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Unlocking the Potential of On-Farm Testing for Agriculture and Environment

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Abstract

The increasing interest among agriculturalists, agronomists, and the scientific community has fueled the expanding importance of on-farm research. On-farm research is not new, but its importance has grown because of the partnership between farmers and researchers from different industries and colleges. The scope and influence of on-farm research have increased due to the quick development of modern technology, tools, and analytical techniques coinciding with this popularity. Several papers in this special issue focus on using on-farm testing to improve socioeconomic for both the environment and the economy in both Africa and the Americas. In order to allow a more thorough understanding of on-farm research outcomes, unique collaboration frameworks for summarising, visualizing, and presenting research findings are also being developed. Innovative analytical techniques built on Bayesian hierarchical and multivariate analyses are also being developed to evaluate complex connections between management and farming practices. Furthermore, statistical parameter estimate techniques and the most productive experimental approaches have been evaluated using simulation methodologies. On-farm research directly leads to farmers' improved satisfaction, higher agricultural productivity, better economic outcomes, and increased application of conservation practices.

Keywords: *on-farm research, precision agriculture, conservation practices, statistical analysis, agricultural productivity, collaborative learning, environmental sustainability*

Introduction

On-farm investigation and interactive learning are becoming more common because of the rising interest in regional consequences among producers and the more accessible manner offered by current technology. On-farm education is not a new concept, but its significance has been steadily increasing due to actual improvements in crop and farming practices that have raised yield. On-farm studies, which are jointly carried out by farmers and commercial and university researchers, are quickly advancing thanks to the creation of new technology, tools, and analytical techniques.

This issue's articles address a broad variety of subjects. Most research indicates that collecting and evaluating farm data significantly enhances farmers' experiences, satisfaction with interactive learning, agricultural and financial performance, and the pace at which conservation practices are implemented. You will also discover papers in this special issue that describe methods for improving data summary and analysis across several trials with related treatments carried out across several years and places.

Utilizing on-farm studies and precise farming technology resources may inspire farmers.

Agricultural research has significantly risen in the last 20 years, particularly in industrialized nations. This increase is primarily due to implementing precision agriculture (P.A.) technologies. Farmers and academics may perform farming studies at an acre size and multiple locations more affordably by using the tools in the P.A. toolset. These tools include automated guidance, light barriers, yield tracking, GNSS, and fluctuating rate of devices. Based on a comprehensive analysis of industry and legislative survey data from various countries throughout the globe, the most often used technologies are planter interruption, pesticide boom management, and GNSS (Lowenberg-DeBoer & Erickson, 2019). Farmers have unexpectedly adopted variable rate technology at relatively low rates despite it being a crucial part of the P.A. toolset. Most of the time, adoption rates in a particular nation or area seldom exceed 20%. For instance, according to statistics from 2016, just 32% of maize farms in the United States employ yield maps, partly because it is difficult to understand the variables affecting yield variability within fields. The lowest P.A. adoption rates are seen on small- and medium-sized farms in developing nations, partly because of the low levels of mechanization and high prices of P.A. technology.

Particularly in less developed nations, the future of on-farm research is promising as P.A. methods become more widely available and reasonably priced. According to a study from Nebraska (Thompson et al., 2019), on-farm research and farmer motivation are two essential topics. Farmers often perform agricultural experiments to increase profitability, tickle their interests, and get objective results, according to in-depth interviews with members of the Nebraska During Farming Investigation Network and qualitative analyses of survey data. The poll results also showed that farmers valued interactions with academic and other agricultural experts. Surprisingly, over 75% of the farmers who responded to the poll said they had either concluded that their practises did not need to be altered or had modified them in response to their involvement in on-farm investigations. Although presenting comments and ideas to researchers did not decrease their opinions, in contrast to when researchers sought their input, farmers still hoped to participate more actively in all areas of doing on-farm research.

Methods of analysis for on-farm experiments

Effective on-farm research necessitates thorough analysis, concise summarization, and clear communication of findings to farmers and agricultural scientists. Several networks cooperate closely with farmers in the U.K. to conduct farmyard strip experiments. These networks are associated with university extensions, for-profit businesses, and farmer groups. The results of these inquiries are routinely disseminated to farmers through distinct field reports, whether in print or electronically.

To make better-informed decisions about farm management, developing a novel analytical data framework that can harness the insights gained from on-farm strip trials is imperative. Iowa researchers have introduced the "Interactive Summary of On-Farm Experimental Results" as an analytical framework (Laurent et al., 2019). The computational aspect of this web-based program is based on Statistical assessments of treatment yield proportions or changes in a sequenced way. However, the core of its visual aspect comprises the captivating and dynamic Shiny images. This user-friendly tool delivers dynamic visuals that effectively convey statistical summaries and yield disparities, drawing from over 2,500 maize and soybean recurring strip trials conducted over the past 15 years.

Moreover, the application includes economic break-even analyses considering user-adjustable cost and price variables. The continually updated summaries also feature highlights related to field scouting, soil and tissue assessments, and downloadable reports available online to assist the agricultural community in making informed decisions. The application aids users and scientists alike in comprehending the intricate interplay between management, weather, and treatment variables.

The intricacies of on-farm wheat trials are further compounded by the necessity to account for grain quality and the intricate relationships characteristic of various forms of agriculture, particularly within the context of on-farm investigations. The Global Cereal Research Institute has been conducting field experiments with wheat and durum wheat varieties. Researchers in the United Kingdom have developed a statistical method to analyze data and assess the genetic and environmental interactions in different farmer-irrigation-year scenarios. This method employs factor analysis and linear mixed models to identify both non-crossover and crossover traits of the genotype's environment. The approach effectively distinguishes between less variable factors (such as the farmer, irrigation limits, and grain types under various conditions) and more variable (unpredictable) factors like yearly variations. By using wheat from the Yaqui Region in the southern Mexican state of Chihuahua, researchers were also able to determine the arbitrary impacts of lineage on biological and genetic environmental elements via field experiments. When considering unexpected consequences and the genetic and residual linkages among wheat features, this statistical methodology offers a more accurate and modern understanding than conventional methods of analyzing comparable field trial data.

GNSS-enabled harvester production monitors are widely used in developed nations for farming research to generate crop maps over time, especially in areas that exhibit spatial heterogeneity. In order to map and assess the production of maize silage (Zea mays L.) and determine treatment regions based on yield variability, research carried out in Britain used 847 fields, totalling 9,084 acres, spanning six dairy farms (Kharel et al., 2019). Using a 10-by-10-meter grid, the soybean silage yields from every year were combined and divided into four groups. While the yields of the other two groups varied but were below the farm's average, two of these groups continuously displayed yields that were either above or below the average. The research results showed a modest association between these two variables, which underlined the need to consider geographical and temporal variation when defining management zones. 32% and 46% of the farm's area were categorized as variable (Q2 and Q3), emphasizing the importance of using precision agriculture technology and modifying management practices throughout the growing season.

In the realm of on-farm research, various possibilities exist for experimental design and statistical analysis. A study by Alesso et al. (2019) evaluated the precision, bias, and Type I error of prediction testing using 27 different methodologies for statistically estimating parameters and ten on-farm experimental designs. The simulations revealed that the overall treatment mean was minimally impacted by the experimental design, estimation method, or the structure of on-farm experiments. More significant geographical autocorrelation increased Type 1 error rates while enhancing the accuracy of statistical model parameter estimates. Although treatment randomization increased derived parameter variance, estimation accuracy improved with repeated iterations. The most effective methods for on-farm research with two treatment levels were split-plot, chessboard, or striped trials.

According to Bullock et al. (2019), a complex effort called the "Data-Intensive Farm Planning" project is now conducting randomized economic field trials to evaluate various elements of landowners' properties utilizing precise agricultural technology. Brazil, Argentina, and Colombia are now being evaluated as part of the nine areas in the United Kingdom that this initiative is being implemented throughout. The project's objectives encompass the regulation and management of data, the planning and execution of on-farm experiments, and the development of cyberinfrastructure to facilitate collaborative activities across various research disciplines.

Collaborative learning is encouraged by on-farm research.

Direct engagement with farmers can be integral to on-farm studies to promote their practicality and acceptance. Two research investigations, one involving smallholder farmers in Botswana and the other encompassing extensive agricultural practices in Michigan, were documented by scholars from Michigan State University (Snapp et al., 2019). They utilized laser charts to communicate financial, ecological, and productivity data. In Malawi, they identified significant tradeoffs between agriculture that could be sustained in mesic locations compared to marginal sites. It was discovered that the performance of field crops, the condition of the soil, and different tillage techniques were all influenced by the regional climate in Michigan. Participatory learning among farmers resulted in increased adoption rates and overall farmer satisfaction.

In addition to challenges such as soil erosion, declining soil fertility, and changing climates, agriculture in southern Africa faces various external risk factorsOptimising resource allocation requires knowing where methods of preservation work better than traditional approaches and where they should be extended for broader regional advantages. A study examined the impact of various conservation practices on smallholder farming risk preferences and farm earnings, involving 17 communities and 918 properties in three agricultural ecological regions of Mozambique (Kidane et al., 2019). It was observed that maize yields were higher with conservation tillage techniques at higher and lower altitude zones than traditional cultivation, leading to reduced variability. Power utility assessments suggested that direct seeding methods were preferred at higher altitudes, while farmers at lower elevations, particularly risk-averse ones, might still favour traditional farming methods.

Agricultural research is essential to calculate the advantages of different conservation strategies, particularly in areas with environmental issues (Barrera Mosquera et al., 2019). The lifestyles of farmers in the Andean highlands of Ecuador were studied to evaluate the impacts on crop yields and farming productivity along with enhanced crop rotations of various techniques such as groundwater drainage ditches, decreased crop residue absorption in the soil, and decreased nitrogen levels. These fields had witnessed significant soil erosion and a sharp decline in crop productivity. Analyses revealed that implementing proven conservation techniques increased crop output and financial gains in an ongoing potato-pasture system by 21% compared to conventional farming methods. Immediate economic benefits observed at the project's outset motivated farmers to become more interested in and adopt conservation practices.

In Sub-Saharan Africa, on-farm trials conducted on fields used by farmers can effectively promote the adoption of drought-tolerant maize hybrids. Over 5,000 demonstration plots were set up on Kenyan farmer fields to evaluate 39 drought-resistant maize hybrids (Obunyali et al., 2019). Drought-resistant hybrids can be planted to mitigate the adverse effects of drought on maize productivity. The possibility that farmers will continue to utilize drought-tolerant seeds in the following years has increased dramatically due to the study results being examined in over 240 meetings and seminars with nearby farmers.

Conclusion

The growing attention from farmers, agronomists, and scientists has significantly enhanced the importance of on-farm research in recent years. Advances in technology and statistical methods have greatly benefited this research, often conducted in collaboration with farmers and professionals from various sectors. The papers in this special issue explore how on-farm testing impacts both environmental sustainability and economic viability in Africa and the United States. New cooperative frameworks and analytical methods like multivariate and Bayesian hierarchical analyses are being created to evaluate the intricate relationships between farming and management. Using modelling instruments, the most effective trial designs and statistical parameter estimate techniques are also found. Direct advantages of on-farm research include higher farmer satisfaction, better crop yields, better financial performance, and increased uptake of conservation measures.

In summary, combining technological advancements and collaboration among diverse stakeholders has amplified the significance of on-farm research. This research contributes to agricultural sustainability and outcomes, benefiting developed and developing regions. It underscores the importance of efficient data analysis and precision agricultural technology. On-farm research also promotes participatory learning, facilitating the adoption of conservation techniques. It is a critical tool for improving agricultural practices and achieving better economic and environmental results.

Reference

- Alesso, A.C., P.A. Cipriotti, G.A. Bollero, and N.F. Martin. (2019). "Experimental designs and estimation methods for on-farm research: A simulation study of corn yields at field scale." Agron. J. doi:10.2134/agronj2019.03.0142
- Barrera Mosquera, V.H., J.A. Delgado, J.R. Alwang, L.O. Escudero, Y.E. Cartagena, J.M. Dominguez, and R. D'Adamo. (2019). "Conservation agriculture increases yields and economic returns of potato, forage, and grain systems of the Andes." Agron. J. doi:10.2134/agronj2019.04.0280
- Bullock, D.S., M. Boerngen, H. Tao, B. Maxwell, J.D. Luck, L. Shiratsuchi, L. Puntel, and N.F. Martin. (2019). "The data-intensive farm management project: Changing agronomic research through On-farm precision experimentation." Agron. J. doi:10.2134/agronj2019.03.0165
- Hernández, M.V., I. Ortiz-Monasterio, P. Pérez-Rodríguez, O.A. Montesinos-López, A. Montesinos-López, J. Burgueño, and J. Crossa. (2018). "Modeling genotype × environment interaction using a factor analytic model of on-farm wheat trials in the Yaqui Valley of Mexico." Agron. J. doi:10.2134/agronj2018.06.0361
- Kharel, T.P., A. Maresma, K.J. Czymmek, E.K. Oware, & Q.M. Ketterings. (2019). "Combining spatial and temporal corn silage yield variability for management zone development." Agron. J. doi:10.2134/agronj2019.02.0079
- Kidane, S.M., D.M. Lambert, N.S. Eash, R.K. Roberts, and C. Thierfelder. (2019). "Conservation agriculture and maize production risk: The case of Mozambique smallholders." Agron. J. doi:10.2134/agronj2018.05.0331
- Laurent, A., P. Kyveryga, D. Makowski, & F. Miguez. (2019). "A framework for visualization and analysis of agronomic field trials from On-Farm research networks." Agron. J. doi:10.2134/agronj2019.02.0135
- Lowenberg-DeBoer, J., and B. Erickson. (2019). "Setting the record straight on precision agriculture adoption." Agron. J. 111:1552–1569. doi:10.2134/agronj2018.12.0779

- Montesinos-López, O.A., A. Montesinos-López, M.V. Hernández, I. Ortiz-Monasterio, P. Pérez-Rodríguez, J. Burgueño, and J. Crossa. (2018). "Multivariate Bayesian analysis of On-Farm trials with multiple-trait and multiple-environment data." Agron. J. doi:10.2134/agronj2018.06.0362
- Obunyali, C., J. Karanja, S. Oikeh, G. Omanya, S. Mugo, Y. Beyene, and R. Oniang'o. (2019). "On-farm performance and farmer-preferred traits evaluation of droughtTEGO-Climate-smart maize hybrids in Kenya." Agron. J. doi:10.2134/agronj2019.08.0600
- Snapp, S.S., J. DeDecker, and A.S. Davis. (2019). "Farmer participatory research advances sustainable agriculture: Lessons from Michigan and Malawi." Agron. J. doi:10.2134/agronj2018.12.0769
- Thompson, L.J., K.L. Glewen, R.W. Elmore, J. Rees, S. Pokal, and B.D. Hitt. (2019). "Farmers as researchers: In-depth interviews to discern participant motivation and impact." Agron. J. doi:10.2134/agronj2018.09.0626