UK COOPERATIVE EXTENSION SERVICE
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LEXINGTON, KY 40546

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Soil Science News & Views

Vol. 26, No.1, 2006

On-Farm Field Research: Setting Up a Valid Comparison

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Producers now have the tools (grain carts with load cells, yield monitors, GPS) to do on-farm field research. Additionally, growers are being made aware of more and more products/management options that they might use. One might read farm magazines, talk to neighbors, attend extension and industry presentations, but still wonder whether a particular recommendation would be of benefit. So the question remains. How would this (product, change in management) work on the land that I farm? Tools plus uncertainty equals motivation for an on-farm comparison.

On-farm research can provide information that you can use in making important management decisions. But important decisions require good information. And for on-farm research to provide good information, you need to set up the research in such a way as to achieve a "valid comparison" of your proposed treatments, products, or programs.

On-farm research requires investment, especially in time and management. Many comparisons are initiated at crop establishment and concluded at harvest, seasonal activities where lost time due to inadequate planning can be especially costly to growers. To avoid such problems, pre-planning of on-farm comparisons is needed. Good planning starts with having a well-defined objective for your comparison(s).

The objective of your comparison should be carefully understood and written down. The objective defines and set parameters for the comparison(s). Are you trying to "spot the winner"? Are you trying to understand "why" the treatments caused the observed results? A well-defined objective will help you avoid "confounding" your intended comparison(s) with other factors you might be tempted to "add" (ex. changing seeding rates as part of a comparison intended to evaluate different varieties). You may need to define an additional objective requiring another comparison (ex. a separate seeding rate comparison).

After setting the objective, the comparison should be described, giving the treatments, the size of the comparison, the materials to be used, and the measurement(s) to be made.

Randomization is not really a consideration in a simple single comparison, when the treatments are not repeated, as long as "valid comparison" principles are not violated. Randomization is needed when the comparison is repeated/replicated.

What is a "valid comparison"? A valid comparison requires, as much as is possible, that everything is the same except for the treatments being compared. Your comparison should be uniform in space (field, soil type, previous crop, tillage, etc.), uniform in time (same season, planting and harvest dates, etc.), and uniform in management (variety, fertilization, seeding rate, pest control, etc.).

The layout of treatments within the comparison needs to avoid **systematic bias**. With systematic bias the comparison is laid out in such a way that one treatment is always favored over another. An example of a systematic bias is planting the comparison treatments along a slope such that one treatment is always below the other, where the soil depth may be consistently deeper or shallower. So, even though general management practices recommend planting with the contour, the position of treatments on the slope could favor one treatment over another. It would be more optimal to plant both treatments perpendicular to the prevailing topographic gradients (up and down the hill).

The comparison is **confounded** when it is laid out in such a way that the difference between the treatments may not be entirely due to the treatments themselves, but includes differences in other important factors. An example of confounding is to compare a treatment in one field with another treatment in a second field, where one could have differences in one or more factors such as soils, planting dates, varieties, fertility, etc. between the two fields. Some other examples of invalid comparisons include: planted with different planters; split-planter configuration with unequal unit performance; point rows resulting in unequal row length; planted unequal portions of treatments at edges of field or in areas compacted by traffic; unequal pest control; etc.

What is the "control" treatment? It may be a treatment which, in itself, is not interesting, but has value because it reveals whether or not the other treatments were effective. The control treatment will usually consist of not adding a product when different products are compared (ex. no fungicide when comparing different fungicide products). Some comparisons need no control. You simply compare one product against another. Some comparisons suggest what happens when a product is no longer used and others are intended to suggest what happens when an input is added to your management system. The control could be the normally accepted practice for the area, or for your farm. A new fertilizer recommendation might be evaluated against your existing plant nutrition protocol. The "control", like beauty, is in the eye of the beholder/investigator.

There are limitations to your "valid comparison". You may find a 20 bushel/acre difference between treatments in your comparison, but you will not know whether the same difference would be found in other parts of the same field, in other fields, on other farms, with other varieties, in other years, etc. This particular "not knowing" problem can only be dealt with by replication. Repeating the comparison within the field, in other fields and other years adds to the understanding of, and the confidence in, the results.

A valid comparison is an excellent first step in on-farm research. Each year, there are hundreds of extension and industry demonstrations that are representative of this approach. However, a valid comparison is not yet an experiment. An experiment provides an assessment of the consistency/variation in the response (difference between treatments) that you observe, an assessment that a single comparison can not accomplish. This becomes important if you want to know whether an entire field or farm (or state) would have responded in a manner consistent with what you observed in your

comparison. To understand consistency in treatment differences, your experiment will require replication. However, each replication still needs to be a valid comparison. A replicated experiment will require you to revisit your research objectives.

Below you will find an outline of an on-farm comparison that you might use to guide you in your own on-farm research. Alternatively, to be a better "consumer" of the on-farm research information presented by others, you might use it as a guide in asking questions about the "comparisons" you hear others talk about.

And remember, not all comparisons "work out". They do not always give useful information. They may have to be repeated.

ON-FARM RESEARCH COMPARISON:

Objective:
Determine if I can reduce my standard rate of fertilizer N, for corn, by 50 pounds of N per acre.

Control Treatment:
My standard rate of fertilizer N, for corn.

Comparison Treatment:
My standard rate of fertilizer N, for corn, reduced by 50 pounds of N per acre.

Uniformity Requirements:
Same field, same soil type, same position on slope, same hybrid, same planting date, same seeding rate, same N application technique, same N source, same soil pH, soil test P, K and Zn levels, same weed, disease and insect control protocols over both treatments.

Experimental Observations During the Season:
What are things that likely affected the outcome of my comparison? What were the limitations (rainfall, weed patches, insect infestations, foliar diseases, etc.)?

Experimental Observations at Harvest:
Are the differences, if any, in final yield due solely to the N rate comparison, or did something else affect final yield? Was your experiment "a fair comparison"?

Limitations to Decision-Making:
Make decisions based on your understanding of the limitations to using the results of your comparison. Will future results be similar (on similar soils with similar soil management, crop history, etc.), or might they be different (due to differences in soils, growing seasons, or because of something observed during the experiment)?

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