ESTABLISHING (AND DIFFERENTIATING) ON-FARM RESEARCH AND DEMONSTRATION TRIALS[1]

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Introduction

As the 1990s begin, funding agencies are looking beyond the traditional definition of who does "research." While university, USDA and private industry have traditionally conducted research in the past, grassroot organizations, local agency personnel and individual farmers are now proposing and implementing research of various types.

An overall trend seems to be for research experiments to be evaluated on farmers' fields. Some of this movement may be a political statement against traditional methods and research agendas of state experiment stations. However, there are valid justifications for on-farm investigations: they permit evaluation of specific treatment scenarios not present on current research fields (pest infestations, fertility levels, soil types) and they permit evaluation of treatments in the context of a specific management system.

Farmers are demanding more localized databases before accepting new research results. However, the reliability and accuracy of the local on-farm research must be established.

Background

As research becomes more of an everyday term to all members of the agricultural community, its definition has seemed to change. According to the The American Heritage Dictionary, research is defined as "scholarly or scientific investigations," an implication that scholars or scientists are conducting the research.

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From a statistical perspective, Steel and Torrie, in their Principles and Procedures of Statistics, identify three types of research or experiments--preliminary, critical and demonstrational. Preliminary experiments test a large number of treatments to determine which treatments merit further studies. For example, in developing a herbicide to control a specific weed in corn, agronomists screen countless chemicals. Critical experiments are designed to compare a limited number of treatments in order to detect meaningful differences or test specific hypotheses. This can be exemplified by an entomologist comparing management strategies for control of spider mites in soybeans. In the third type of research, demonstrational, an extension worker might put out plots to show the effect of a new product relative to that of the standard product.

In an article discussing on-farm research in the publication American Journal of Alternative Agriculture, Lockeretz (Vol. II(3)) comments that projects that "inform farmers about a new practice or to persuade them that this is desirable" are "loosely referred to as 'research,' but should really be called demonstrational projects." Lockeretz continues that on-farm research can be either farmer problem-solving or adaptive research. Adaptive research deals with techniques that have been developed at experiment stations and involves evaluating the techniques under a farmer's particular circumstances. Research designed to answer a farmer's specific question based on his or her production methods and circumstances is problem-solving research.

To avoid semantic confusion, these on-farm trials might best be delineated into two categories--research or demonstration. On-farm research trials would be those studies that have objectives that involve answering scientific questions regarding the treatments. These research trials should be conducted by people who have the proper equipment to apply treatments and collect data and who can objectively evaluate and interpret the data. On-farm demonstrational trials would be those studies that have objectives that involve showcasing treatments that have already been proven superior or acceptable in other research studies. These demonstrations need not be replicated nor does data need to be taken to prove the technology works on the farm.

On-farm demonstrational trials can serve many important purposes for the organization promoting and funding them. According to J. Bohlen (Iowa State University) there are five steps in the adoption process of new (or old) ideas by farmers. These are: 1) awareness, 2) information, 3) evaluation, 4) trial and 5) adoption. While only the trial stage is accomplished by one farmer in an on-farm demonstration trial, the awareness, informational and evaluation stages are met for numerous other people.

Both demonstrational trials and research trials can be successful on farmers' fields when the objectives are known ahead of time. Figure 1 represents how both sets of objectives can be met. If the on-farm trial is for demonstrational purposes, the treatments would have been first evaluated through private industry or university research programs in the laboratory and/or experimental fields. Note that on-farm demonstrational trials are not neccessary since many farmers adopt ideas based on experiment station results. While on-farm research trials could also be used for critical evaluation of treatments, there may be some advantages for cooperating with concurrent research projects in private industry or university experiment stations.

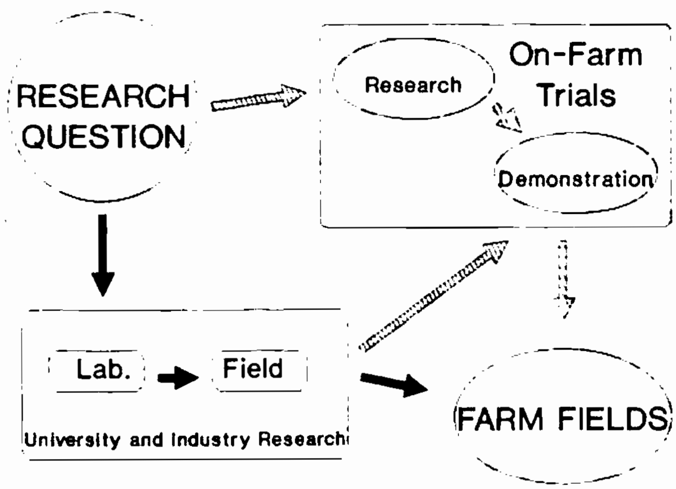

Figure 1. Research program progression using traditional university/industry and on-farm trial pathways.

The number of on-farm trials will probably continue to increase in the coming years. Part of this trend will include more researchers from university and private industry who conduct their research in on-farm trials. There also will be an increase in on-farm research by people who have not been exposed to principles of research methodology. The following guidelines for establishing on-farm trials are listed primarily for non-traditional researchers who plan to conduct on-farm demonstrational trials. The guidelines also may be of interest to traditional researchers who may be contemplating their initial on-farm research trials.

Steps in Establishing On-Farm Trials

1. Define trial objectives clearly

Before starting any field work, objectives must be defined for a trial, since the process depends on the specific objectives. Write down the questions to be answered. Then determine what data need to be collected or what events must occur for these questions to be answered.

On-farm trials of research and demonstration can be differentiated by their objectives. With on-farm research trials, the objectives are more apt to be met with intensive data collection and analysis; with on-farm demonstration trials, the objectives may be met with local tours and press releases along with notes and data from some general observations.

2. Select cooperator and field carefully

The prudence involved in selecting the farmer and the field is directly related to the trial's objectives. With on-farm research trials, selecting of a homogeneous site, or a site with which an experimental design can account for heterogeneity, is paramount. Also, if the on-farm research trial is to measure treatment effects within the context of a management system, the cooperators are extremely important. The cooperators must be willing to provide extra effort and have top management skills. This is necessary for data credibility.

Although a good field location is of high value with an on-farm demonstration trial, emphasis should also be placed on selecting the proper cooperator. One important consideration is the rate with which this cooperator adopts new ideas/practices. Classified groups range from the earliest adopters, "innovators" and "early adopters," to the slower adopters, the "laggards" (E.M. Rogers, Diffusion of Innovation, 3rd Ed.). Because most farmers look to the "early adopters" for information/trends, cooperating with farmers in this group enhances the effectiveness of the demonstration.

3. Communicate frequently with cooperator

All on-farm trials need clear communication between the investigators and the cooperator. While some on-farm trials (either research or demonstration) operate within the farmers' existing system and some trials consist merely of having the farmer avoid a sequestered portion of their field, a lack of communication can lead to the demise of the best plans.

Communication regarding the conditions that must be met for the objectives to be tested is vital. Current year input information and plans are useful and should be communicated between the cooperator and the investigator. The previous year's pesticide, fertility or management system is important information that should be provided by the cooperator, since this may affect the proposed treatments.

There are two specific examples of poor communication between the farmer/cooperator and the investigator that lead to the greatest problems in on-farm research. The first is that the farmer/cooperator does not think of mentioning a previous factor regarding the field until after the trial has been started and a problem is noted. The second example relates to harvest scheduling. It must be clear who is harvesting what and when. There are many incidents of farmers combining through trials--either because the location of the trial within the field is unclear or because they thought the plotwork was completed.

4. Select treatments to meet objectives

Select treatments that are straightforward and yet still meet the objectives. Including more treatments in a trial does not generally answer an increasing proportional number of questions.

Treatment selection should be based on meeting the objectives. Within this guideline, treatments are categorized into two groups. In one group, the optimum rate of a factor (e.g. chemical rate, date of planting, etc.) is investigated. For these treatments, the rates must be in increments so that the question of the optimum rate can be answered.

The second group of treatments involves comparing products, management and/or systems. This type of treatment will provide one of three possible answers: better, worse or the same. The most important issue with these types of treatments is that a control/check be included as a treatment. Knowing that product A is equal to product B is meaningless if neither product has a benefit compared to a control treatment.

5. Implement proper experimental designs

There are just a few experimental designs that are frequently suggested for on-farm trials. The appropriateness of the design is related to the objectives of the trial. With on-farm research plots, the complexity of the experimental design can be related to the magnitude of the expected treatment differences, probability levels of errors and the funds available. The following is a partial list of commonly mentioned on-farm designs (Figure 2).

a) Unreplicated strip trials. For a demonstrational trial, this design is good for "show and tell" because it is easy to implement with available equipment, it meets the objectives of creating awareness and generating interest and it answers some logistical questions. However, if data are to be collected, there is no replication, and hence, no measurement of experimental error with which to compare treatment means.

If an unreplicated strip trial were used for on-farm research trials, it is imperative that these data be combined with similar trials at several other locations and for two or more years. This would then provide a treatment-by-environment interaction that could be an appropriate error term for many treatments.

b) Unreplicated strip trials with "tester" plots. In this design, a common treatment is located in every other or every third plot. The means of adjacent treatment plots are adjusted based on the performance of the recurring "tester." This design is of questionable value due to its implied assumption of linear correlation between plots. Therefore, some of the effort put forth in implementing this design may be considered inefficient.

c) Randomized complete block design. This design is acceptable for any kind of trial. Blocks are laid out so that all area within each block is uniform and each treatment occurs in each block. Blocks are replicated so an estimate of experimental error can be calculated to test treatment differences. The scope of inference, however, is sometimes limited unless combined with other trials.

The issue of plot size is often mentioned with on-farm trials. Plot size should be large enough to fit equipment needs and small enough to permit an adequate scope of replication. Theoretically, increased precision can be obtained from plots grouped into homogeneous blocks with which to test the treatments. Effective blocking of larger plots is difficult to achieve, and adequate replication is expensive with the increasing larger plots.

The theoretical length or size of each plot is estimated to be such that the dimensions of a block are square. Therefore, if each plot is 10' long and there are 5 treatments per block, the length of each plot should be 50'. This is only an estimation; the major concern should be the pattern of heterogeneity in the field.

d) Paired plot design. This design situates two treatments next to each other in a paired series across a field. It is the simplest form of a randomized complete block design. The major limitation is that the effects of only two treatments can be compared and that 15-20 replicates are necessary to provide a statistically adequate number of degrees of freedom for the error term. An appropriate use for this design might be to compare a new product or system with the old product or system.

6. Maintain thoroughness throughout trial

A trial does not consist of only the application of treatments and the harvest. All on-farm trials will require some degree of explanation as to the performance of the treatments. In-season monitoring, sampling (and analysis) and regular observations will provide information to substantiate the results. Conducting a thorough study requires careful planning before the trial begins and must continue past the harvest of the crop.

7. Analyze and interpret data carefully

The analysis of on-farm trial data is of special concern since the wrong interpretation of the analysis can lead to wrong decisions. With on-farm research trials, the data should be analyzed according to regimented statistical procedures such as analysis of variance, regression and/or correlation. The interpretation should then be based on probability levels of the statistical tests of significance.

On-farm demonstration trials do not always need to have data collected in order to have served their purpose. For some of these trials, the differences between results may be so small that the potential for a wrong interpretation is great. In these cases, it would be better to not have recorded results.

Conclusions

On-farm trials can be used in many situations to provide answers to the unending questions that are faced in modern agriculture. While on-farm trials are sometimes viewed as a by-pass for traditional research methods, they best fit as a complementary portion of the flow and adoption of ideas. Project objectives can distinguish whether on-farm trials are considered demonstration-oriented or research-oriented. With the appropriate guidelines, all on-farm trials should be conducted such that objectives are met in the most efficient manner.

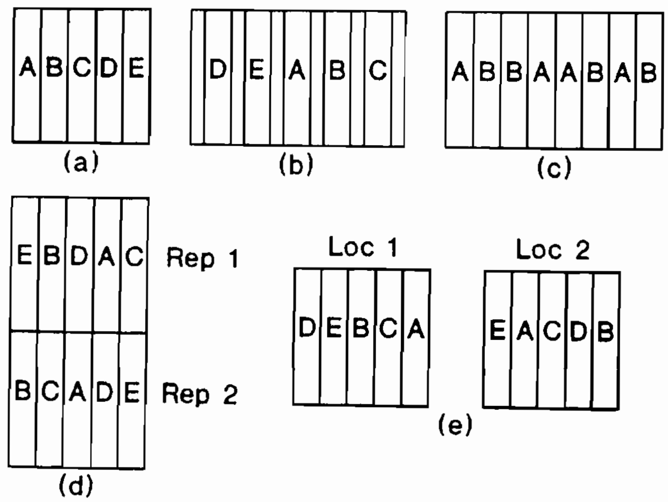

Figure 2. Some frequently suggested experimental designs used in on-farm trials: a) unreplicated strips, b) unreplicated strips with a "tester" or control, c) paired plots, d) replicated strip test (RCB) and e) unreplicated strips repeated at several locations.

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