ABSTRACT

On-farm research is becoming widespread due to a growing interest among farmers, agronomists, and the research community. While the concept of on-farm research is not new, the scale and influence of on-farm studies conducted by farmers in partnership with industry and university researchers are expanding. New technologies, tools, and analytical approaches are rapidly evolving to advance the reach and impact of on-farm research. Papers in this special issue include the use of on-farm testing to increase economic and environmental sustainability in Africa and South America, the development of a new analytical collaborative frameworks for better summarization, visualization and communication of research results, and a new analytical approaches based on Bayesian hierarchical and multivariate analyses that can be used to assess complex relationships between management, genetics, soils, and the environment. Simulation approaches were also tested to identify the most efficient experimental designs and estimation methods of statistical parameters. In all situations, on-farm research leads to improved productivity, better economics, higher adoption of conservation practice and greater farmer satisfaction.

Core Ideas

• Precision agriculture technology adoption benefits on-farm research expansion.
• New analytical and visual frameworks aid in farmer decision making.
• On-farm research reduces barriers to adoption of new management techniques.
• On-farm research increases farmer interest and motivation.

INTRODUCTION

On-farm research and participatory learning are becoming standard practices due to their facilitation through new technologies and farmers’ growing interest in local results. While the concept of on-farm research is not new, the scale and impact of on-farm studies conducted by farmers in partnership with industry and university researchers is expanding due to demonstrated improved crop and land management with greater productivity.

New technologies, tools, and analytical approaches are rapidly evolving to enhance on-farm research. The papers in this issue cover a range of topics. Almost every study found that on-farm data collection and analyses enhanced farmer experience and their satisfaction in participatory learning through improved productivity and economic performance and it increased their adoption of conservation practices. In addition, this special issue contains papers that showed how to improve data analyses and summarization of a large number of experiments containing similar treatments across years and locations.

Precision Agriculture Technology Tools and Farmer Motivation through On-Farm Research

On-farm research has expanded rapidly during the last two decades, especially in developed countries. This increase is attributed to an increase in the wider use of precision agriculture (PA) technologies. Technologies in the PA tool box such as yield monitoring, Global Navigation Satellite Systems (GNSS), light bars, auto guidance, and variable rate devices enable farmers and researchers to conduct on-farm experiments at a field scale, in multiple locations and at much lower cost. Extensive analyses of private and government survey data collected in different countries around the world showed that GNSS, sprayer boom control and planter shutoffs technologies have been adopted at the highest rates (Lowenberg-DeBoer and Erickson, 2019). Surprisingly, variable rate technologies, one of the main and original components in the PA tool box, have not been widely adopted by farmers. On a whole country or regional basis the adoption rate rarely exceeds 20% of farmers. In the United States, 2016 data showed that 54% of maize farms have a yield monitor but only 32% use yield maps, in part due to the difficulty in interpreting the reasons for yield variability within fields. The largest PA adoption gap is the low rate of uptake by small and medium size farmers in developing countries, due in part to their lack of mechanization and also the cost of PA. In the future, on-farm research has
that better communicate statistical summaries and yield differences. The tool also provides break-even economic analyses using cost and price inputs that can be adjusted by users. The dynamic component is based on RShiny dynamic and interactive graphics of the online tool is based on Bayesian Hierarchical analyses of (ISOFAST) (Laurent et al., 2019). The analytical component of the online tool is based on Bayesian Hierarchical analyses of treatment yield differences or yield ratios and the visual component is based on RShiny dynamic and interactive graphics. The tool is based on more than 2500 on-farm replicated strip trials on corn and soybean conducted during the last 15 yr and is publicly available and providing users with dynamic graphics that better communicate statistical summaries and yield differences. The tool also provides break-even economic analyses using cost and price inputs that can be adjusted by users. The dynamic summaries also include summaries of scouting, soil and tissue observations and online downloadable reports for aid in decision making by farmers and agronomists. This tool can help researchers and users understand better complex relationships between treatments, weather, and management.

On farm research can involve direct engagement with farmers generating ideas themselves; however, farmers expressed the desire to be more involved in all phases of conducting an on-farm research project.

**Analytical Approaches for On-Farm Trials**

One of the critical components of on-farm research is to effectively analyze and summarize study outcomes and communicate results to farmers and agronomists. There are several on-farm research networks across United States that conduct on-farm strip trials with farmers. These networks are affiliated with university extension, private companies or grower associations. Often, results of these on-farm trials are presented to farmers as individual field reports in electronic or hardcopy format. There is a need for developing a new analytical data framework to make better informed management decisions using on-farm strip trial data. Researchers from Iowa have developed an analytical framework called the “Interactive Summary of On-Farm Strip Trials” (ISOFAST) (Laurent et al., 2019). The analytical component of the online tool is based on Bayesian Hierarchical analyses of treatment yield differences or yield ratios and the visual component is based on RShiny dynamic and interactive graphics.
case-studies that involved mother-and-baby trials conducted with small holder farmers in Malawi and under intensive agriculture systems in Michigan (Snapp et al., 2019). Productivity, environmental, and economic domains were presented via radar charts. In Malawi, a mesic site was associated with steep sustainable agriculture tradeoffs compared with a marginal site. In Michigan, diversity in tillage practices, field crop performance, and soil health were affected by local environment. Farmer participatory learning lead to greater adoption and greater farmer satisfaction.

Farming in southern Africa is subject to multiple external risk factors in addition to soil degradation, declined soil fertility and climate change. To optimize resource allocation, it is important to know where conservation practices outperform conventional practices and should be scaled for larger regional benefits. A study conducted with 17 communities, 883 farms in three agro-ecological regions in Mozambique, assessed how different conservation practices affect risk preference of small holder farmers and farm economic returns (Kidane et al., 2019). Compared with conventional tillage, maize yields were higher, and variability was lower with conservation tillage practices at low and high elevation zones. Power utility analyses showed that direct seeding technology was preferable at higher elevations. For extremely risk-averse farmers, conventional practices could be preferred at low altitudes.

On-farm research is critical to quantify the benefits of various conservation practices, especially in vulnerable regions of the word (Barrera Mosquera et al., 2019). Farmers’ fields in Ecuador’s Andean highlands with excessively high rates of soil erosion and rapid declines in crop productivity were used to study the impact of surface water deviation ditches, reduced tillage, retention of crop residue on the soil and reduced nitrogen rates on yield and farm profitability with improved crop rotations. Analyses showed that crop productivity and economic returns in a long-term potato-pasture system have increased by 21% using tested conservation compared with traditional farming practices. Short-term economic benefits were detected at the beginning of the project that aided in greater interest and adoption by farmers of the conservation practices.

Demonstration on-farm trials on farmer fields can be effective in adoption of drought tolerant maize hybrids in Sub-Saharan Africa. Approximately 5000 demonstration plots of 39 drought tolerant hybrids were tested on farmers’ fields in Kenya (Obunyali et al., 2019). Drought impact on maize yield could be reduced by planting drought tolerant hybrids. Results were discussed at about 250 field days and workshops with local farmers, increasing the chance of adoption and that farmers will continue use drought tolerate seeds in the future.

SUMMARIES AND CONCLUSIONS

This collection of 12 papers demonstrates advancements and experiences in on-farm research and farmer participatory learning in North and South America and Africa. Examples presented include different data collection, data summarization and visualization frameworks, decision management tools and community approaches through farmer networks and collaboration among farmers and researchers. In the future, on-farm research will continue to contribute to the body of knowledge in different disciplines and will aid in adoption of conservation practices and technologies to improve the economic wellbeing of farmers and the sustainable development of local communities.

REFERENCES


