2014-2017 Northeast SARE State Program Project Plan for The Pennsylvania State University

Project Title: Monitoring and Predicting Ecosystem Functions in Agricultural Systems

PROJECT TOPIC AND JUSTIFICATION OF TRAINING NEED

The sustainability of agricultural systems depends upon the maintenance of ecosystem functions such as carbon (C) and nitrogen (N) cycling, pest regulation, and weed suppression, and the sustainability of society as a whole depends upon the services provided by these functions, such as clean water and air, food production, and biodiversity (Foley et al., 2005). Ecosystem functioning affects all sectors of plant-based agriculture as the ecological processes that regulate production and environmental outcomes transcend differences in farm size, commodity type, and geography. Maintaining ecosystem functioning in agricultural systems is especially critical in Pennsylvania (PA) due to ongoing water quality concerns in the Chesapeake Bay, the development of Bt resistant corn rootworm in neighboring regions, the importance of pollinators in specialty crop production in PA, and the rising occurrence of herbicide resistant weeds in PA. Maintenance of ecosystem functioning can reduce the need for synthetic and purchased production inputs, reduce environmental contaminants, and slow the spread of pesticide resistant organisms (Mortensen et al., 2012, Drinkwater and Snapp, 2007), thus increasing the sustainability of agricultural production.

To maintain ecosystem functioning in agricultural systems, farmers and ag service providers must be knowledgeable about the processes, monitoring methods, and prediction tools relevant to each ecosystem function. Farmers and ag service providers can then use information gained from monitoring and predicting ecosystem functions to inform management actions.

Our needs assessment survey completed by 99 ag service providers revealed several patterns about the current knowledge of processes, monitoring and prediction methods, and management tactics related to ecosystem functions (summarized in Table 1, complete findings attached). These findings inform our development of a training program that will focus on **monitoring and prediction methods** related to the ecosystem functions of C and N cycling, insect pest regulation, and pollination.

Table 1. Summary of knowledge level about processes, monitoring methods, and management tactics related to different ecosystem functions based on needs assessment survey of 99 extension educators and conservation practitioners.

Ecosystem Function	Processes	Monitoring Methods	Management Tactics
C cycling	High	Low	High
N cycling	High	Low	High
Pest regulation and pollination	Low	Low	Low

5. BENEFICIARY AUDIENCE DESCRIPTION and RECRUITMENT EFFORTS

We expect to reach approximately 200 ag service providers with our training program in each year of the project. These beneficiaries include Extension educators, crop consultants, input suppliers, NRCS field staff, conservation district field staff, state agency staff, and NGO employees from Pennsylvania and neighboring states. We will integrate our training sessions into existing high-profile events that are already well attended by ag service providers including the Agronomic Diagnostic Clinic and the Farming for Success Field Day. Recruitment for these events will take place through established contact lists and membership rosters. We will also conduct a webinar series, recruitment for which will take place through established e-mail lists and clientele databases, as well as viral networking.

We will develop a small cohort of service providers who are more deeply engaged in the training program, including approximately 25 service providers who participate in the 'Soil Carbon Challenge' activity (described in section 4) and a small group of input suppliers who we will work with to field test nitrogen cycling monitoring methods.

3. LEARNING OUTCOMES

Topics that will be included in our training initiative include:

- Factors affecting soil C inputs, losses, and storage
- Soil testing methods to measure soil C including organic matter by loss on ignition, carbon by combustion analysis, active C by permanganate oxidation, and 24 hr flush of CO_2 by the Solvita CO_2 Burst test
- Predicting N mineralization potential and fertilizer recommendations using the Solvita test
- Measuring cover crop biomass N content using NDVI sensors
- Predicting N fertilizer recommendations using computer models
- Habitat requirements for insect predators and parasitoids
- Nutritional and habitat requirements for pollinators
- Effects of pesticide use on insect predators and parasitoids
- Measuring pollinator activity with bee visitation counts
- Measuring ground-dwelling predatory insects with pitfall traps
- Predicting risk of damaging stages or populations of insect pests using computer models

4. EDUCATIONAL ACTIVITIES PLANNED

Year 1: We will focus on C cycling and introduce the 'Soil Carbon Challenge' activity. This activity will engage 25 ag service providers in learning how to monitor and predict soil C cycling. Service providers will attend a webinar training about different soil C testing methods and will learn how to use a soil C computer model to predict how different crop rotations and management decisions affect soil C storage. Service providers will then work with a cooperating farmer to develop a soil C management plan. Service providers can submit soil samples from the cooperating farms for State Program personnel to analyze using different soil C testing methods at the beginning of the project and again in year 3 to see if changes in soil carbon are observed. We will also conduct a hands-on workshop about monitoring soil C cycling at the Farming for Success field day in June 2015.

Year 2: We will focus on the topics of N cycling, pest regulation, and pollination. We will hold an ecosystem functioning webinar series in winter 2016 consisting of two webinars on N cycling and three webinars on pest regulation and pollination. In July 2016 we will organize a hands-on workshop at the Agronomic Diagnostic Clinic related to monitoring N cycling and predicting N fertilizer needs. We will also work with two input suppliers to field test methods to measure cover crop biomass N content using NDVI sensors and predict N fertilizer needs in a subsequent corn crop using computer models.

Year 3: In year 3 we will provide individualized follow-up to help participants in activities from year 1 and 2 implement ecosystem monitoring methods. We will also work with participants in the 'Soil Carbon Challenge' to test soil samples from cooperating farms after 3 years of implementing soil C management plans to determine if there are changes in soil C properties.

SEE ATTACHED MILESTONES FOR YEARS 1, 2 AND 3

VERIFICATION OF LEARNING OUTCOMES

We will conduct evaluation surveys at the end of workshop sessions, conference presentations, and webinar presentations to measure changes in knowledge, skills, attitudes and intentions using standard post-then-pre question formats.

2a. AG SERVICE PROVIDER ACTIONS PROJECT PERFORMANCE TARGET

Twenty ag service providers offer training to farmers about monitoring and managing ecosystem functions or directly monitor ecosystem functioning on a client's farm, reaching 1,000 farmers managing 10,000 acres of land.

2b. INDICATORS OF AG SERVICE PROVIDER ACTIONS

Ag service providers provide training or work with a farmer to:

- Conduct soil tests to measure soil C quantity and quality and/or soil N mineralization potential
- Measure cover crop N content using NDVI sensors
- Use a computer model to predict soil carbon storage or N fertilizer requirements
- Reduce N fertilizer recommendation by appropriately crediting N availability from soil organic matter and cover crops
- Implement cropping system management tactics that increase soil C storage
- Assess pollinator activity with bee visitation counts
- Increase habitat and nutritional resources for pollinators
- Assess ground dwelling and predatory insect activity with pitfall traps
- Increase habitat for insect predators and parasitoids
- Reduce insecticide use and Bt-traited crop use when appropriate

VERIFICATION OF PERFORMANCE TARGET

We will use electronic surveys at the end of project years 2 and 3 to verify the actions of ag service providers who have participated in any of the State Program training activities. We will also conduct interviews of selected participants who have shown a high level of involvement in training activities and demonstrated significant outcome potential in order to obtain more detailed and qualitative project impacts.

1a. FARMER ACTIONS DESIRED

Twenty farmers monitor one or more ecosystem function on their farm and take actions to improve or maintain ecosystem functioning on 2,000 acres of land.

1b. INDICATORS OF FARMER ACTIONS

Farmers:

- Conduct soil tests to measure soil C quantity and quality and/or soil N mineralization potential
- Measure cover crop N content using NDVI sensors
- Use a computer model to predict soil carbon storage or N fertilizer requirements
- Reduce N fertilizer use by appropriately crediting N availability from soil organic matter and cover crops
- Increase soil C storage through cropping system management tactics
- Assess pollinator activity with bee visitation counts
- Increase habitat and nutritional resources for pollinators
- Assess ground dwelling and predatory insect activity with pitfall traps
- Increase habitat for insect predators and parasitoids
- Reduce insecticide use and Bt-traited crop use when appropriate

VERIFICATION OF FARMER ACTIONS (optional)

We will send electronic surveys at the end of project years 2 and 3 to any farmers that have participated in educational activities as well as to farmers that service providers have worked with as a result of learning about ecosystem monitoring practices through the State Program activities.