How to Optimize Farm Trials

On-farm testing provides an opportunity to evaluate new methods or technologies under controlled conditions without committing a large amount of acreage or costs to the exercise. On farm testing needs to be conducted to ensure that the results observed are real and that all the work put into conducting the test is not wasted.

The primary goal of on farm testing, like any experimentation, is to reduce the variability that exists so that the real effects of interest can be determined.

To ensure that treatment differences can be separated it is important to design trials to be simple and straight forward. It is best to attempt to answer a single question with a trial. For example it will be much easier to determine if notill is different from conventional tillage for a single variety of wheat then if you ask the question about the tillage difference in relation to nitrogen application rate. Keep the question simple.

Following a standard series of trial establishment will reduce variation and ensure meaning to the results. This involves proper Site Selection, Plot Layout, Assessment and Interpretation.

Site Selection to Reduce Variability

Trial Positioning
All fields have some underlying variation even if it is not obvious on initial inspection. Picking the site or the best location for the site within the field is critical to ultimate success of an on farm test.

If a field site has variations in elevation or some other topography issues or obvious soil type variation on visual inspection, position the plot to avoid these areas (Figure 1). If treatments are oriented as in A below, then all treatments will have the same exposure to all the topography effects within the field. In example B, the treatments located at the top of the slope will likely be on poorer, doughtier soil and will not perform as well as those at the bottom of the slope so will be disadvantaged relative to the lower slope plots.

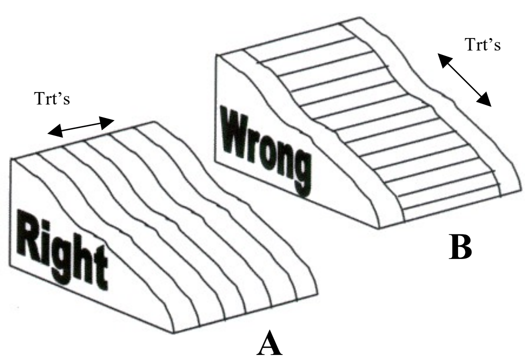
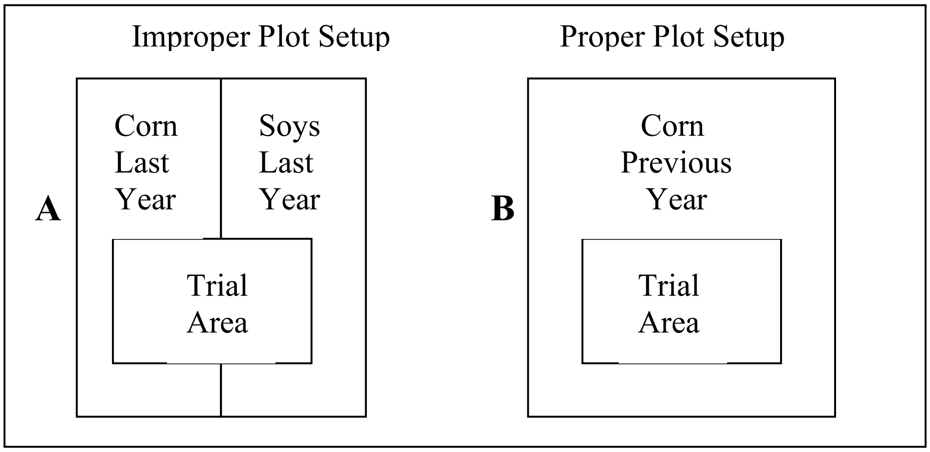


Figure 1: Orientation of Treatments to Field Topography

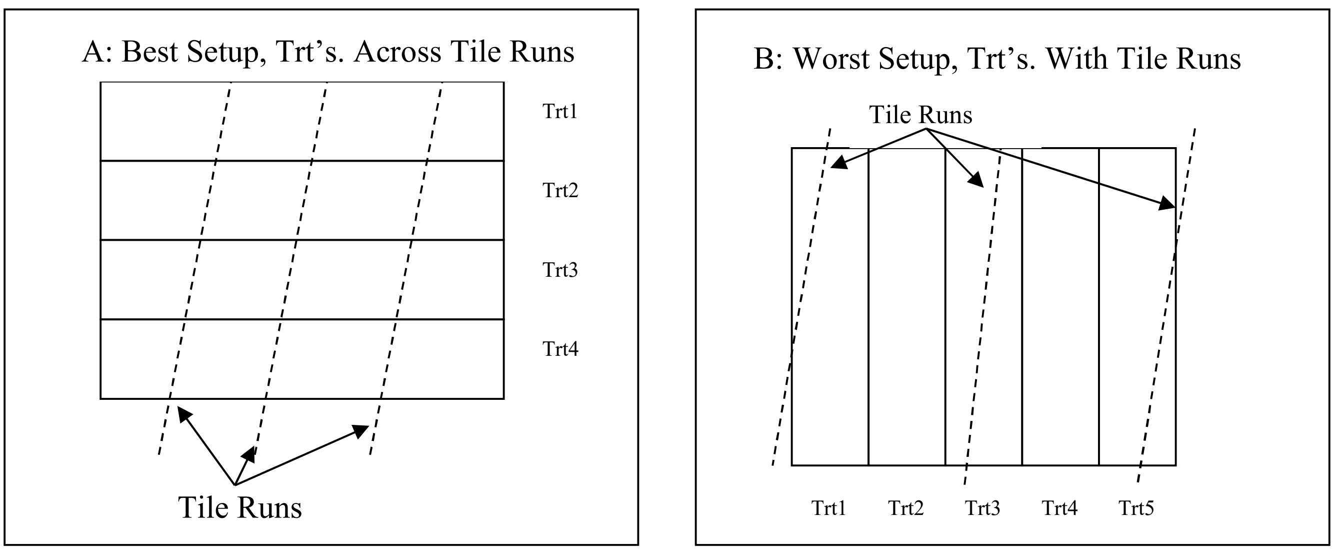
All plots should be located in fields where the intended plot area was treated as a single field unit in previous years (Figure 2). This would include the same crop, herbicide, fertility, manure application programs, or other agronomic practices. This will ensure that no underlying variation from previous years can negatively influence the plot results.

Figure 2. Locating On-Farm Trials in Relation to Previous Year(s) Cropping Practices.



Orientation of Treatments
Where possible, plots should be located perpendicular to known sources of potential variation such as tile lines, primary tillage dead furrows, gullies or low spots that cut across the plot area (Figure 3). The intention is to reduce variation over the whole plot and where variation can not be removed, to at least have it occur equally across all treatments (3A). Otherwise variation may affect only one or a few treatments in a trial (See example 3B) leading to incorrect conclusions from results. It is understood that this alignment of plots may not be possible.

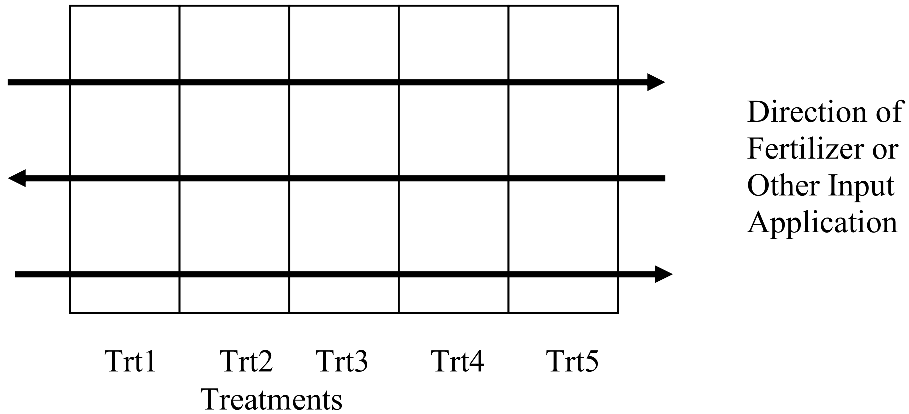
Figure 3. Orientation of Trial Treatments in Relation to Potential Sources of Variation.



Where possible, apply herbicide, fertilizer or other inputs to the plot area perpendicular to the direction of treatments (Figure 1-4). Where not practical, the application of inputs to the whole plot area should be done as accurately as possible. This will help to reduce the potential of introducing variation into the plot because one or a few treatments received more/less fertilizer or a high/low rate of herbicide etc, then adjacent treatments. By applying inputs perpendicular to treatments, all treatments have the same opportunity to experience an application error.

Although the goal is to reduce inherent or applied variation in the whole plot so that the treatment differences observed are real and not due to some underlying variation, it is extremely important to ensure that applied variation is not inadvertently applied to only a few of the treatments within a plot. This is the quickest way to mask the real treatment effects and ruin a test plot.

Figure 4. Direction in which inputs should be applied on plots to reduce inherent or applied variation.



Trial Design

Replication and randomization are extremely important in on farm trials. Replication can mean repeating some or all treatments within the test, conducting the test in more then one location and over more then one year. All of these contribute to reducing variation in the tests and increasing the precision with which the results can be proven.

Trials that are established with fewer treatments and more replication provide better results because they are better able to reduce variation. Trials having three to four replicates are preferred while trials having only one replicate are least desirable for reducing variation and essentially provide no defendable results. Where replication is not possible, duplication of a single treatment within the plot will help to provide an estimate of the variation that may be present at a site but should be considered a poor design.

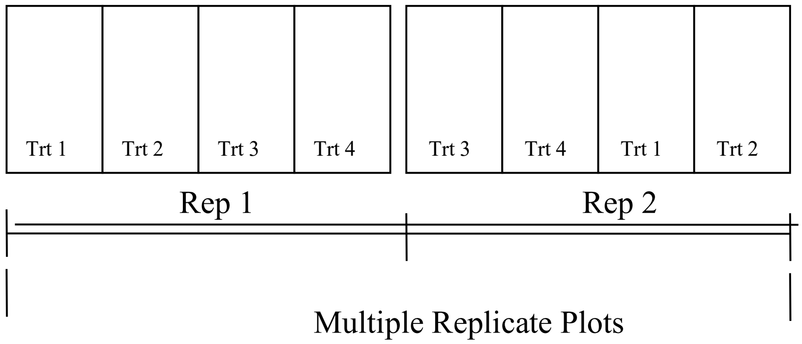
Randomization is also important. It essentially means that any treatment within a test has an equal possibility of being assigned to any specific location within the test site. Without randomization there is a potential bias that some treatments would get assigned to parts of the test site that are less productive due to soil type, topography, fertility, weed pressure differences. Randomly assigning the treatments to the plots within the test overcomes this bias.

Place a trial in the middle of a field. Avoid field edges where compaction, weed pressure, equipment traffic and shading from trees amoung others may influence results. Also, if the plot is placed in the middle of a field, the edges of the plot can be used as check strips for the plot (see plot layout #3 below). A single treatment equal to the overall field program (check) can then be included in the middle of the trial, providing three strips for use in the trial as checks to estimate the plot variation.

The layout of an on-farm trial is important to ensuring that meaningful data can be collected, interpreted and reported.

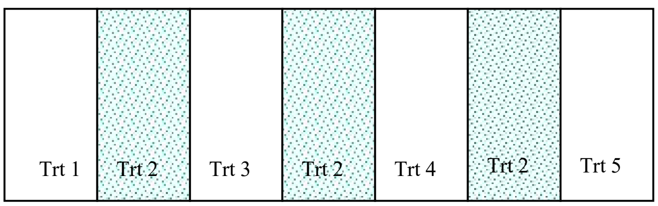
Figure 5. Potential On Farm Test Plot Designs.

1.



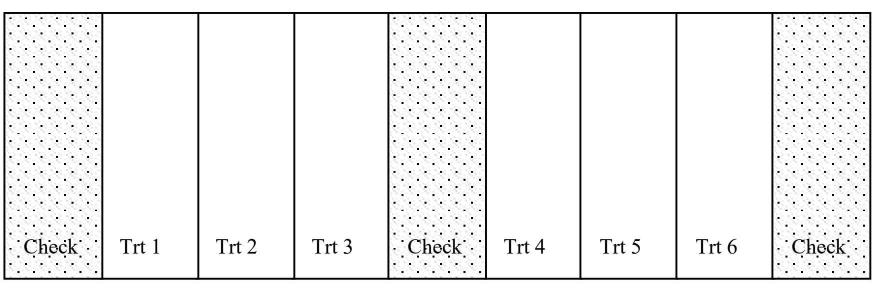
Two or more replicate plots where all treatments are repeated in each replicate. Replicates can be placed beside one another or behind each other. Note that treatments are randomized from one rep to the next.

2.



Plot design with a standard single treatment repeated between each test treatment to provide a measure of field variability. This is a tremendous design since there is a large assessment of field variation when the numerous standard treatments are compared.

3.



In this plot layout the check plot is repeated at the ends and in the middle. This provides an estimate of the amount of field variability present across a field since the yield or treatment result for the check plots can be compared for consistency across the width of the trial area. If the results of these treatments vary widely, the trial may need to be discarded, since the variability is too high.

Treatment Selection

On-farm trials should be kept simple. Choose a small number of treatments to answer a simple question. Treatments should be chosen that accurately reflect a comparison of new and existing technologies or methods. Design the trials carefully to ensure that they are answering the questions being asked and that the treatments chosen can generate those answers.

Identify up front the types of information wanted from the trial. From the beginning, know what data needs to be collected, how to make the assessments and when to record the data.

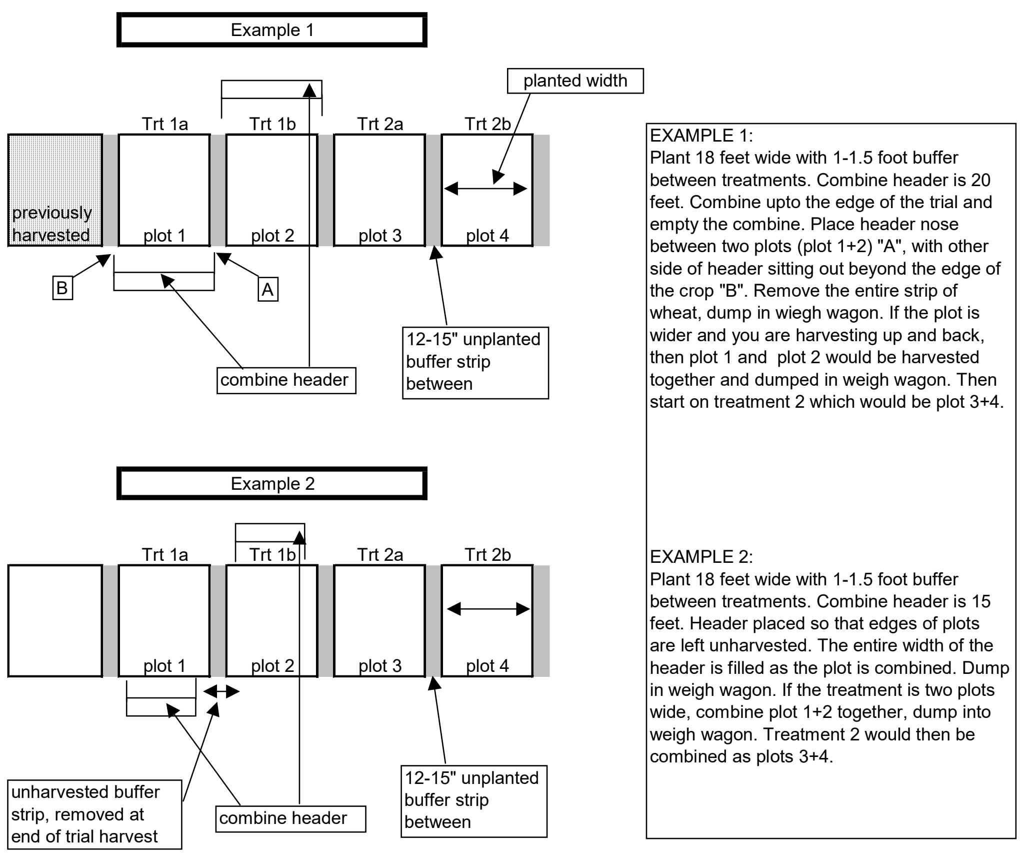
Plots should be kept as consistent as possible. It is important to have an accurate measure of plot size, especially the sampled or harvested area. Sampling should be consistent from plot to plot and should occur across all plots in the shortest time frame. Where an individual on-farm trial is a portion of a larger project with several locations, try to use the same input types and equipment. This removes the possibility of input source, equipment and/or field operation from contributing to trial variation.

Plot Harvest

It is important to consider how you are going to harvest or assess plots when you begin the design phase. It is a shame to loose an entire season's work because the setup did not accommodate plot by plot harvesting. Consider the size of the harvester and create plots accordingly. Ensure that all swaths of harvest are equal and that if plot sizes vary significantly, each plot size should be measured separately.

Figure 6.

Plot Setup and Harvesting Layout Example



This consideration is especially critical with solid seeded crops. With big combine headers there can be significant error introduced if the combine is operated up and down the plot, where the one direction has a full header width of material and the return pass has a varied amount of the cutter bar not harvesting. Ensure that the header is getting a full cut in both directions.

Data Collection

Data to be recorded should be identified at the beginning of the trial and every effort be made to record the data in an orderly and timely manner. The type and timing of data collection will vary with the nature of trial.

Since a great deal of on-farm research/demo trials are ultimately concerned with the yield impacts of various treatments, the method of harvest and the appropriate equipment and people involved in yield data collection should be identified.

> **Communication between those involved in trials is important to ensure that an entire season's work is not lost because a weigh wagon or the right people are not present when the combine is in the field.**

In general, the following data should be recorded for an on-farm trials:

- Planting date
- Harvest date
- Cultivar or hybrid
- Sampling/assessment dates (tissue, soil samples, height, silking/flowering dates etc)
- Soil type, soil condition at planting
- Tillage system used
- Fertility amount, type, time and method of application
- Weed control program or other inputs used
- Daily temperature (min/max)
- Rainfall
- Notes on site with reference to any factors could contribute to plot variation

Generic forms and other information on conducting on-farm research and demonstration trials is available on the OMAFRA Crops Web Pages.

Always make a plot map to indicate the type and placement of treatments. This is valuable to the grower and any people assisting with the trial. Include reference and distances to permanent makers like fence rows, buildings, trees, etc. Include an indication of direction.

DATA ASSESSMENT

The check plots are included in trials so the amount of variability can be evaluated. It is important to review trial results in light of the variation present in the trial area. The error variation present in a trial comes from soil type, fertility, topography, drainage and/or other factors that are not uniform across the whole trial area. Therefore the difference in treatment results (i.e. Yield) may be partially due to random variation in the trial area and not solely to treatment (i.e. Hybrid) differences.

By looking at the amount of variability between the check plots in a trial , it can be determined if the treatment differences observed are actually due to treatment (i.e. Hybrid) and not some other unrelated factor(s) (fertility, drainage, etc.).

If the difference in yield (or other parameter being evaluated) of the check plots is greater than +/- 10% of the average of the Check plots, it is suggested that the variability is too great and the trial results should be discarded.

The following charts sets out examples of hybrid strip trial harvests where the amount of variability is different despite average yields across the checks being equal.

Plot Layout of a Typical Hybrid Strip Trial

Tests	←Hybrids→							
	CHECK 1	A	B	C	CHECK 2	D	E	F	CHECK 3
Example 1	112				127				106
Example 2	132				101				112
Example 3	114				127				120

Example Calculations to Determine if Plot Variability is Within Suitable Limits

	Example 1	Example 2	Example 3
Yield 1	112	**132**	114
Yield 2	**127**	**101**	111
Yield 3	106	112	120
Total Yield	345/3	345/3	345/3
Average Yield	115 bu/ac	115 bu/ac	115 bu/ac
Range (10%)[1]	103.5 to **126.5**	**103.5** to **126.5**	103.5 to 126.5
Acceptable (Y/N)	no	no	**yes**

([1]Calculation of range around average yield: 115*0.9=103.5 and 115*1.1=126.5)

In this case, examples 1 and 2 would be considered to have too much variability across the trial and the data would be rejected. Example 3 has all the Check plot yields within the 10% range of the average yield suggesting that variation is minimal or evenly over the plot area. This data would therefore be accepted. A person would have confidence that differences seen between other hybrids in the strip trial would be real.

If in reviewing the data from a trial, the difference in yield between two treatments (i.e. Hybrids) is less then the largest difference between the Checks, then it is unlikely that the treatments (i.e. Hybrid) are different.

Example

Check	#1	103 bu/ac	
Check	#2	109 bu/ac	→difference = 109-97= 12 bu/ac
Check	#3	97 bu/ac	
Hybrid A		107 bu/ac	→difference = 107-99 = 8 bu/ac
Hybrid B		99 bu/ac	

Therefore in this case you would not consider Hybrid A to be different from Hybrid B since the difference between the two is less then the difference between the Check Hybrids.