INTEGRATED AND IMPACTFUL RESEARCH AND EXTENSION THROUGH DIGITAL ON-FARM RESEARCH

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ABSTRACT

The Nebraska On-Farm Research Network helps farmers evaluate products and practices that impact the productivity, profitability, and sustainability of their operations. On-farm research has the potential to center farmers in the discovery and innovation process and integrate the research, extension, and teaching missions of the university. Synergistic partnerships with industry advance technology adoption. Advancements in digital agriculture tools have increased the scale and complexity of agricultural challenges which can be addressed through on-farm research. Opportunities to leverage the changing landscape of on-farm experimentation will be discussed, drawing examples from 30+ years of on-farm research in Nebraska Extension.

INTRODUCTION

The complex challenges facing agricultural producers require collaboration and dynamic solutions. On-farm research can play a critical role in both generating solutions and transferring technology to farmers (Kyveryga, 2019; Thompson et al., 2019; Lacoste et al., 2021). Within the University of Nebraska – Lincoln (UNL) Extension, on-farm research efforts formally began in 1990 with a pilot group of farmers in one county. In subsequent years, additional efforts were launched throughout the state. In 2012, the Nebraska On-Farm Research Network (NOFRN) was formed, and the program scope was expanded to be statewide. The program is supported by the Nebraska Soybean Board, Nebraska Corn Board, Nebraska Corn Growers Association, and Nebraska Dry Bean Commission. Currently 80 to 100 studies are completed each year.

MATERIALS AND METHODS

The NOFRN operates within the six principles for on-farm experimentation as outlined by Lacoste et al. (2021): farmer-centric, real systems, evidence-driven, scalable, co-learning, and specialist-enabled. The practical approaches NOFRN uses to implement these principles are described as follows:

Farmer-Centric

The development and execution of the on-farm research project is collaborative and can involve the farmer, crop consultants, industry, commodity organizations, conservation partners, UNL extension faculty, and graduate students. Farmers take an active role in determining the research question and the process is generally viewed as collaborative and iterative (Thompson et al., 2019). Through the project, the farmers participating are engaging in transformational learning which leads to adoption. At the

same time, research data which is generated can be used to inform future recommendations for a broader group of farmers.

Real Systems

Farmers participating in the program generally implement the trials and collect the data using their own equipment. The protocols are designed to fit each farmers' unique management system, growing conditions, and questions. All studies are conducted using sound experimental designs featuring randomization and replication. Traditionally on-farm research has relied on field-length strips (Kyveryga et al., 2018). While this approach is still used, GPS technology can make establishing studies and collecting data more convenient for the farmer. For example, GPS technology is used to log the application location for strips of products, such as nitrification inhibitors and biologicals. Then, yield data is recorded on-the-go using a calibrated yield monitor. Finally, yield data is then summarized for each application strip, allowing for whole strip analysis. Due to the spatial yield data collection, sub-field analysis can also be used to detect site-specific responses to products.

While strip trials can provide meaningful data, the availability of variable-rate application (VRA) equipment has made it possible to move to more complex experimental designs, expanding the potential questions which can be addressed through on-farm research. Variable-rate application equipment is being used to establish seeding rate and N rate blocks throughout farmer fields in whole-field "checkerboard" designs (Alesso et al., 2019; Bullock et al., 2019) or within contrasting homogenous sub-field zones. An example is provided in Figure 1, detailing the process of developing the variable-rate prescription, applying the varying N rates, collecting the yield data, post-processing data, extracting yield data for corresponding N rates, and estimating the economic optimum N rate (EONR).

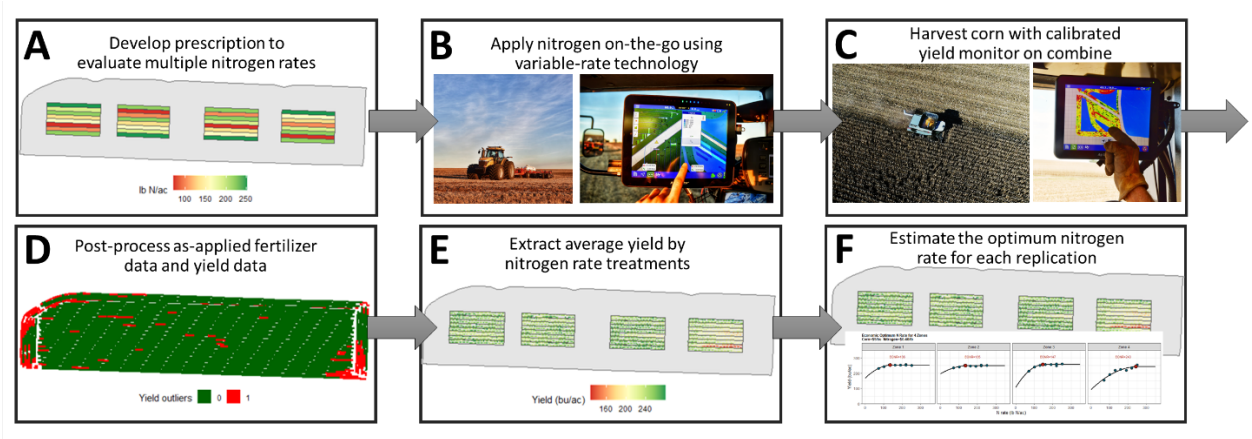

Figure 1. On-farm research nitrogen trial implementation workflow: A) variable nitrogen rate prescriptions are created with the nitrogen rate blocks, B) trial is applied on the go while the producers apply fertilizer, C) end of season yield data collection with yield monitor, D) post-processing to clean as-applied fertilizer and yield data, E) data summary, F) analysis of economic optimum nitrogen rate by replication.

Evidence-Driven

In many cases, extension educators, specialists, graduate students, and crop consultants collect in-season data including imagery, soil moisture, disease pressure, leaf area index, soil chemical, physical, and biological properties, crop establishment, and others. Farmers collect the end-of-season yield data, either with weights of field length strips or on-the-go using a yield monitor. Data post-processing and statistical analysis is conducted by extension faculty and individual reports are generated. In addition to yield analysis of treatments, all reports also include an economic analysis to assess if the treatments evaluated resulted in a positive return on investment. All studies go through a standard peer-review process for extension publications. Reports are published in an extension circular that is available in hard copy and online at: https://onfarmresearch.unl.edu/result-publications. Additionally, extension articles and peer-review journal articles often result from the aggregation of multiple on-farm research studies.

Scalable

The NOFRN works closely with the network of local extension educators to implement the program statewide. These educators provide structure and support for farmers conducting on-farm research. Educators are able to build close and long-term relationships with farmers and agronomists in the area. This results in 80 to 100 studies being conducted each year on topics including cover crops, crop production, crop protection, equipment, soil fertility, and non-traditional products (Figure 2). Coordinated efforts among the group of extension educators and specialists results in the development of aligned protocols, ensuring that generalizable insights can be gained from individual farmer efforts.

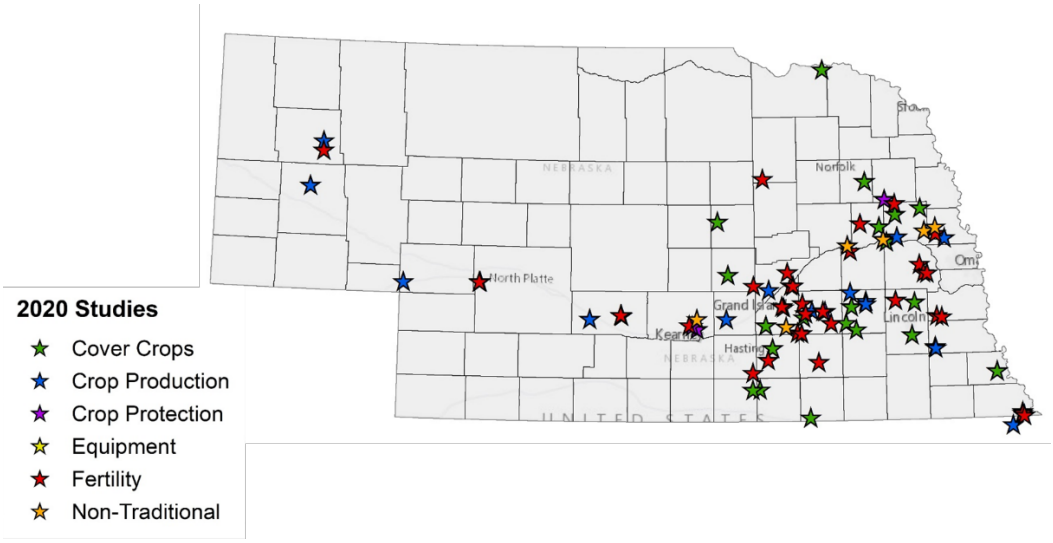

Figure 2. Example of on-farm research study topics and state-wide distribution from the 2020 growing season.

Specialist-enabled

In the NOFRN, specialists enable on-farm research through subject matter expertise, technical expertise enabling use of digital tools, and through development of tools to support on-farm research. Here we focus on several tools that have been developed by specialists to support on-farm research efforts. First, the *Growers Guide to On-Farm Research* provides an overview of the fundamentals of conducting on-farm research in the form of text, embedded audio, and video. Second, the *Results Finder Database* is a filterable and searchable database which contains results of over 1,000 past on-farm research studies, allowing users to find research that is relevant to their location and topic of interest. Third, the *Digital Ag Training Course* is an online course that covers the basics of utilizing common agricultural data management software to design and analyze geo-spatial on-farm research studies. Fourth, the *FarmStat* tool is a web application that enables users to conduct an ANOVA and mean-separation statistical analysis of their on-farm research study and obtain detailed output as well as simple and direct interpretations of the statistical output.

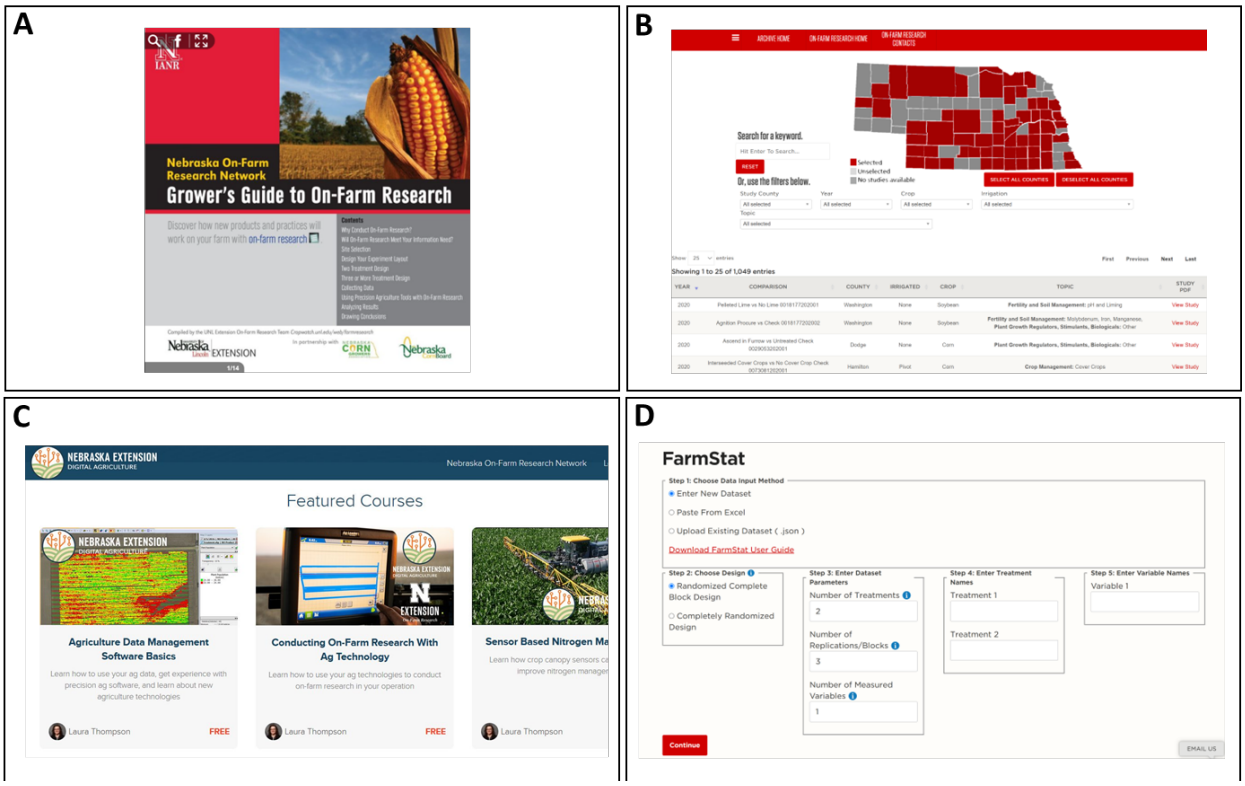

Figure 3. Tools to facilitate on-farm research provided by the Nebraska On-Farm Research Network. A) Grower's Guide to On-Farm Research, B) Results Finder searchable and filterable database, C) Digital Ag Training Course to learn to design and analyze on-farm research experiments, and D) FarmStat web tool for statistical analysis of research data.

Co-learning

Each year, participating farmers share their research results at the annual results update meetings which are open to the public. In this way, insights from on-farm research studies are valuable to non-participating farmers, expanding the reach of the program. These meetings are designed to be highly interactive with discussion about the research ideas and results. Annually, participants in the NOFRN results update meetings, rate the value of the knowledge they gain by attending at approximately $10 million. In 2022, attendee responses indicated that 93% learned new information about how to set up an on-farm research plot, 85% had a better understanding of cover crop management as a result of the programming, 79% learned new information about crop production practices, 86% learned new information about available ag technologies, and 96% have a better understanding of how ag technologies can be used to conduct on-farm research. Attendees noted that they liked the "variety of research done" and "networking around the state."

A highlight for many is hearing from their peers. Attendees noted that “I like farmers sharing experiences,” “at annual meetings we get to talk to others, share with others and without that, it would be half the value,” and “the on-farm research on my farm has allowed me to use less inputs and increase yields in the last 25 years…we learn a lot from each other.” The value of co-learning and social interaction in the program was documented through in-depth interviews which highlighted that the majority of people reported positive experiences from participating in the program were due to liking the university people they worked with and that they found value in the interactions at annual meetings (Thompson et al., 2019). This highlights the importance of co-learning and social interaction as part of an impactful on-farm research program.

Resources in this document can be found at https://onfarmresearch.unl.edu/.

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