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August 1, 2023

To: Bret Hess, Executive Director Western Association of Agricultural Experiment Station Directors

From: FRST Executive Team (D. Osmond, N. Slaton, J. Spargo, M. Yost, D. Kaiser, and G. Buol) and FRST Administrative Advisors (N. Slaton, G. Pierzynski, and E. Webster)

We welcome the review of our project, *The Fertilizer Recommendation Support Tool (FRST)*, for a national project and appreciate the thoroughness of the evaluation by the NRSP Research Council. We (the administrative advisors and the FRST executive team) would like to take this opportunity to respond to project concerns under the two general questions that were asked of us. We have provided specific answers to the discussion points that encompass the general questions. The two concerns raised by the NRSP review committee are listed below in shaded and bold font, and specific concerns are in bold, italic font. Our response to each concern follows in regular text.

How will expectations with the fertilizer recommendation support tool going to be managed? The response must address management of social, regulatory, environmental, and industry expectations.

1. *It can be difficult to meet expectations with fertilizer recommendations. The proposed project is taking baby steps and back filling data from 70 years ago to make it usable. It does not seem like FRST participants are trying to fertilize crops, rather it seems like FRST is bringing soil fertility to a certain level across the country. However, the team is promoting this project as a recommendation tool. Soil fertility is their focus, but not how they are presenting the project. People want more localized recommendations. Variable rate applications are hard to track and manage and are not often practical.*

- a. The FRST Project is working to improve assessment of crop available soil phosphorus and potassium (fertility) and crop fertilization decisions by creating a relational database for storing relevant data and developing a web-based support tool for summarizing crop response to soil test phosphorus and potassium data. The tool will identify and define critical soil test values and ranges, and eventually provide sufficiency-based fertilizer rate recommendations. Our conversations with public and private soil test labs suggest that localized fertilizer recommendations are being developed by industry, but they are being based on little to no scientific information and without knowledge of the soil test correlation and calibration process. Research-based uniform and variable rate fertilizer recommendations can only be developed with proper data. Much of the legacy data has been permanently lost or is located in file cabinets or computer hard drives and is inaccessible for soil test correlation and calibration

analyses and more sophisticated multivariate meta-analyses. The need to collate and archive these data to answer questions relevant to agronomic, environmental, and economic nutrient management has been the driving force for our project.

- b. Users accessing the FRST tool will select data to interrogate for soil test correlation to identify the magnitude and frequency of crop response to fertilization across soil-test values and eventually fertilizer rate recommendations. Data selection (nutrient of concern, crop, soil type, location, data years, soil depth, and extractant) allows unique solutions regarding the critical soil test level above which additional nutrients do not increase crop yield. The critical soil test level is based on developing a model that relates crop yields to field-specific soil test values and management and therefore is unique to the dataset selected by the user, thus the soil fertility levels will vary based on the conditions selected.

2. *To be real and relevant there needs to be billions of data points. Can they create something that is usable? Will the expectations of the tool be too broad?*

- a. We started this project with a focus on phosphorus and potassium nutrients and eight crops in order to constrain expectations and dedicate sufficient resources to the endeavor. Soil fertility has made inferences from smaller data sets than many other research areas because the work is time-consuming, expensive, and historically and currently underfunded. Many organizations make nutrient recommendations based on land-grant recommendations or proprietary algorithms that may or may not be supported by research. USDA-NRCS requires land-grant recommendations, even if a company is making its own recommendations. *The database being developed for this project already contains more data than any assembled anywhere else that we know of.* Without a doubt, there will be data holes, but the expectation is that this will help researchers and funding agencies prioritize areas where more work is needed. We have already seen this phenomenon as one of our collaborating states, a major corn- and soybean-producing state, was identified through FRST as having no historical data for soil test phosphorus and potassium correlation data to support their recommendations. As a consequence, they have started soil fertility trials across their state which will be added to the FRST database.

3. *Industry needs to be involved because people look to industry for recommendations. Just because we collect data does not mean that the data will influence the public.*

- a. We absolutely agree that the private sector needs to be involved and mentioned that we have started engagement with industry. It was important to lay a solid framework that demonstrated FRST's direction and a tool that could be beta-tested. Having met these guideposts, we started with ALTA (Agricultural Laboratory Testing Association), which represents many private soil testing labs, especially those in the Midwest. We are working on a survey with them for their membership that explores nutrient management decision-making and are providing speakers for their annual meetings and webinar series; we just provided a sneak preview of the FRST decision tool. Preliminary conversations have begun with AgGateway and several other companies; one of these companies is funding some phosphorus rate trials with our FRST collaborators.

4. *Will the fertilizer recommendation tool account for downstream environments that suffer from over-fertilization?*

- a. The FRST tool indirectly accounts for downstream consequences of over-fertilization by identifying critical soil test values with a higher degree of confidence than is currently available in most areas. Above the critical soil test value, there is no crop response (e.g. increased yield). This information can save the farmer's money, reduce nutrient applications that can cause water quality problems, and help maintain soil test levels that maximize crop yields, while minimizing

environmental damage. The USDA-NRCS prescribed that all states develop their own phosphorus index tool that accounts for downstream environmental degradation; all phosphorus assessment tools include soil test phosphorus level as a parameter. Potassium is not considered environmentally problematic, but edge-of-field potassium loss represents a significant economic loss to growers which is exacerbated by high fertilization rates. Accurate soil-test-based fertilizer recommendations for phosphorus and potassium represent the first step in developing agronomic and environmental nutrient management recommendations that are compatible and scientifically defensible.

5. ***FRST should engage the social sciences to help with understanding and managing expectations.***
 - a. The first phase of FRST has been building our land-grant network and database and working collaboratively to build consensus on several important soil fertility concepts that needed to be discussed and brought to consensus to create the FRST decision tool. More recently, we have been developing the FRST decision tool, which will be beta-tested by all our collaborators, and more importantly, our advisory board which will consist of four each Certified Crop Advisors, soil test lab managers, farmers, collaborators, the executive team, and the programmer. Each category of reviewer will be from a different region of the US: northeastern, southern, north central, and western. The advisory board will provide us with feedback that will help us manage expectations and allow us to provide more precise communication about the project to users.
 - b. We have already discussed the need to include social scientists in FRST for a larger survey of our user groups' needs and expectations. Thus, we expect social scientists will be involved in these efforts and will be essential team members for building successful funding proposals.

What is the expectation for continued funding after this cycle of funding?

1. ***Dr. Osmond's response to the question about expectations for continued funding was there is a need to continue to support the infrastructure to maintain, but it might not be at the level we are at now. NRSP RC recognizes there are challenges and there is a solid plan for progression. The question about funding expectations is asked as a concern about the project's longevity.***
 - a. We see this as a long-term activity, that will need continued funding, which the team will continue to pursue from many different sources. When we began this project, we recognized funding acquisition would be a long-term endeavor. To that end, we were successful in securing two initial funding streams (USDA-ARS and -NRCS). To ensure continuation, we sought additional funding from USDA-NRCS Conservation Innovative Grants (CIG) as well as NRSP. Efforts initiated in the fall of 2022 resulted in three NRCS-funded projects for \$1.62 million (one national and two regional projects) that facilitate educational activities, development of the decision support tool, and population of the national database with soil test correlation and calibration data (<https://cig.sc.egov.usda.gov/cig-fiscal-year-2022-awards>). We understand that the NRSP model is for national projects to become self-sustaining, and we will continue to seek federal funding that facilitates our activities. That said, we also recognize that "soil testing" and agronomic nutrient management do not fit well into many federal funding initiatives (e.g., NIFA) and that we will have to be creative to be successful.
 - b. As we alluded to in response #3 above, we have successfully engaged private industry in funding field research efforts that will help populate the national database with current data collected using the minimum dataset (Slaton et al., 2022). A second member of private industry will sponsor an upcoming symposium. We will continue to engage private industry and encourage collaborative participation.

- c. Development of a national database and a publicly accessible decision-support tool will aid scientists in identifying data gaps related to specific crops, soils, geographic areas, soil test methods, and issues related to the accuracy of soil-test-based crop nutrient recommendations that require additional research. Such information will be instrumental in building collaborative teams and developing strong funding proposals.