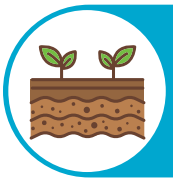
ONFARM

How to Conduct On-farm Research:
Guidebook



WHAT IS ON-FARM RESEARCH?

Every year, your crop input suppliers, agronomist or even the farm media will tell you about new crop production practices, seed varieties, fertilizer options, crop protection products and technologies for your farm. You are faced with the decision of which products and technologies to incorporate into your operation.

You can review trial results from public or private research, which certainly has value. But farm operations across Ontario are unique, so learning how a particular product or technology will fit your production system is helpful.

Through on-farm research, you can evaluate potential changes to your crop production system in your own fields. You can set your research priorities and see the results directly. You can then decide whether it makes sense for your operation to change a component of your management practices. Typically, a change in a management practice should result in a short or long-term return on investment.

The types of individuals involved in on-farm research can vary by the project. On-farm research can be fully farmer led, where the farmer designs the research question and conducts the trial themselves. Farmers can also collaborate with their crop advisory teams (e.g., their agronomists or Nutrient Management Consultants). Finally, academic or industry researchers may ask farmers' permission to run trials in their fields and the researchers do all the work. Regardless of the players involved, a successful on-farm research project follows the same key guiding principles and methodology, which are outlined in this guidebook.

Through this Guidebook, you will learn:

- How to develop an on-farm research question
- How to design your trial
- How to collect data
- How to analyze your data
- What you can extrapolate from your data
- What resources you can access to learn more

> *"It's a good business practice to challenge your status quo. On-farm research provides a great way to learn and stay current with potential new technologies and practices, which enables you to get better at doing what you do."*
>
> – Greg Hannam, ONFARM Cooperator

> *"My number one reason for conducting on-farm research is that you can't manage what you don't measure. A lot of great innovations and products are being thrown at farmers. But until you can see how these innovations and products will work within your ecosystem and management style, you're flying blind. I need to be able to understand how a new product or system change will work within my current practices to evaluate if it will be a good fit for my operation."*
>
> – Jennifer Doelman, ONFARM Cooperator

OUR ON-FARM RESEARCH EXPERTS

Throughout this guidebook, two Ontario farmers share their experiences and lessons learned through on-farm research.

These farmers are participating in the **On-Farm Applied Research and Monitoring (ONFARM)** program, developed by the Ontario Ministry of Agriculture, Food and Rural Affairs and delivered by the Ontario Soil and Crop Improvement Association. This four-year applied research initiative began in 2019 and it supports soil health and water quality research on farms across the province. This program is funded by the Canadian Agricultural Partnership, a five-year federal-provincial-territorial initiative. A component of the ONFARM program uses a "side-by-side" approach to trials (explained in further detail below) while recognizing changes in soil across the field. A network of 25 farmers is collaborating with the Soil Resource Group (SRG) to investigate the impact of best management practices on soil health. The SRG conducts applied research in the agriculture and environmental sectors.

Let's Meet Our Experts

Greg Hannam operates Woodrill Farm Enterprises in Guelph with his family. They grow corn, soybeans and wheat. In his ONFARM trial, Hannam compares the use of municipal compost with and without a multi-species cover crop. Both municipal compost and cover crops are important parts of Hannam's regular farming practices. His soil health goals are to improve soil structure and organic matter levels to increase the long-term viability of his soils to produce crops.

Jennifer Doelman operates Bonnechere Haven Farms in Douglas with her family. They grow barley, canola, corn, flax, forage peas, oats, soybeans, spring triticale, spring wheat, sunflowers and winter wheat. They also incorporate cover crops in their rotation. Through her ONFARM trial, Doelman studies the use of a cover crop and the application of biosolid pellets at different rates. Her soil health goals are to increase soil resilience and biological processes to reduce risk and improve profitability.

> *Make a plan and don't try to boil the ocean. Keep it simple. Start small and hone your management practices over time.*
>
> – Jennifer Doelman

HOW DO YOU DEVELOP YOUR ON-FARM RESEARCH QUESTION?

A successful on-farm research program begins with an effective research question. Start by asking yourself – and your farm team, if applicable – what you want to learn.

Chances are, throughout a growing season, topics of interest will arise.[1] You may ask if an application of biosolids will help you reduce your fertilizer costs while maintaining or increasing your corn yield. You may be curious about practices your neighbours are trying, or that you have seen demonstrated at an ONFARM event or by your local Soil and Crop Association. Jot those ideas down as they come to mind and revisit them when you develop your crop plans for next year.

You will want to refine these ideas into research questions that are specific, straightforward and measurable. In the most general terms, the research question should determine if a given management practice affects a given outcome.[2] Typically, you will want to see an economic or environmental benefit from a change in management practices.

For example, your research questions could be:

- Does an application of biosolids help reduce my fertilizer costs while maintaining or increasing my corn yield?
- Does a cover crop help to address my soil health goals of improving nutrient availability and minimizing compaction?
- Does an application of manure help to improve soil life to boost productivity and profitability?

HOW DO YOU DESIGN YOUR TRIAL?

"Side-by-side" Demonstration

The most basic trial design is a simple splitting of your field or a "side-by-side" demonstration. Typically, in this approach, you would manage half of your field following your standard practices. In the other half of the field, you would change one practice. You must keep all other management practices the same in the trial. Otherwise, you will not know which particular change resulted in any differences you observe.

Let us return to the research question of "Does an application of biosolids reduce my fertilizer costs while maintaining or increasing my corn yield?"

In this case, your standard management practice – also referred to as a **control** – would be your standard fertilizer program. Your new management practice – also referred to as a **treatment** – would be the biosolids application plus your reduced fertilizer program. You would develop this reduced fertilizer program in consultation with your agronomist, Certified Crop Advisor (CCA), Professional Agrologist (P.Ag.), or Nutrient Management Consultant based on your soil test results and the nutrient analysis of the biosolids. You would apply your standard fertilizer program to half of your field. On the other half of the field, you would apply your biosolids and reduced fertilizer program.

Your trial design could look like the below:

Understanding Field Research Terms

Control: Your standard management practice.
Treatment: The single management practice that changes across a trial.

Side-by-side demonstrations often serve as a good starting point for individuals beginning on-farm research; this design helps to simplify the data collection process.

We know, however, that fields are not uniform. Perhaps you have a sandy knoll at one end of the field or a lower-lying area where water tends to collect. Many topographical and soil conditions can affect yields.

A side-by-side trial may lead you to conclude that the control outyielded the treatment. In reality, the yield difference might be due to more favourable conditions on the control half of the field. It is best to pick a field or area that is uniform but such options are not always available.

As a result, it may be worthwhile to consider a replicated and randomized trial design, which minimizes the influence of field variability on your results.

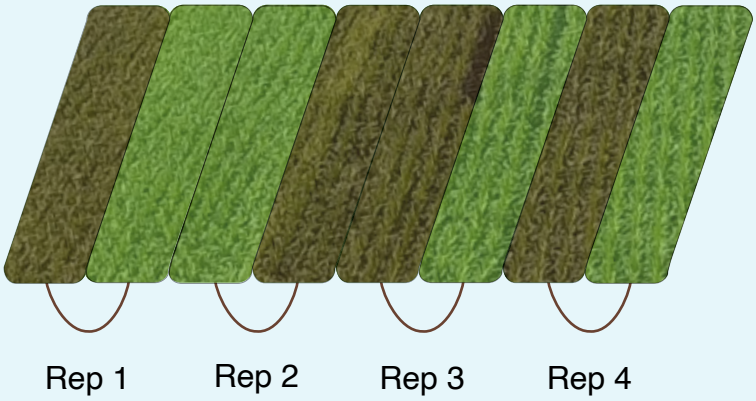
Replicated and Randomized Trial

Repetition is key to be able to compare control and treatment results accurately. So, you want to compare the treatment and the control in more than one section of a field. The number of times each "grouping" of a treatment (or treatments) and a control is repeated in a field is known as a **replication**.

At a minimum, it is best to have three replications in your trial.[3] If you have the resources (i.e., space in the field, sufficient product, etc.), consider doing more replications. That way, you have a backup if a problem arises in one replication (e.g., maybe you briefly had a problem with your planter and your seeding rate dropped). More replications also increase your ability "to detect a difference" between the control and treatment(s).[4]

Rather than repeating the treatment(s) and the control in the same order in each replication, it is best to randomize the order of the treatment(s) and the control within the replication.

Let us return to the example of our biosolids trial. In a replicated and randomized trial, you would have multiple "groupings" of the same-sized treatments and controls, and you would switch up the order of the treatment(s) and control within each replication. Your trial design could look like the below:



LEGEND:

Control

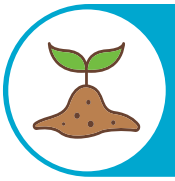
Treatment

Rep = Replication

In our example, we applied our control with the standard fertilizer program and our treatment with the biosolids plus reduced fertilizer program in four sections of the field or four replications. The Ecological Farmers Association of Ontario provides a good overview of how to generate the randomization for your trial.

By designing a replicated and randomized trial, you help decrease the impact of field variability on your trial results.

> *"Don't forget about the rest of your team. You need buy-in if you're going to do on-farm research. Make sure they understand the plan and why it is important. You need your team on board to carry the trial through to successful completion."*
>
> – Jennifer Doelman



HOW DO YOU COLLECT DATA?

Your data collection system can vary depending on personal preference. Some people, for example, might feel most comfortable keeping records in a notebook, while others will rely on a digital field data management system.

Regardless of which approach you take, accurate and thorough data collection throughout the growing season is key to ensuring usable results at the end of the trial. And remember – you need to collect data for both your control and your treatment(s).

Below, we outline the types of data to collect at planting, during the growing season and at harvest.

> *"Keep records and notes on everything you do. Even though you have the best intentions when implementing a trial, you won't remember the details two weeks or two months from then. Recordkeeping is super important."*
>
> – Greg Hannam

TYPES OF DATA TO COLLECT

TIMING: AT PLANTING

- Field length
- Planting date and rate
- Hybrid/variety
- Weather and soil conditions (i.e., temperature)
- Locations of controls, treatments and replications

At the start of each control or treatment, place flags and/or wooden stakes labelled with the control or treatment number and replication number. These flags and markers will serve as handy reference points throughout the season. Make a map, even a hand-drawn one, of the field to indicate the order of the controls and treatments and any errors made during planting or product application.

TIMING: THROUGHOUT THE GROWING SEASON

- Insect and disease pressures
- Weather data (i.e., temperature and rainfall)
- Notes from field walks (e.g., Does the control or treatment(s) look healthier or more robust? Does the control or treatment(s) look further along in crop staging?)
- Photos of the control and treatment(s)

During the growing season, consider collecting both quantitative and qualitative data. Quantitative data includes daily high and low temperatures and total amounts of rainfall. You may consider investing in an on-farm weather station or may opt to access regional data online. The Government of Canada, for example, releases monthly climate summaries for weather stations across the country.

Qualitative data includes observable differences between the control and treatment(s). You may consider pulling sample plants periodically throughout the growing season to observe differences in crop staging, plant health, root architecture, etc.[5] Ensure you pull the plants from similar areas of the field and make notes about what you see. Take photos of these samples and clearly label whether they are from the control or treatment(s).

This data will help you make sense of your trial results at the end of the growing season.

TIMING: HARVEST

- Yields
- Test weight
- Moisture
- Grade

The harvest season is busy on the farm, so it is helpful to prepare as much as possible in advance to ensure the data collection process will unfold smoothly.

Set up a template (paper or electronic) to record yields, etc., during harvest and prepare sample collection bags for your harvested grain. Medium or large freezer bags work well for this purpose; be sure to label them with the replication and control or treatment numbers.

You may opt to collect the key data from your yield monitor. Alternatively, you can measure each treatment or control strip using calibrated scales on your grain buggy or arrange for a weigh wagon and operator to assist you when you harvest your trial. No matter which equipment you use (i.e., yield monitor, weigh wagon, moisture tester, etc.), it should be calibrated. Your local agricultural service technician and/or scale service provider can assist with calibrating your equipment.

Before harvest begins, review roles and responsibilities for data collection. If you use grain buggy scales or a weigh wagon, ensure you unload your combine into the grain buggy/weigh wagon after harvesting each control or treatment in each replication. Have the operator record each harvest weight on the template and pull a representative sample for each control or treatment.

> *"Be patient as you go through the process. As farmers, we have the greatest intentions and can set up all kinds of trials when we plant or spray but we're always crunched for time at harvest. Be patient to make sure you harvest the data you set up through a trial. Do not rush through harvest and destroy all the work you did earlier in the year."*
>
> – Greg Hannam

HOW DO YOU ANALYZE YOUR DATA?

After you finish harvest, you are ready to analyze your data.

You can determine the moisture of the samples you collected using a handheld moisture meter. You can use this tool from the Canadian Grain Commission to calculate your test weights.

You can also calculate the yields in bushels/acre for each control or treatment. Purdue University offers a helpful resource for this purpose.[6] Seed companies also typically have fillable Excel spreadsheets for calculating yields from plots; consider contacting your local farm input dealer to see if they have a template to share.

If you conducted a side-by-side trial, you could compare the yield, test weight, moisture, etc., of the treatment(s) versus the control, keeping in mind that field variability may have influenced your results.

If you conducted a randomized and replicated trial, you could use statistical analysis to understand whether the difference between your control and treatment(s) "is by random chance or due to the treatment you are testing."[7] Sustainable Agriculture Research and Education provides a good overview of the relevant types of statistics;[8] your agronomist, CCA or P.Ag. may also be able to help you with this work.

WHAT CAN YOU EXTRAPOLATE FROM YOUR DATA?

Once you analyze the data, take the opportunity to reflect on the broader picture. Consider whether the trial answered your research question. If the trial did not answer your question, consider if growing conditions affected your results. Perhaps, for example, your field was hit with a disease that decreased yields. In such a situation, it might be worthwhile to run the trial again next year in hopes of more favourable growing conditions.

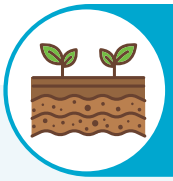
Reflect on the management practices associated with your treatment(s). Did they produce a return on investment? Would it be feasible and worthwhile to implement the changed management practices on more acres?

If possible, compare your results to what other farmers and researchers are sharing through grower or social networks, or extension resources. These comparisons can help to contextualize your results and provide insights into whether your observations are part of a larger trend. The ONFARM program shows the benefits of a grower network in advancing on-farm research and knowledge of best management practices.

Finally, consider your experience with the on-farm research process more generally. What lessons did you learn? How could you improve or streamline this process for your next trial?

Remember, on-farm research is a continual learning journey. If you saw promising results from your trial, consider repeating the trial in a different field next year or testing more acres under the new production practice. If you did not see the desired results, consider the factors that may have caused this outcome and revise your on-farm research process or treatments for next year. By repeating the trial over several years, you can analyze the consistency of results. And, if you conduct the trial several times in the same field, you can see if "compounding" results occur. For example, you may see increased soil health benefits through the regular use of cover crops in your crop rotation.

> *"It is key to understand the rest of the factors around the trial. The biggest one I find is understanding your soil and how it varies across the field. Understanding your baseline information first will give you more credible information at the end."*
>
> – Greg Hannam



WANT TO LEARN MORE?

If you want to dive further into the world of on-farm research, you may want to start with the ONFARM website. Then, you can move onto the following resources:

- BC Forage Council. (2016.) A Guide to On-Farm Demonstration Research: How to Plan, Prepare and Conduct Your Own On-Farm Trials. Retrieved from: https://www.climateagriculturebc.ca/app/uploads/FI03-On-Farm-Demonstration-Research-Guide.pdf
- Ecological Farmers Association of Ontario. (n.d.) Farmer-Led Research. Retrieved from: https://efao.ca/farmer-led-research/
- Jeremy Boychyn. “Simple Steps for On-Farm Trials.” *Better Farming Prairies*. July/August 2020. Retrieved from: https://www.betterfarming.com/flippingbook/better-farming-prairie/2020/july/#40
- Organic Seed Alliance. (2014.) Introduction to On-Farm Organic Plant Breeding. Retrieved from: https://seedalliance.org/publications/introduction-to-on-farm-organic-plant-breeding/
- Practical Farmers of Iowa. (n.d.) Farmer-Led Research. Retrieved from: https://practicalfarmers.org/programs/farmer-led-research/
- Sustainable Agriculture Research & Education. (January 2017.) How to Conduct Research on Your Farm or Ranch. Retrieved from: https://www.sare.org/wp-content/uploads/how-to-conduct-research-on-your-farm-or-ranch.pdf.

ENDNOTES

1 Jeremy Boychyn. “Small Steps for On-Farm Trials.” *Better Farming Prairies*. July/August 2020, 41. Retrieved from: https://www.betterfarming.com/flippingbook/better-farming-prairie/2020/july/#40

2 Jeremy Boychyn. “Small Steps for On-Farm Trials.” *Better Farming Prairies*. July/August 2020, 41. Retrieved from: https://www.betterfarming.com/flippingbook/better-farming-prairie/2020/july/#40

3 Ecological Farmers Association of Ontario. (2021.) Farmer-Led Research FAQ. Retrieved from: https://efao.ca/research-faq/.

4 Ecological Farmers Association of Ontario. (2021.) Farmer-Led Research FAQ. Retrieved from: https://efao.ca/research-faq/.

5 OMAFRA’s Agronomy Guide for Field Crops provides a helpful overview of plant growth stages. See Ontario Ministry of Agriculture, Food and Rural Affairs. (2017.) Agronomy Guide for Field Crops. Publication 811. Retrieved from: http://www.omafra.gov.on.ca/english/crops/pub811/pub811.pdf.

6 In your search engine, search “‘Calculating Harvest Yields’ AND Purdue University.’”

7 Ecological Farmers Association of Ontario. (2021.) Farmer-Led Research FAQ. Retrieved from: https://efao.ca/research-faq/.

8 Sustainable Agriculture Research & Education. (January 2017.) How to Conduct Research on Your Farm or Ranch. Retrieved from: https://www.sare.org/wp-content/uploads/how-to-conduct-research-on-your-farm-or-ranch.pdf, 16-19.

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