4.6: The Study Diagram

In **Section 1.1** we encountered a brief description of an experiment. The description of an experiment provides a *context* for understanding how to build an appropriate statistical model. All too often, mistakes are made in statistical analyses because of a lack of understanding of the setting and procedures in which a designed experiment is conducted. Creating a study diagram is one of the best ways to address this, in addition to being intuitive. A study diagram is a schematic diagram that captures the essential features of the experimental design. Here, as we explore the computations for a single factor ANOVA in a simple experimental setting, the study diagram may seem trivial. However, in practice and in lessons to follow in this course, the ability to create accurate study diagrams usually makes a substantial difference in getting the model right.

In our example, as described in **Section 1.1**, a plant biologist thinks that plant height may be affected by the fertilizer type and three types of fertilizer were chosen to investigate this claim. Next, 24 plants were randomly chosen and 4 batches, with 6 plants in each, were assigned individually to the 3 fertilizer types; the last batch was left untreated, constituting the Control group. The researchers kept all the plants under controlled conditions in the greenhouse. The individual containerized plants were randomly assigned the fertilizer treatment levels to produce 6 replications of each of the fertilizer applications.

Here is the data from the example that we were using in this lesson:

Control	F1	F2	F3
21	32	22.5	28
19.5	30.5	26	27.5
22.5	25	28	31
21.5	27.5	27	29.5
20.5	28	26.5	30
21	28.6	25.2	29.2

So we have a description of the treatment levels and how they were assigned to individual experimental units (the potted plant), and we see the data organized in a table. But what are we missing? A key question is: how was the experiment conducted? This question is a practical one and is answered with a study diagram. These are usually hand-drawn depictions of a real setting, indicating the treatments, levels of treatments, and how the experiment was laid out. They are not typically works of art and no one should ever feel embarrassed by a lack of artistic ability to draw one. For this example, we need to draw a greenhouse bench, capable of holding the 4 × 6 = 24 experimental units:

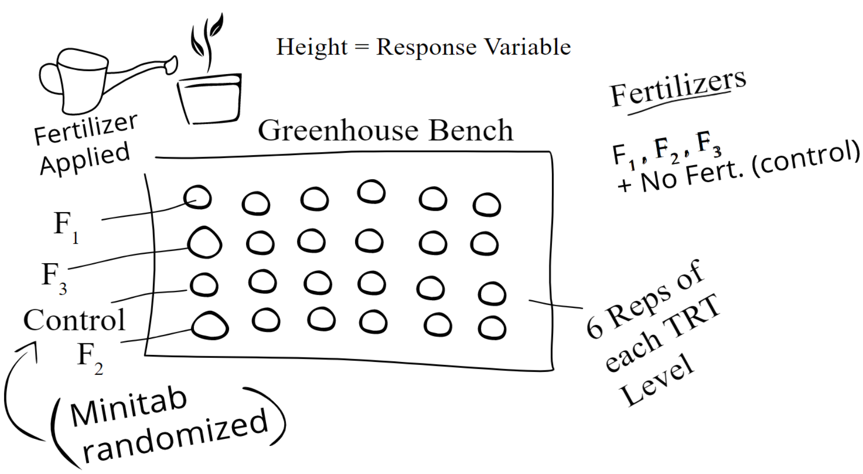

Figure 4.6.1: Study diagram for response variable of height, showing 4 treatment levels with 6 units in each.

The diagram identified the response variable, listed the treatment levels, and indicated the random assignment of treatment levels to these 24 experimental units on the greenhouse bench.

This randomization and the subsequent experimental layout we would identify as a Completely Randomized Design (CRD). We know from this schematic diagram that we need a statistical model that is appropriate for a one-way ANOVA in a Completely Randomized Design (CRD).

Furthermore, once the plant heights are recorded at the end of the study, the experimenter may observe that the variability in the growth may possibly be influenced by a second factor besides the fertilizer level. A careful examination of the layout of the plants in the study diagram may perhaps reveal this additional factor. For example, if the growth is higher in the plants placed on the row nearer to the windows, it is reasonable to assume that sunlight also plays a role and to redesign the experiment as a randomized completely block design (RCBD) with rows as a blocking factor. Note that design aspects of experiments are covered in Chapters 7 and 8.

Being able to draw and reproduce a study diagram is very useful in identifying the components of the ANOVA models.
