Conducting on-farm trials is a key component in validating the effectiveness of fungicide applications. This research may be conducted independently, at university agricultural experiment stations, or in everyday farm operations.

On-farm trials are different from small-plot research trials in several ways. Conducting trials using small plots allows researchers to examine many products or product uses (such as timings, rates, etc.) over a relatively uniform field area (Fig. 31). In contrast, conducting on-farm trials tests products using larger plots, which may affect trial uniformity. However, proper trial design can minimize the errors associated with larger plot trials and allow farmers to determine differences among treatments.

**Steps in Developing an On-Farm Trial**

Developing an on-farm trial involves following these basic steps:

1. Establish the trial goals and objectives.
2. Determine the treatments.
3. Assess the need for an untreated check or control plot.
4. Select a site and gather its history.
5. Determine the plot layout.
6. Determine what data will be collected.
7. Determine how the data will be evaluated.

**Including an Untreated Check or Control Plot**

On-farm trials are often designed to compare the effectiveness of a new fungicide with a currently used product. However, to make a true assessment of effectiveness requires measuring the amount of disease that would have been present had the fungicide not been used.

An untreated check or control plot is an essential part of university experiments, but its use in larger field plots is viewed as more difficult. Regardless, an untreated check should be included as another treatment in the experimental setup. The untreated check plot must be the same dimensions as the other treatment plots, and the check must be replicated and randomized within the other treatments to determine the fungicide’s effectiveness in the trial.

Fig. 31. Plots for evaluation of soybean rust fungicide in Florida. (Courtesy Tristan Mueller)
Considerations for Conducting an On-Farm Trial

Key considerations for conducting an on-farm trial are as follow:

- Select a field site that is as uniform as possible. Avoid sections with hills or low-lying areas.
- Plan for at least three replications at each farm site.
- Determine what equipment is needed and available, and then design the trial accordingly.
- Calibrate the equipment before treatment application and harvest.
- Avoid fungicide treatment overlap by harvesting and taking data from the center of the plot.
- Take appropriate notes and photographs throughout the experiment.
- Stay in regular contact with researchers or farmers to avoid miscommunication.

Using Statistics to Interpret Experimental Results

Every on-farm trial will have a certain amount of experimental error because of environmental factors (such as differences in soil, topography, field history, etc.) that are beyond researchers’ control (Fig. 32). The use of statistics allows researchers to determine how much error is present in the experiment and whether differences exist among treatments after accounting for this error.

Unfortunately, error cannot be estimated from a single plot, which is why treatments must be replicated within a field site. It is also important to assign treatments to plots randomly to be sure that estimates of error are not biased by underlying field conditions. Examples of improperly and properly randomized and replicated on-farm trials are shown in Figures 33 and 34, respectively.

The calculated experimental error in a properly conducted (replicated and randomized) on-farm trial is used to assess whether significant differences exist among treatments. This significance is based on probability and is usually referred to as a $P$ value. The level of probability that defines significance is selected by the person conducting the experiment. The preferred level set by the scientific community is 90 or 95%. This means that to state with a 90% level of confidence that the differences observed among individual treatments resulted from the treatment itself (and not by chance), the $P$ value is set at 0.10, or 10% (100% – 90%).
Fig. 33. Examples of on-farm field designs that contain common design mistakes. These mistakes include lack of replication (top) and variation in plot sizes (middle and bottom) and do not account for the natural variation (yield potential) in the field that can bias the results. Making these mistakes can result in drawing conclusions that are incorrect or unfounded. (Courtesy Iowa State University)

Fig. 34. Examples of on-farm field designs that have proper replication and randomization. Each replication (Rep) must contain all of the treatments (treated and untreated) that are being examined in the test and should be equal in size. Treatments are to be randomly assigned to plots within the replication. Replications should be placed within the field to account for other factors influencing yield (such as soil fertility, moisture, etc.). This can be done by placing the replications in strips (top), quadrants (middle), or randomly (bottom) throughout the field site. (Courtesy Iowa State University)
To compare individual averages among treatments with equal numbers of replication, researchers use a comparison method called the least significant difference (LSD). The LSD value is the smallest allowable difference between two treatment averages that can occur for them to be considered statistically different. Thus, the difference between the averages of two treatment values must be greater than or equal to the LSD value for it to be considered significant. For example, if the LSD value is 10, then the average yield between the two treatments must vary by 10 units or more for the difference to be considered statistically different. Otherwise, no statistical difference is observed between the treatments, and they can be considered as having the same effect, even if the averages are not the same.

The use of statistics provides researchers with a tool to explain and analyze errors associated with on-farm trials that cannot be controlled. Accounting for these errors allows researchers to evaluate whether differences exist among treatments. Thus, using statistics allows drawing meaningful conclusions about fungicide products that may be beneficial to agricultural production systems.