ROOTS OF PEACE

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Extension Toolkit Notes

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One-on-One Dialogue: Designing Simple Experiments for Informal Demonstrations

A primary function of extension agents is to *advise* farmers of the Best-Farming-Practices available given the farmers' economic, social and environmental constraints. An equally important function is to encourage *adoption* of Best-Farming-Practices. This requires the extension agent present a convincing argument if the farmer takes on a 'show-me' attitude.

The best way to handle this situation is to do a small field demonstration for the benefit of that farmer. Experimental design provides the basis for ensuring that the demonstration clearly shows differences between the recommendation (treatment 'D') and the farmer's current practice (the control).

There are two situations in which an extension agent performs experiments. The first is an experiment to obtain information. The agent might need this information to develop an extension strategy. Sample size and sampling strategy are very important considerations because statistical inference will be used to interpret the data.

The second situation is when an extension agent needs to convince a farmer that his recommendation is appropriate. An informal demonstration experiment does the trick. The agent knows the outcome before the demonstration is started; he is merely attempting to convince the farmer. The agent's recommendation needs to be noticeably better than the current practice. He will need to show clear differences between treatments without resorting to statistical significance of t-tests or ANOVA. Sample size and sampling strategy are less important considerations in this situation.

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Demonstrations can be formal and designed with a large audience in mind, or they can be informal and designed for the benefit of an individual farmer. Demonstrations for an individual farmer are really part of an ongoing dialogue with that farmer. Such demonstrations are personal in that they are designed to address the specific concerns of the farmer. They must have a simple design and be easy to interpret. The simplest designs have only a single demonstration treatment (i.e., the practice recommended to the farmer) and a control treatment (i.e., the current practice).

An extension agent should have the basic elements of a demonstration experiment in mind before he speaks with a farmer. That will allow him to quickly suggest a demonstration if the need arises and make a good impression on the farmer. The basic elements are sample size, location of the selected vines within the vineyard, randomization of treatment assignments, and control of treatment application. The vines selected for the demonstration are referred to as experimental units.

A sample size of twelve vines is adequate for most demonstrations. Using too few vines might not be convincing and too many might be counter-productive in that it will emphasize the work involved in doing the demonstration and distract the farmer from the main point. The actual sample size chosen will depend on the situation. Issues to consider include the work required to do the demonstration and the size of the expected differences between the treatments. The expense of doing the demonstration also must be considered.

The location of the selected vines within the vineyard is situation dependant as well. It is best if they are close together so that a farmer can easily see differences between the control and experimental treatment. Choosing twelve consecutive vines in a row or six consecutive vines in two adjacent rows is a good first thought. However, issues particular to both the vineyard and demonstration may cause the extension agent to revise that scheme.

For example, if the demonstration treatment involves applying sulfur with a duster, then confining the treatment to the intended experimental units is problematic. Sulfur drift onto control vines must be avoided. This can be accomplished by spacing out the experimental units. One way to do this is to select a group of nine vines—in a 3x3 square arrangement—for each experimental unit (the demonstration then requires a total of 108 vines). The vine in the center of each square is used as the experimental unit. The remaining eight vines surrounding each experimental unit are used as a border and not counted when interpreting results.

Another issue concerning location of the experimental units is their variability. Experimental units should be as uniform as possible (e.g. in size, vigor, shape and health). In that way, differences among them can be more easily attributed to the treatments. If a vineyard has a lot of variability among vines, it may not be possible to find twelve contiguous vines of uniform status. Then it is necessary to randomly select twelve uniform vines from throughout the vineyard.

Once the experimental units have been selected, the treatments (demonstration and control) must be randomly assigned to them. This can be done by dividing the total number of experimental units by the number of treatments (e.g., 12 experimental units and 2 treatments is 12/2=6) to obtain the number of experimental units for each treatment. Take twelve pieces of paper and on six of them write ‘d’ for demonstration, write ‘c’ for control on the remaining six. Mix them together and randomly select one paper at a time. Each time a paper is selected an experimental unit is assigned that treatment—either d or c—until treatments have been assigned to all of the experimental units. Alternatively, a six-sided die could be rolled; even numbers on the die are assigned a value of ‘d’ and odd numbers a value of ‘c’. Each time the die is rolled its treatment value is assigned to an experimental unit until all units are have a treatment.

Blocking also may be necessary when choosing experimental units. For example, if a vineyard has obvious discontinuities—e.g., one part is on a steep slope and the other part on level ground, or one part shaded and the other part in full sun—then it may be wise to split the experimental units into two groups of six vines each, placing one group in each part of the vineyard. Each group of six vines is called a 'block'.

The most important thing to remember about blocking is that all treatments must be distributed across the blocks. That is, if a demonstration has a sample size of twelve vines with two blocks and two treatments, then in each block three vines receive one treatment and three vines the other treatment. It is never the case that all six vines in one block receive the demonstration treatment with the control only applied to the six vines in the other block. When it is time to show the farmer the results of the demonstration he is shown each block and allowed to evaluate them separately.

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Hypothetical case study

You visit a vineyard of your client farmer shortly after berry-set and he points with pride to the many clusters on each of his 2500 vines. You do a quick survey and notice that many canes have four or five clusters and there are obviously many more clusters than canes on each vine. Almost every vine is over-cropped. You tell the farmer that he is severely over-cropping his vineyard and that the clusters will be light with extremely small berries. Immediately, you can see that he is reluctant to accept your advice. His way of thinking is that more clusters per vine are always better. Although, you explain that the plant can only produce enough food to support a certain number of clusters, he is hesitant to intentionally remove any through thinning. However, eventually you are able to convince him to try an experiment using twelve vines. You suggest that he might use the immature berry clusters you thin to make a spice for kabobs.

The proper number of clusters per vine is approximately equal to the number of canes it has or about 18 leaves per cluster. However, to count with the farmer both the number of canes and clusters on each vine, and then remove the appropriate number of clusters, would be too time consuming. It might cause the farmer to lose interest in your suggestion, even if he is convinced it is correct.

So, you adjust the experiment to the situation. You decide that your recommendation for this demonstration is to simply remove 50% of the clusters from each vine. You expect that will give you a noticeable response in cluster weight because it will bring most of the vines down to the ideal number of clusters. The farmer should see that fewer clusters on his vines will mean he produces larger, higher-value berries. Once, he sees that point you plan to discuss with him why thinning works, how to determine the appropriate number of clusters his vines should have, and the roles of pruning and thinning on crop yield. You also plan to discuss with him the consequences of over-cropping to the long-term health of his vineyard.

The vines in this vineyard are fairly uniform with regard to size, shape, vigor, health and crop-load. You suggest he experiment with twelve vines near the front of his vineyard that are easy to approach—six vines in one row and the six corresponding vines in the next row. You write a list of numbers in your notebook from 1 to 12 for the vines you selected (you also record the name of the farmer, the village and date). Next, you tear a sheet of paper into twelve pieces, label six pieces 'd' and six pieces 'c', and mix them together. You randomly pick up one paper at time and record its label (d or c) next to the vine number in your notebook. In this case, the sequence of labels you pick up is: c, c, c, d, c, d, c, c, d, d, d, and d.

You number each of the selected vines, 1 to 12, and tag them in an easy to locate position (e.g., with red plastic surveyors' tape or metal tags high up on the vine). You count the number of clusters on each of the twelve vines and record that data in your notebook. Vine #4, in this example, is labeled 'd'. If you count 135 clusters on it, you remove 68 of its clusters. You also remove 50% of the clusters from vines #6, #9, #10, #11, and #12.

It is very important that you involve the farmer in each stage of the process, especially randomly selecting the treatments for each vine, counting the number of clusters and removing 50% of them. The idea is to make clear for him the results of the experiment.

When harvest-time approaches, you examine with the farmer the tagged vines. Hopefully, differences between the demonstration and control are obvious by sight alone. In any event, you harvest each cluster, weigh it on a balance, record the weight in your notebook, and discuss the results with the farmer.

The mechanics of this case study can be applied—using ingenuity and with appropriate adjustments—to other demonstrations (e.g., frequency of irrigation, amount of pruning per vine, amount of fertilizer applied, and weed control). The requirements for success are that the extension agent (1) chooses appropriate vines for experimental units, (2) *randomly* assigns treatments to experimental units, and (3) controls the application of treatments to the experimental units so that the affect of the demonstration treatment on the control plants is minimized.