn enhances our ability to make more informed and timely decisions as we evolve with our production and marketing strategy.

Finally, one of the greatest strengths of this project is its long-term and multidimensional perspective. We believe that it is this kind of research and demonstration that gets to the root of agro-ecosystem function, which we believe is most relevant to today's farmers. Today's agriculture demands that farmers and their farming systems also evolve, designing into their systems greater resiliency to allow for more and more perturbations from our emerging global economy. The strength of local food economies to smooth out global market shifts is critical to not just the producer, but to the consumer. Due to the high stakes involved in the future of agriculture, we would very enthusiastically embrace the long-term nature of this project, and would look forward to a long-term relationship with this project and all other stakeholders involved.

Sincerely,

Jeff Dickinson, PhD

Executive Director/Farmer, Stratford Ecological Center

3083 Liberty Road, Delaware, OH 43015 • (740) 363-2548 • StratfordCenter@aol.com

www.StratfordEcologicalCenter.org

Documentation of Collaboration

Aullwood
Audubon Center and Farm

1000 Aullwood Road Dayton, Ohio 45414-1129 Tel (937) 890 7360 Fax (937) 890 2382

April 20, 2009

Mr. Casey Hoy, Professor in Agricultural Ecosystems Management
The Ohio State University
Ohio Agricultural Research and Development Center
The Ohio Sate University Extension
1680 Madison Ave.
Wooster, OH 44691
(fax: 330-263-3686; cell: 330-749-5456)

Dear Mr. Hoy:

Aullwood Audubon Center and Farm, was one of the first educational farms created in the Midwest. Since our inception in 1962, we have been interested in demonstrating innovative farming strategies. Since the late 1970s, Aullwood has farmed organically and sustainably.

We would like to collaborate with you on the *Sustainable Agroecosystem Science on Diversified Farms Producing for Local Food Systems* proposal.

Thank you for sharing this opportunity with us.

Sincerely,

Charity Krueger

Charity Krueger
Executive Director

John Stedman

John Stedman,
Farm Manager

April 23, 2009

Dr. Casey Hoy, Kellogg Endowed Chair in Agricultural Ecosystems Management
Agroecosytems Management Program
Ohio State University
OARDC
1680 Madison Ave.
Wooster, OH 44691

Dear Dr. Hoy:

This letter is in support of the *Sustainable Agroecosystems Science on Diversified Farms Producing for Local Food Systems Grant* Application for Conneaut Creek Farm and Transition Farm of Conneaut, Ohio. Hereafter these entities will be referred to as the Conneaut Creek family of farms.

The Ashtabula County Parks Board, Center for Ecological Culture, and the members of the Conneaut Creek family of farms are proud to be participants of this grant. As farm members, we believe that our participation as representatives of beginning and transitional farming will have a positive and enlightening impact on the research. As the prospective owners of the park which includes Transition Farm, the Ashtabula County Parks Board gives its full consent and support in participation in this project.

Sincerely,

Brett Joseph, President
Ashtabula County Parks Board and
Co-Founder, Center for Ecological Culture

Sustainable Agroecosystem Science on Diversified Farms Producing for Local Food Systems
Logic Model

Resource/Inputs	Activities	Outputs	Outcomes	Impact
AFRI Funding (this grant) **The Ohio State University** OSU faculty contribution represents a wide range of disciplinary expertise that is well integrated in several interdisciplinary programs, the Agroecosystems Management Program being foremost with regards to this proposal. Remote sensing and GIS expertise and equipment provided by the Agroecosystems Management Program and Dr. Vadrevu, including computational and statistical resources for analysis across spatial scales from within farms to landscapes. Networking among institutions will include an existing collaboration between Hoy and Stuart Gage, MSU and Kellogg Biological Station LTER site, … **OSU Extension:** • Sustainable Agriculture Team • Small Fruit Team • Vegetable Crop Team • Direct Marketing Team **Aullwood Farm** **New Agrarian Center:** **Crown Point Farm & Education Center:** **Cuyahoga Valley Countryside Conservancy (CVNP farms):** **Greenwood Farm** **Mellinger Farm, OARDC**	**Research Activities**: Research on baseline conditions and changes in soil carbon over time due to diversification, including soil carbon sequestration capabilities as they relate to production systems, novel sensor based monitoring systems Quantitative analysis of • the factors that influence participation in local food systems and diversification • Integration of biophysical, ecological processes with socioeconomic and cultural processes. Qualitative analysis of • the barriers that farmers face in local market systems • the quality of life benefits perceived from diverse production and healthy soil Longitudinal analysis of changes in production systems, soil carbon, viability of local foods, and sustainability of farms and communities Design analytic strategy for • statistical analysis of distributed network of farm sites • scaling-up to landscape and regional scale • developing implications for larger scales (multi-regional, national) • evaluation of models and standards for participation of agriculture in markets in carbon credits Research reports, scientific papers, research methodology manual written	Scientific papers for peer-reviewed publication Research Methodology Manual Comprehensive research reports and summary reports for policy makers A package presentation template for workshops and educational programs across the network Proposed carbon credit system for local food transactions Farmer profiles and podcasts Digital sound and video media that raises awareness of the opportunities in farming. Social networking tools that can improve connections among farms and between farms and communities. Availability of	**For the research community:** • Better understanding of long-term impacts of farm diversification in terms of both soils and social connections for farms • Improved ability to measure and integrate biophysical and socioeconomic processes in ecosystems, address questions of scale, and conduct cutting-edge science in support of policy and innovation. • Proof of concept of the LTAP idea. • Integrated long-term biogeochemical data sets for input into evolving decision-making models. **For New and Current Farmers:** More people begin farming their land or acquire land to begin farming. People gain an image of what living on the land and producing food can be like and move in that direction. Farmers gain experience with and understanding of how their diversification both meets market demand and impacts soil quality and therefore production capacity. The new production capacity opens new opportunities for business, social and farmer-farmer relationships. Farmers gain a new capacity to plan for diversification, sustainability and economic viability of their farm businesses. **For community leaders:** Critical insights and evidence regarding the role of sustainable farms and local food systems in community viability, jobs and economic development. **For Consumers:** A better understanding of how food	<u>**Short and Intermediate Impacts**</u>: **For research community:** New ability to tackle new, more complex and meaningful kinds of questions with long-term implications**For Farmers**: Farmers will shift production and gain more profit from local food systems in Ohio New revenues in carbon credits become possible **For Policy Makers:** Meaningful policy will be implemented that supports production for local food systems. **For Demonstration Farms**: Demonstration farms are seen as being drivers of development and innovation in the agricultural sector, and not fundamentally different from working farms. **For Extension Educators:** Educators will have a more effective instruction model to support profitable

SUSTAINABLE AGROECOSYSTEM SCIENCE ON DIVERSIFIED FARMS PRODUCING FOR LOCAL FOOD SYSTEMS
LOGIC MODEL

Resource/Inputs	Activities	Outputs	Outcomes	Impact
Stratford Ecological Center **Transition Farm at Conneaut Creek Park:** **Stakeholder Groups:** • Farmers • Farmers' Market Management Network Cooperative • ODA – Ohio Department of Agriculture • SFI - Small Farm Institute • OFBF – Ohio Farm Bureau Federation • OEFFA – Ohio Ecological Food and Farming Association • IFO – Innovative Farmers of Ohio • OPGMA – Ohio Produce Growers and Marketers Association **Existing Social and Digital Media:** www.oardc.osu.edu/amp • Ohio Local Food Systems Collaborative localfoodsystems.org • OSU Direct Marketing website http://directmarketing.osu.edu • Uprooted video series. **Existing Data Sets:** • NASS Ohio Crop Data Layer • Ohio Soils Data • MarketMaker • U.S. Census	**Extension Activities:** Series of annual workshops and tours Extension Presentation Package to include: • Power Point Presentation summarizing research results and opportunities • Farm profiles Production of video and other visual media, podcasts, website entries, social networking **Education Activities:** An academic conference on sustainable agriculture research and education taking place on demonstration farms will be held for faculty, staff and students at Ohio public schools, colleges and universities and NGO's operating demonstration farms. including sessions on: • Demonstration farms as "living laboratories" • Student research on • internship opportunities • Connecting farms and classrooms via the internet • Graduate program development The conference will facilitate collaborative research and education programs between sites. **Project Evaluation** Integrated evaluation of research and extension activities	resources, research summary and mapping materials online Presentations to annual conferences and other organizational meetings of OPGMA, IFO, OEFFA and OFBF (farmers' groups) and to extension educators Presentation of results to policy makers (OFPAC) Project evaluation reports	purchase choices impact agricultural production. Better social relationships between consumers and neighboring farms. **For Policy Makers:** Awareness of both soil and social conditions that are influenced by diversified farms supporting local food systems, and the incentives and barriers on which policy should focus. Recognition of the relationship between people and the land in policy. How to design carbon markets for agricultural participation at a broad range of scales with incentives to shift production methods. **For Demonstration Farms:** A new ability to monitor their soil and farm systems. Farms are better able to interpret for the public how they connect social quality of life with environmental indicators. Demonstration farms with different emphases and capabilities now share these across a network, which creates synergy and contributes in the aggregate to research, education, and extension. **For Extension Educators:** Extension educators will have necessary resources to inform farmer decision making towards profitable crop production in local markets. Extension Educators will have new and interactive arenas to host demonstration field days and workshops to promote outreach for farmers and professional development for themselves.	agricultural production and a strengthened relationship and support of demonstration farms **Long Term Impact**: • The local food system in Ohio will be expanded and strengthened providing larger quantities of fresh local food to Ohio consumers • Rural Communities in Ohio will be strengthened by food systems that improve social connections, economic prosperity and the environmental quality of agroecosystems • Ohio can emerge as a national leader in innovative ways to connect food systems with climate change issues.

Management Plan

During the proof of concept period, the organizational and management structure to reach our research, extension and educational objectives will consist of a committee comprised of one representative from each of the participating farms, 3 faculty members engaged with the project, 3 graduate students, and 3 undergraduate or k-12 students. The committee will be facilitated by Casey Hoy at The Ohio State University, with support from the Agroecosystems Management Program staff as a donated service to the project. This committee will meet quarterly to discuss near-term project goals and tasks, long-term objectives, and new opportunities and insights that arise as a result of the project. Between the quarterly meetings, communication will take place via phone and the internet connection among farms with communication/collaboration tools that are currently available and are being further developed in the USDA SCRI project under Hoy's direction. The academic network will be developed as a result of employing students from multiple institutions on the project.

The advisory committee also will assist with ensuring that project outputs are formulated for the multiple educational audiences including k12, undergraduate and graduate levels.

To prepare for a longer term effort, the demonstration farm conference proposed for year two will be used to generate a candidate list of individuals who are not directly involved in the project but who could serve as an advisory board for the network of long-term monitoring sites. We would expect this advisory board to consist of individuals that represent the breadth of research, education, extension and farming inherent in the project. Accordingly we anticipate recruiting farmers, students, faculty, leaders in Ohio agriculture, consumers, and business people/entrepreneurs to serve on the advisory board. The board would serve to evaluate the progress of the work, provide overall direction to the project, and assist with continuity in the effort of the long term.

Timeline (milestones marked with *)

Activities	**2009**			**2010**								
Month:	10	11	12	1	2	3	4	5	6	7	8	9
Baseline data collection on farm histories, guiding principles of decision maker(s)	x	x	x	x								
Baseline data collection on market structure				x	x	x						
Georeferencing of farms, fields, surroundings					x	x						
Establish internet link among farms*				x	x	x	x					
Establish weather, sensor platforms on each farm*						x	x					
Initial soil samples							x	x				
Monitor farm outputs, sensor platforms							x	x	x	x	x	x
Monitor farm market participation, production								x	x	x	x	x
Initial k12 and undergraduate engagement							x	x	x			
Planning for field days and tours, other extension engagement					x	x	x					

Activities	**2010**			**2011**								
Month:	10	11	12	1	2	3	4	5	6	7	8	9
Data entry and transcription, verification	x	x										
Quantitative and qualitative analysis/ data interpretation*		x	x	x	x	x						
Comparison among farms and upscaling*			x	x	x	x						
Development of digital media including narrative and video, establish means of ongoing production and display via the internet		x	x	x	x	x	x	x				
Development and delivery of k-12 programs			x	x	x	x	x	x	x			
Development and delivery of extension programming		x	x	x	x	x	x	x	x	x	x	
Presentation of results to policy makers							x					x
Academic conference to engage regional institutions in the network								x				
Analysis of temporal trends for first two years											x	x
Upscaling and agroecosystem health index mapping											x	x
Evaluation of the project/ follow-up survey										x	x	x
Evaluation report												x

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