Demonstration and Research Design

Demonstrations

Demonstrations are conducted to show the effectiveness of proven or new treatments or specific practices.

There are two basic types.

- A **method demonstration** shows how to do a specific task in a step-by-step process; for example, calibrating a sprayer.
- A **result demonstration** shows the effective use of a piece of application equipment or the effectiveness of a fungicide for disease control. Demonstrations effectively persuade by being visually convincing. Usually, they are conducted at a specific site for a short time and not replicated.

Effective result demonstrations require:

- A complete plan with clear, simple objectives and differences that will be easy to measure.
- Appropriate production practices.
- A good cooperator that is interested in the project and is known and respected in the area.

Experiments

An **experiment** is a test under controlled conditions that is designed to test an hypothesis or to determine the efficacy of something previously untried.

Data from a well-designed experiment can be used to:

- Support new pesticide uses or methods: new rates, or application frequencies.
- Add new target pest species to the label.
- Support existing knowledge.
- Close gaps in existing information.
- Develop new information.

Experiments require careful design and close management. The data must be collected and analyzed in a way that produces scientifically sound conclusions.

Scientific Method

Steps in the scientific method

Most research experiments follow these fundamental steps:

- **Formulate a hypothesis (a suggested solution or explanation for a specific problem or question).**
- **Design an experiment to test the hypothesis objectively.**
- **Collect, analyze and interpret the data.**
- **Accept, reject, or alter the original hypothesis.**

Terms

Bias – a prejudice in favor of or against an outcome. A researcher can consciously or unconsciously bias an experiment by unequal or unfair (non-random) assignment of plots or animals to treatment and control groups.

Block – experimental subjects are first divided into similar blocks before they are randomly assigned to treatment groups. This helps to reduce known variability in an experiment, such as differences in weed pressure across a field.

Border rows are used around test plots or between treatments when one treatment may affect the results in adjacent plots, such as through spray drift. Also, field margins may have different fertility, weed pressure, sunlight and moisture availability so normally they are not used.

Check or control plots are experimental units that do not get any treatments or to which a standard treatment is applied for comparison to other treatments.

Experimental error or variation refers to the inherent variability among experimental units or plots against which differences among treatments will be tested.

Experimental unit – land area or animal

Hypothesis – a suggested solution or explanation for a specific problem or question.

Randomization - assign treatments to experimental units by a purely objective method. The simplest way is literally to pull the treatment options out of a hat. Assign each treatment a number, write the numbers on individual pieces of paper, mix the slips of paper up, and then select the slips one at a time without looking at them first. The order in which the numbers are drawn is the order in which they will be arranged in a block. Repeat these steps for each block in the experiment.

Replication - each treatment appears two or more times in an experiment. This is necessary because all test plots are not identical. Replication increases the ability to detect differences between treatments.

Sample - representative unit(s) taken from an experimental unit or plot (e.g. the number of infected plants, percentage ground covered by weeds, etc.)

Treatment - the factor being tested in an experiment (e.g. different herbicides to control velvetleaf).

Experimental Design

Designing an experiment is an extremely important step. Errors in the design can affect the results of the entire experiment and can prevent you from reaching valid conclusions.

It is generally best to avoid complex experiments that involve elaborate designs unless you check with a statistician. If you have trouble with a design or doubt its validity, get help before starting the research. Variations in soil type, drainage, compaction, erosion, or pest infestation can affect the outcome of an experiment. They may change with time and location in a field. Select plots carefully to avoid ones that may differ from others. Sources of bias may be minimized by randomization.

Some Types of Experimental Designs

A	B	C	D
A	B	C	D
A	B	C	D
A	B	C	D

Non-random design with 4 treatments (letters) replicated 4 times.

The arrangement of treatments in rows or repeating several treatments in the same order (above) is a common design mistake. One treatment can affect nearby treatments and lead to incorrect conclusions.

A	B	D	D
D	C	C	A
C	D	B	C
A	A	B	B

Completely randomized design with 4 treatments (letters) replicated 4 times.

The **completely randomized design** (above) is simple and flexible. It can be used when the test units are very uniform. All treatments are assigned randomly to plots. This design allows any number of treatments to be tested. It is best to assign the same number of plots to each treatment. **This design may be better for livestock tests than for field crop work.**

Block 1	Block 2	Block 3	Block 4
C	A	D	D
B	C	B	A
A	B	C	C
D	D	A	B

Randomized complete block design with 4 treatments (letters) replicated 4 times.

The **randomized complete block design** (above) is a common design in agricultural field research if you can identify patterns of non-uniformity, such as changing soil types, drainage patterns, etc. Plots are first assigned to groups of similar characteristics relative to the non-uniformity (e.g. sandy vs. clay soils). The 4 treatments are then assigned randomly *within the groups* of plots called blocks (columns).

The experimental units or plots that are not treated commonly are called **controls or checks**. Control plots are recommended for all statistically sound experimental field work. They **should be selected with the same objectivity as that of other plot selection**. Variable factors that may affect treatment plots will affect control plots. Control plots should not be arbitrarily assigned, like along a fence row, lane, or simply in the middle or side of the field.

Important Design Points

Good experimental technique should minimize error and bias. Reduce or eliminate these problems through appropriate experimental designs.

To help eliminate experimental error and bias:

- **Apply all treatments uniformly.**
- **Measure all treatment effects in an unbiased way.**
- **Prevent gross errors.**
- **Control external influences so that all treatments are affected equally.**

Properly designing and implementing an experiment is a logical process.