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The DIRECT[4]AG Project, Part 2: Helping Advance Adoption of Cover Crops

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Technological adoption benefits from data collection and use, all of which can help farmers make critical changes to their production systems and adapt to changed circumstances. To succeed, farmers need to sort out the practical implementation of such technologies and blend traditional knowledge with new approaches. As discussed in Part 1, the "Digital Infrastructure for Research and Extension on Crops and Technology for Agriculture" (DIRECT^{4}AG) project funded by USDA's National Institute for Food and Agriculture (NIFA) seeks to facilitate adoption of emerging agricultural advancements by providing farmers with decision support tools and unbiased research data (*farmdoc daily*, October 14, 2024). This article continues the discussion by focusing on how DIRECT^{4}AG collected, assembled, and applied valuable data to validate cover crop decision support, furthering innovation in research, Extension, and farming.

Background

As discussed previously, the DIRECT^{4}AG project seeks to help the adaptation of agricultural research, demonstration, and Extension in the digital era. A key focus of the project is connecting research advancements with local or on-the-ground knowledge and data through digital infrastructure to facilitate informational feedback loops. A priority application for demonstrating the goals of this project is to help inform and address the multiple challenges for farmer adoption of cover cropping practices to help reduce nutrient losses from farm fields (see e.g., Gentry et al., 2024, Ruffatti et al., 2019; Lacey and Armstrong, 2015; Lacey and Armstrong, 2014; Malone et al., 2014; Drinkwater and Snapp, 2007; Kaspar et al., 2007; Snapp et al., 2005; see also, *farmdoc daily*, May 2, 2024).

Discussion

The DIRECT^{4}AG project turned to an earlier project that developed the Cover Crop Analyzer, a digital tool that predicts cereal rye cover crop growth in Illinois fields (*farmdoc daily*, October 1, 2020; February 4, 2021; October 28, 2021). DIRECT^{4}AG measured weekly growth of cereal rye for improved verification and validation of the model-based predictions in the tool. A team of researchers at the University of Illinois and Purdue had previously developed the Cover Crop Analyzer to aid farmer adoption of cover crops by providing model predictions of cereal rye biomass accumulation and carbon-to-nitrogen ratio. Modeling cereal rye growth in Illinois fields provides valuable information to farmers about the changed conditions in a field, helping to inform decisions about terminating the cover crop and planning for the cash crop planting window.

To gather data to improve validation and verification of the predictions by the Cover Crop Analyzer, DIRECT^{4}AG partnered with another USDA NIFA funded project: "Illinois Farming and Regenerative Management" located at the Department of Agricultural and Biological Engineering Research and Training Center at the University of Illinois (I-FARM). In the fall of 2022, cereal rye was drilled following corn in a ~15 acre field that had been divided into eight sections. Two biomass samples were taken from each section weekly and were compared with the model predictions by the Cover Crop Analyzer. The results are presented in Figure 1.

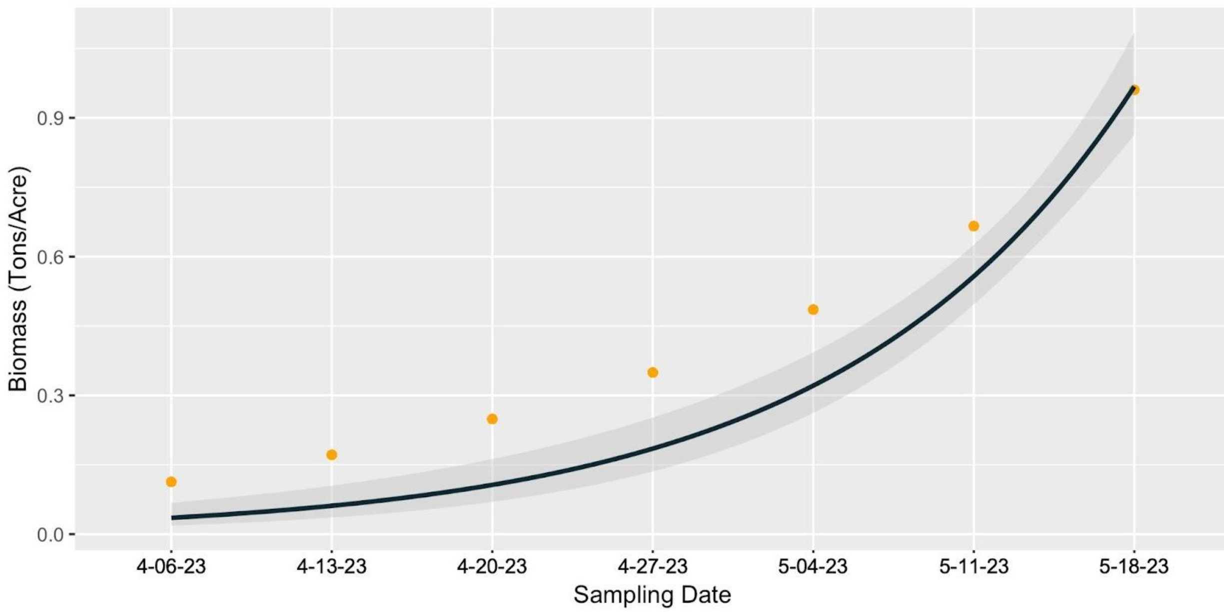

Figure 1: Cereal rye dry weight biomass sampled and modeled across 7 timepoints. The line depicts a smoothed average of the ground truth biomass samples with a 95% confidence interval shown in gray. The orange points are the modeled biomass prediction at each timepoint.

The results demonstrated that the Cover Crop Analyzer can accurately predict cereal rye biomass at termination, and that the model's overall trajectory of biomass accumulation reflects actual growth in the field. Equally important are the departure points between the actual biomass sampled and the modeled biomass early in the season. The cereal rye cover crop was established relatively late in the previous fall (November 11th, 2022). Other studies have observed that a threshold of 800 growing degree days (GDD) are needed to ensure good stand establishment that will produce expected amounts of biomass (see, Crespo et al., 2024). The cover crop sampled experienced less than 600 GDD accumulated between planting and the first biomass sampling. While the model was close overall, the initial biomass measurements demonstrate that the model predictions were overestimating growth and biomass. Future work will expand upon this initial review and apply the process to additional sampling locations to investigate further model accuracy and improve it against different cover crop establishment dates and year-to-year weather variations.

In addition to work described above, DIRECT^{4}AG also collaborated with a long-term on-farm study in Piatt County, Illinois. The project worked with three years of cereal rye cover crop biomass data collected from a 75-acre field implementing a rotation of corn-soybeans-wheat, with cereal rye planted following corn. Additional data included the ratio of carbon to nitrogen (C:N) of the biomass. These on-the-ground results were again used to further validate, verify, and improve the Cover Crop Analyzer with the results presented in Table 1.

Table 1. Ground Truth Data and Model Prediction of Cereal Rye Biomass in Three Years

Year	Measured Biomass (tons/acre)	Observed C:N	Modeled Biomass (tons/acre)	Modeled C:N
2015-2016	0.61	23	0.61	19
2018-2019	2.65	55	2.73	63
2021-2022	1.06	36	1.26	28

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The Cover Crop Analyzer accurately predicted cereal rye biomass in this field all three years. The C:N ratio trend was also matched by the Cover Crop Analyzer across the three years, although the absolute values differed. These results suggest that further adjustment of parameters related to carbon and nitrogen accumulation of the biomass need to be optimized, but overall biomass prediction can be used with confidence.

To build upon this early work in Illinois, DIRECT⁴AG is also working with Tuskegee University to engage minority and limited-resource farmers in the Black Belt Region of Alabama. A primary goal is to digitally demonstrate and apply innovative technology like the Cover Crop Analyzer to help farmers in that region implement and manage cover cropping systems. This part of the project will incorporate remote sensing analysis, field soil sampling, and testing to further assess the green biomass of cover crops and their unique impact and improvement on soil carbon and soil organic matter in participating farmers' fields. More than 40 farmers from Hale, Perry, Dallas, Marengo, Sumter, Greene, and Bullock counties have expressed interest in implementing cover crops, including specialty crop farmers, women farmers, and beginning farmers. The team is working with the interested farmers to sign them up for enrollment and begin building the digital feedback loops that will help with affordability, technology, partnerships, and capacity development.

Conclusion

The DIRECT⁴AG project involves building the digital infrastructure that can facilitate informational feedback loops between research and on-the-ground knowledge and experiences. With this digital infrastructure, research can inform and help with adopting changes in farming systems such as adopting cover crops. The experiences and data from cover crop adoption can further inform the research and drive improvements in both the application of that research as well as future adoption and adaptation efforts. As discussed herein, this project is making progress incorporating real-world data into decision support technology, helping to improve the technology's ability to help farmers adopt and adapt cover cropping practices on their farms. Next week's discussion will explore the project's progress on issues with cover crop planting and establishment.

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