Open Source Decision Support Tools for Soil Health & Ecosystem Services

Purpose and Objectives

The Foundation for Food and Agriculture Research (FFAR), in an effort to advance open source decision support and data collection tools that empower more farmers in the U.S. and abroad to improve the health of their soil and deliver and accurately monitor related ecosystem services, held a convening event October 25 and October 26, 2017 following the annual Tri-Societies meeting.

FFAR is working with FarmOS and LandPKS on envisioning an open source platform to serve as the catalyst for a larger collaborative effort that coordinates existing development of data collection and decision support tools, encourages new development, better aligns technology with users, and creates a shared roadmap for future open source agriculture development.

The purpose of this meeting was to engage in the coordination of existing decision support tools to have an open interactive discussion as to the potential of such of larger collaborative effort and to determine specific research and development opportunities that could be undertaken.

Meeting Objectives

- Develop alignment around long-term goals for an Open Source Decision Support Tools Coalition for Healthy Soils and Ecosystem Services.
- Identify specific needs and opportunities – both near- and longer-term – within the research and user communities, including companies, NGOs, governments, farmers, and ranchers.
- Identify specific next steps including, but not limited to, potential funders, modes of communication to support ongoing interactions, and operational details such as working groups.

Current State of the Science

Background

There is a wealth of opportunity to improve soil health at the farm level, which can also improve profitability and productivity and provide environmental benefits including but not limited to climate mitigation and adaptation, improved water quality and quantity, and enhanced air quality.

There has been an explosion of tools, models, and methodologies for assessing soil health, GHG emissions from the farm, other ecosystem services and there has been movement in a positive direction towards aligning optimal ways to measure these (e.g., work of Soil Health Institute, Soil Health Division at NRCS, Soil Health Partnership). There is also a rapidly evolving set of tools for data management on the farm, some of which are linked to tools that can be used to assess soil health.

There is a growing interest in agricultural sustainability from both consumers and retailers, but with that interest comes a more a crowded, complicated, and –often –confusing landscape of sustainability tools and standards, which can create layers of extra work. And despite all this activity, it's hard to see how much this multitude of sustainability standards and their associated requirements are driving meaningful change on the ground.

It's clear that we have a great opportunity to utilize advances in technology to better support farmer decision making on the ground and measure progress as we collectively address climate change and other ecological challenges.

An open source decision support platform can link together the models, decision support apps, and monitoring tools that we have for measuring and improving soil health and other ecosystem services on the farm. Creating these linkages allows us to maximize the benefits of farm level data collection by enabling the efficient exchange and use of data across tools and among farmers, researchers, and supply chains.

- At the farm level, this will make it easier to use decision support tools that help producers shift from best management practices to adaptive management.
- For researchers, increased availability of high quality farm level data can help speed the pace of improvements to models and decision support tools, and in turn get these improvements back into the hands of producers using these tools.
- At the supply chain level, streamlined availability of farm data will benefit companies that are looking to reduce the overall environmental impact of production and provide transparency to consumers.
- Ultimately an open source decision support platform could serve as the basis for cost-effective producer participation in high quality ecosystem services markets.

Lightning Talk Overview

PowerPoints of each lightning talk have been provided

A key component of the convening event was to have a series of "Lightning Talks". The objective of the Lightening talks was to provide a brief window into several open source decision support tools for farmers that already exist or are in development. This series of presentations were not meant to be a comprehensive survey of the tools that exist but to provide an overview of some of the existing tools.

1. *Rapid soil assessment and open science hardware - Greg Austic, Our-Sci*
2. *Comet Farm - Keith Paustian, Colorado State University*
3. *Location specific cover crop decision tools - Steven Mirsky, USDA/ARS*

International Soil Carbon Network - Marcia DeLonge, Union of Concerned Scientists

4. *Fieldprint Platform - Allison Thomson, Field To Market*
5. *DNDC model & soil health - William Salas, Applied GeoSolutions*
6. *FarmBeats: AI & IoT for Agriculture - Ranveer Chandra, Microsoft*

   FarmOS - Dorn Cox, Wolfe's Neck Center for Agriculture and theEnvironment
7. *LandPKS - Jeff Herrick, USDA/ARS*
8. *Cool Farm Tool- Sustainable Food Lab- Remote Comments*

Lightning Talks Question & Answer Session

Several questions were generated from the lightning talks and they fell into several overarching categories:

Data:

- Intersection and overlap with proprietary tools. Will commercial entities be willing to collaborate with an open source network? Share data?
- How do we protect privacy of data while maximizing benefits of data usage?
- There is a need for guidelines and usage of common architecture, data formats and structures, and language. Shared goals include ensuring data is easily searchable, accessible, and user friendly. Field testing a shared platform can help us work towards this goal.

Funding:

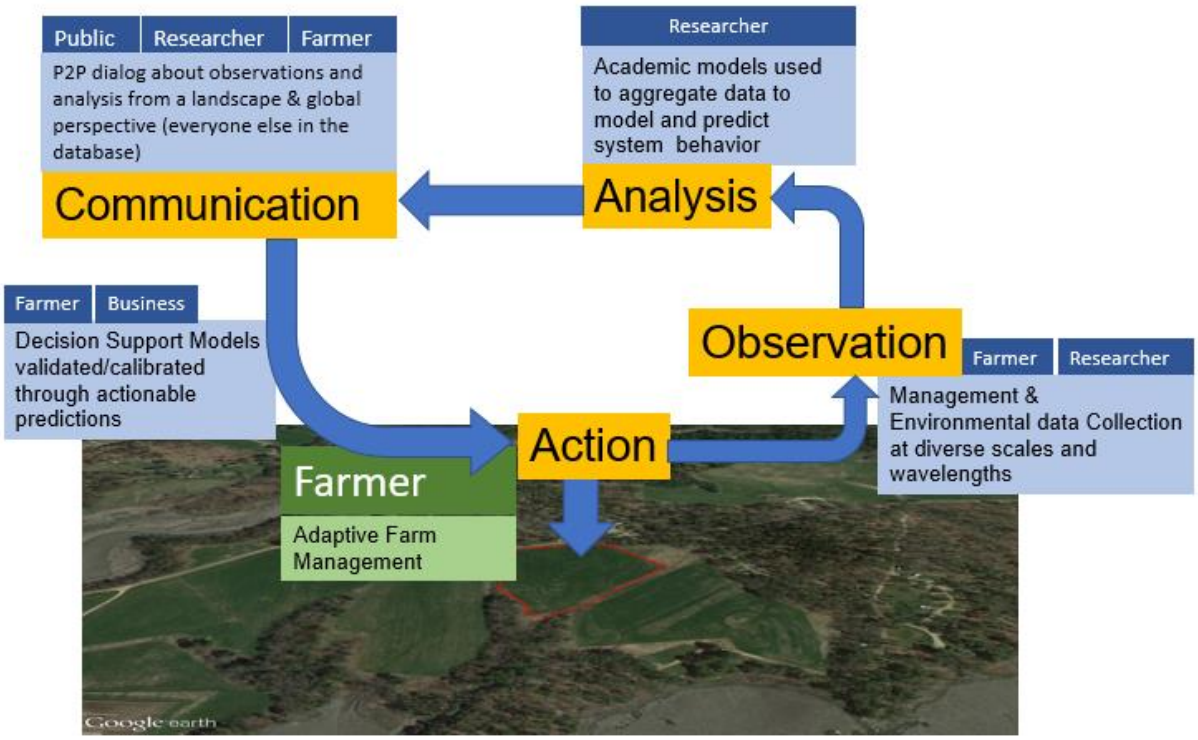
- Funding for specific projects is important, but it requires a different and perhaps more complex project structure.

Adoption:

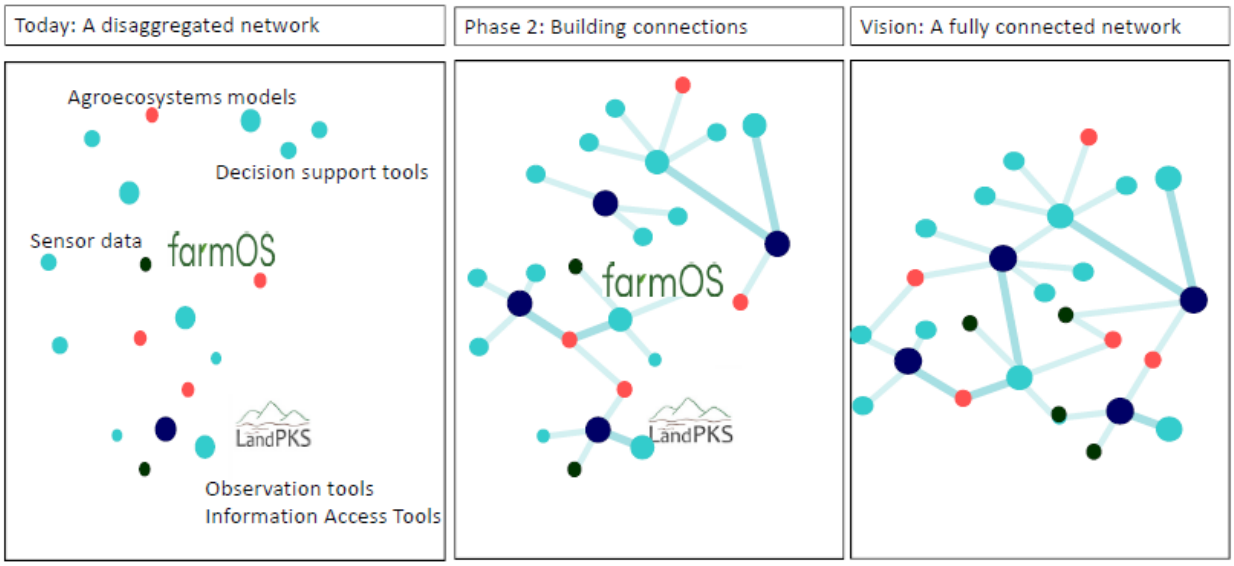
- Shared priorities that will improve farmer education and adoption of tools include: tools that are easy to use, generate results, facilitate a shift from using generalized recommendations to more site specific data driven recommendations, and are tied to profitability.
- There is a need for ground-truthing results.

Visualization Document

Adaptive management action is dependent on feedback. Observational tools gather quantifiable systems data, then analytic tools aggregate, analyze and provide context, and then communication tools provide human interpretable interfaces delivered and adapted to different audiences. We need everyone in this chain to talk and develop trust. The more trust the lower the transaction costs. It's more than just gathering knowledge – farmers need to know how to both contribute their data and also interpret processed results to their specific application.



The objective of this project is to create a system of trust to help data flow between all the steps without requiring individual relationships at every step. Transparency is needed. What is open data and what is open source? The goal of this process is to focus on partnerships to accomplish this goal.



Visualization document dialog

Gaps. Conversations centered on use and management of data across a larger platform, and the role for farmers in this system.

Data: Need coordination to manage and ensure utilization and efficient flow of data across the platform. Building consensus around key measurements and data needs will help with this. Common language and formats needed. This area has not traditionally been well funded.

Farmers: Farmers are a key partner for collecting and sharing data, with researchers and each other. Farmer feedback is fundamental to improving tools over time, and tools must be participatory for farmer uptake to occur. Building trust and strong linkages between data collection activities and farm-level decision making will help to move the needle on management practices over time.

- Former efforts at merging agroecosystem models did not give the same results, and merging to a single model did not work. How can these lessons be applied? Learn from Gates funding effort. What do farmers care about and what can they control? What is open access data? Where does it come from? We need calibration and validation from field ground truth data

<u>Opportunities</u>

Added value of an open source decision support platform:

1. Potential to lower cost for smaller scale operations, and support for diverse production systems
2. Greater control, security, and continuity. No dead ends. Build the longevity of the system as we decouple tools from their creators (avoid situation that when a business folds, the tools disappears too)
3. Accelerating innovation – The faster we can share successful management strategies with people who face the same conditions the faster we can really get innovations going that will help creative farmers to use the tools,
4. Provide trusted data, analytics and data security to farmers, buyers, and customers.

- We can build in emergent properties and adaptability into these models and platforms. This should be embraced as part of versioned open architecture.
- Businesses are also investing in "big data" but they are protective about that information because control of data is core to their business model. The opportunity and uniqueness of a broad collation/consortium is the potential to build on a larger vision.
    - Commercial software can be a good fit for helping farmers with business decisions, eg trying to develop decision support around incremental input planning by managing nitrogen, for example.
    - Our niche is ecosystem-based services. Public goods such as ecosystem services require transparency to be trusted - the data and methods for evaluating these can't be secret, especially if we expect taxpayers or supply chains/consumers to both trust and pay for the benefits.
- Managers of tools that want to engage with this potential open source network can begin by publishing APIs, but also take a step further in making the APIs more extensive and customized.
- Build framework for quantitative conversations beyond yield. Think of soil health metrics, food quality – nutrient density, etc. Useful for farmers, ag professionals, consumers and companies
- In order to grow a successful network of farmers using these tools, we can start with the soil health champions and engage early for field based user experience feedback. These farms will lead the way among their peers as long as the tools provide real value.
- Existing supply chains, crop advisors and crop professionals have an important role in implementation, and also directly benefiting from a unified platform.

<u>Additional Comments</u>

- Pre-competitive space can benefit the entire field. As a community, we will be more effective together, but it requires that we all leave some of our personal interest at the door, and dedicate a percentage of our efforts and budgets to interoperability.
- We want farmers to be more successful, sustainable, and mitigate climate change
- Need to build for change – what we create today will be irrelevant in 6 months. System needs to be adaptive to changes in technology over time.
- How can incremental improvements in models improve the tools? Where do they work and when?

Gaps and Opportunities – Breakout Session

In this section of the meeting, groups were asked to discuss a series of concepts. The key questions and emerging themes are listed below.

Question: *What needs do companies, NGOs, governments, farmers, ranchers, individuals, and institutions have related to decision support to improve soil health and support ecosystem services?*

Question: *How can we efficiently deliver decision support to the farmer, while also advancing accurate data collection for monitoring and evaluation of results to advance landscape-level ecosystem goals?*

Question: *What does this imply for issues including but not limited to research, demonstration projects, funding, and stakeholders to be engaged?*

Combined notes from group discussions:

- Need more open source agreements and rules of engagement; protocols for data input and sharing, more efficient data exchange across platforms
- Calibration of new tools is now the limiting factor, not hardware storage, processing, sensing or communication costs.
- Need to better understand and more fully articulate the value brought by open-source approach vs privately developed tools. Demonstrate the public and local benefits of open source approach.
- Need to better understand long-term funding requirements to maintain this effort into the future
- Need to develop a network of farmers that can work with developers and pilot tools. Network can also build strong peer learning and sharing opportunities for farmers.
- Potential benefits from creation of open source decision support platform are not just soil health and carbon. Goals should include other ecosystem services, farm yield and profitability (business case).
- Farmers are on a seasonal cycle but practice shifts and resulting benefits can take multiple years. Need adequate incentive up front for farmer to engage, and long term agreements that share risk –farmer can't bear the full burden up front. Over time benefits from soil health improvements do help farmers with yield and profitability but this is a long term value proposition – we need short term bridge to get farmers involved. We need to better understand role for supply chain role in driving this process.
- Data ownership, management, and privacy must be addressed. Tension between desire for farmer ownership and control of data vs value of context that can be achieved through aggregation and sharing. The greater the trust, the lower the cost and complexity required
- Validation needs to happen – need to rate quality of data and maybe research farms that can contextualize the info from farmers – you can validate in tool itself, but there is no foolproof machine.
- Need involvement of social scientists

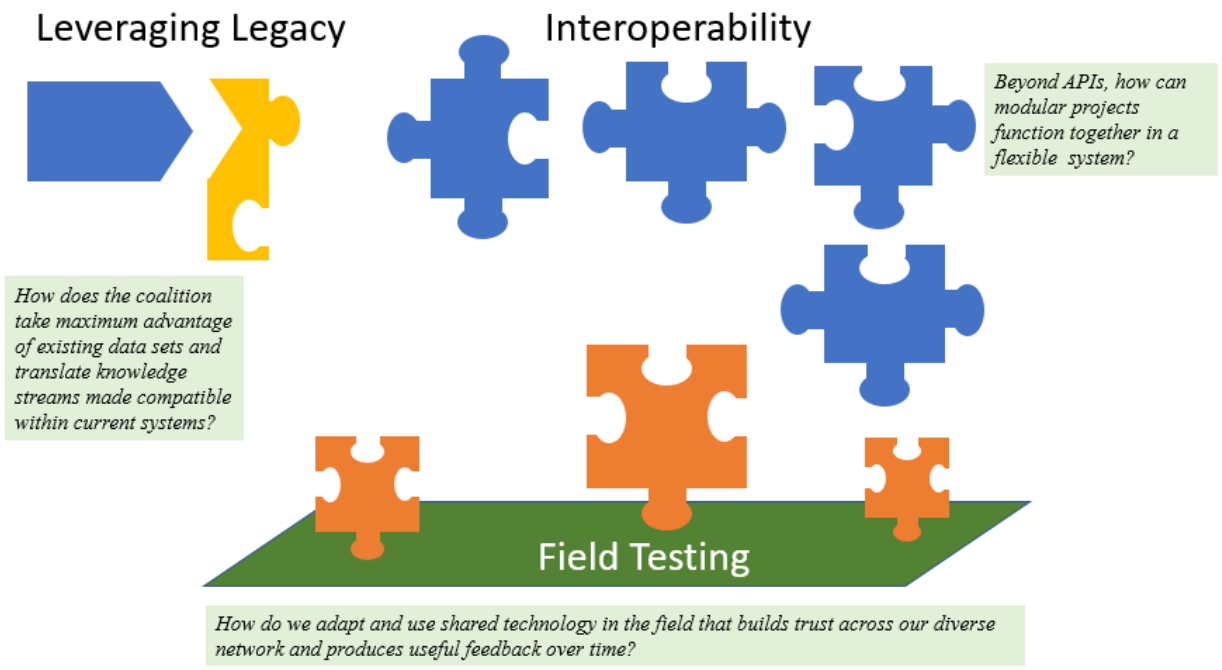
Day 2

Based on synthesis of previous days discussion, three themes emerged that were explored in greater detail by self-selected groups.

Field Test: developing a network of farms to pilot an open source decision support platform

Interoperability – not just API: How projects can function together in a system?

Leveraging legacy – streamlining the management of existing and future data to maximize benefits of the system



Report out

Field Test: developing a network of farms to pilot an open source decision support platform

- Purpose is to (1) test open source decision tools and data management platforms: Move data across different tools and assess ability to drive change on the ground; (2)lay the foundation and begin to build a large network of farms using the open source platform to drive improvements in soil health, soil C sequestration, ecosystem services, and improved yield and profitability
- Effort needs to serve interests of all stakeholders: farmers, researchers, supply chains, government & funders.
- Pilot network of farms allows us to start adaptive cycles around some of the tools. This network should build on existing networks, e.g. NACD and Dairy Grazing Apprenticeship. Network must represent diversity of farm types, scales, and geographies
- Strong monitoring and evaluation component needed
- Field test utilizes mother-daughter trial structure
- Pilot network participants (hub farms) become educators of future farmers in the network
- Need to include farm consultants, advisors + extension in process (train the trainer) to leverage networks, technical capacity and build trust

Data Legacy

- *What data?*
    - National and international public data sets
    - Farmer-generated data
    - Private data
    - Peer reviewed data
    - Modest data – could be very valuable; not just going after big data;

- *How can we incentivize people to submit data?*
    - Data buddy – someone who did the management and gathered as long as someone submitted them
    - Special issue or call in papers – get them to submit
    - Reduce barriers to collection and sharing
    - Industry – what's the added value; some kind of proprietary components may still exist, but be made compatible
    - Maybe a grad student led group who can lead this or cluster group or workplace development group to facilitate storying data
    - Recognize what the trade-off is to publish your data set.
    - How do we store all this data? Who owns it?
    - *How do we get these data sets in hands of scientists?*

- *Groups:*
    - Soil testing labs
    - Farming business network
    - Ag analytics

Interoperability

- Describe ideal world and then current status
- What are the best practices for developing or integrating software?
- Need to develop value proposition – maybe for different people and situations;
- What could the default standard be?
- Stakeholders: ag librarian, etc.
- Funding: Noble, Sloan Foundation, soil labs and testing, Ford Foundation, Rockefeller, crop insurance/risk mgmt.
- Fund for the field testing and pilots, not just development

Key Conclusions

There was agreement around the need to form a coalition/consortium to advance open source decision support and data collection tools that empower farmers in the U.S. and abroad to improve soil health and achieve social, economic and environmental outcomes including but not limited to:

- Sustainably increasing the amount and quality of agricultural production;
- Reducing off-site environmental impacts on air and water quality; and,
- Mitigating GHG emissions and supporting climate adaptation.

To accomplish these goals, the Coalition will focus on identifying or developing a shared set of tools and standards that:

- Improving data access and sharing to enhance the quality of science for the benefit of farmers, and allow farmers to easily move their data between apps and platforms;
- Standardizing language, units, and metrics related to soil health and ecosystem services;
- Developing tools and software that are more likely to be adopted by farmers by working with them during design, development, and deployment.
- Developing the architecture necessary to ensure that data, information and knowledge can be easily shared, and moved between apps/platforms.

These tools need to be tested in the field to improve efficacy and speed adoption. In addition to the above activities, the coalition/consortium will work to create a network of pilot farms to test tools, serve as educators of other famers interested in adopting these tools, and build a network of farms using this open source decision support platform to drive improvements in soil health and other ecosystem services.

Next Steps

FFAR will schedule a follow up webinar; send links to ppt; and the goal statement drafts.

A working group will be formed. Membership of working group will include volunteers from the convening and additional key stakeholders identified by meeting participants. Working group tasks include:

- Organize project governance,
- form tech advisory board for the coalition/consortium
- Identify workstreams for Legacy, Interoperability and Field Testing areas
- review and create a feedback process using the draft Goals, Purpose and Principles document as launching point.

Next steps mentioned by audience:

  - If people have thoughts of stakeholders, contact LaKisha.
- Open ag development conference in planning phase for next May 2018 (Dorn Cox) - could form basis for tech advisory board? Contact Dorn Cox for more detail about this event.

Illustration of the comments captured in the ending sessions where participants were asked to share their closing thoughts and what they were most excited and concerned about. This represents the interest in working together to assist farmers increase sustainability by sharing open data in soil health in an innovative manner and the excitement and concerns that surround moving forward.

This event was made possible with generous support from the following sponsor:

Stonyfield ORGANIC

Special thanks to the Alliance of Crop, Soil and Environmental Science Societies for supporting this event.