# Creating a Split-Plot Factorial Protocol

In this tutorial, we will demonstrate:

- how to set up a factorial protocol,

- fill in the treatments,

- and then view a Split-Plot trial to see how the treatments are built and randomized in a trial.

A factorial arrangement of treatments is used to study effects over a range of 2 or 3 factors. The factorial analysis of variance gives more information about the effects of one factor independent of the other factors than the standard RCB design, as well as detect whether 2 factors interact.

A split-plot design is used when one factor is more conveniently applied to large areas that span several plots than to individual plots. An example would be comparing products applied to several different tillage systems. Because of the difficulty in using large, modern tillage equipment on small plots, tillage can be defined as the "main unit" of a split-plot. Products are then "subunits" that are randomized within each tillage system.
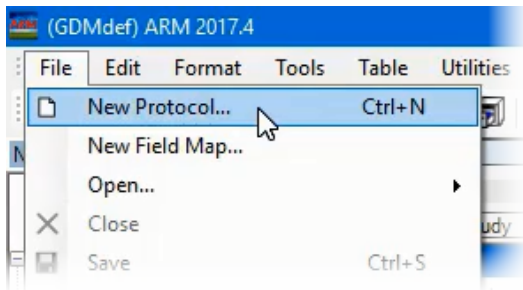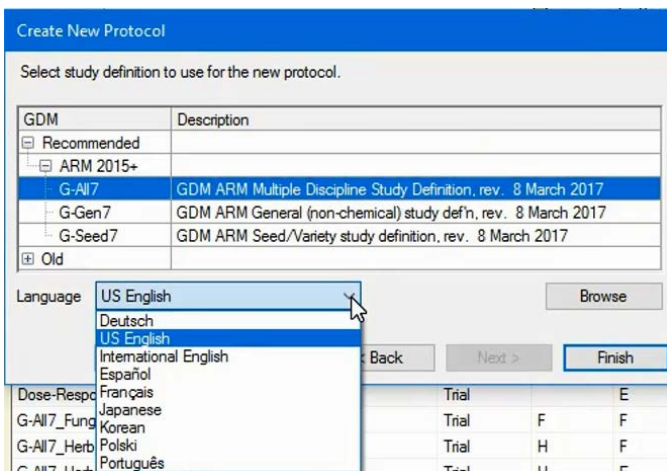
First, select File, then New Protocol.
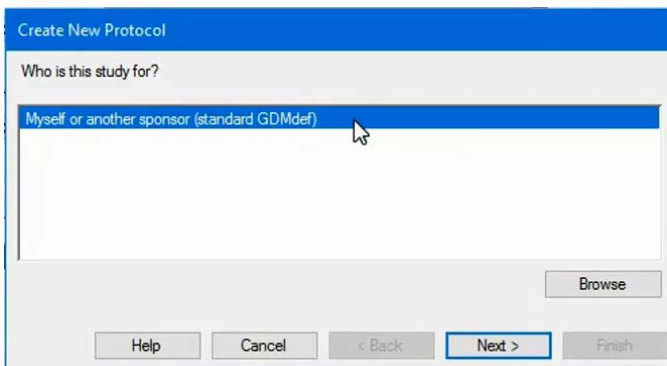
Next, select which company the study will be for. Any corporate customizations that have been installed are listed here.

If not using a corporate customization, then select 'Myself or another sponsor (standard GDMdef)'.

Now we will select the study definition to use. The G-All definition is suitable for chemical, fertilizer, and seed variety trials, so is the recommended choice for nearly all studies.

You can also select the language to display the data entry field prompts and tooltips in.

Click Finish to move to the next step.
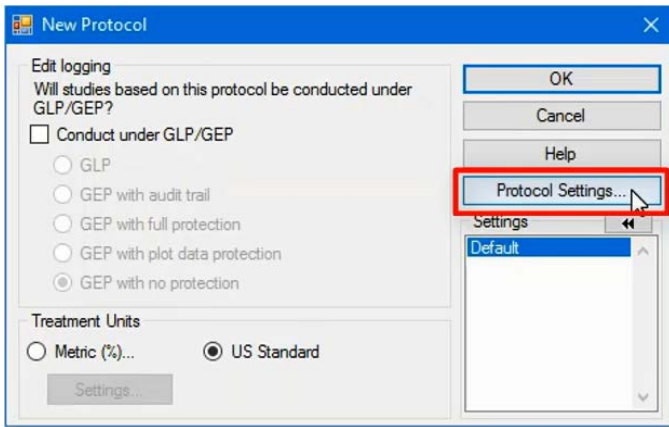
The New Protocol dialog is where you can turn on GLP or GEP for the study, and set what units are available on the Treatments editor.

The most important step in this process is to select the Protocol Settings button, *before* creating the protocol. This way the Treatments editor will be set up for factorial or split plot design from the beginning.
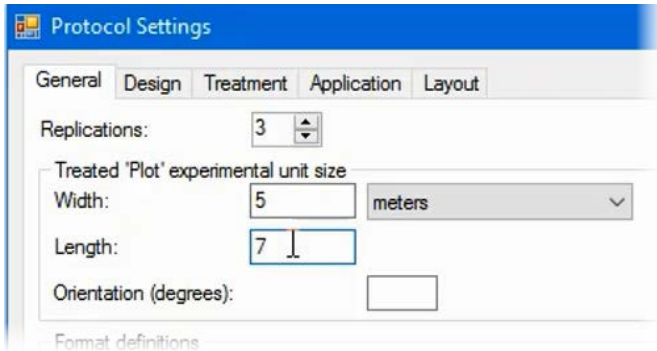
On the General tab, you can set the number of reps for the study, as well as the treated plot dimensions. These can also be changed later in the protocol, if necessary.
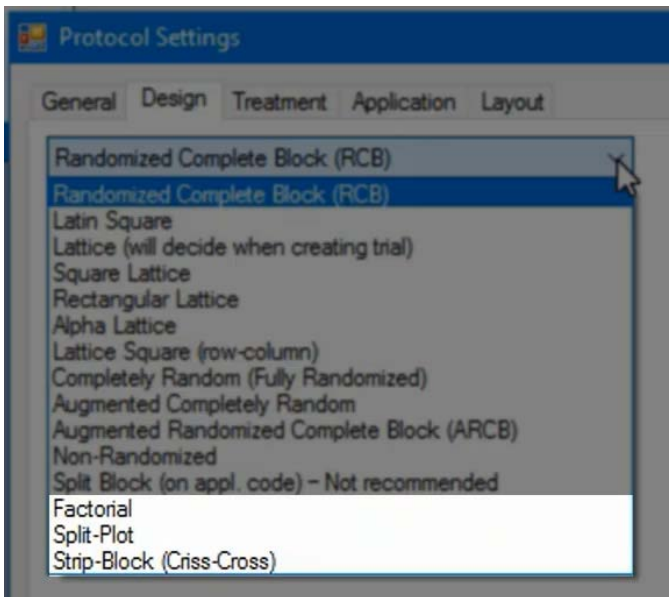
The Design tab sets the experimental design of the study. The three multi-factor designs are: Factorial, Split-Plot, and Strip Block (Criss-Cross).

The Factorial design is the standard multi-factor design, wherein all treatments are randomly distributed throughout each replicate.

The Split-Plot design is a specific type of Factorial design, where the main units (the Tillage methods in this example) are randomized within the replicate, then the subunits (the different herbicides in this example) are randomized within each main unit.

In this example, we will use the Split-Plot design.
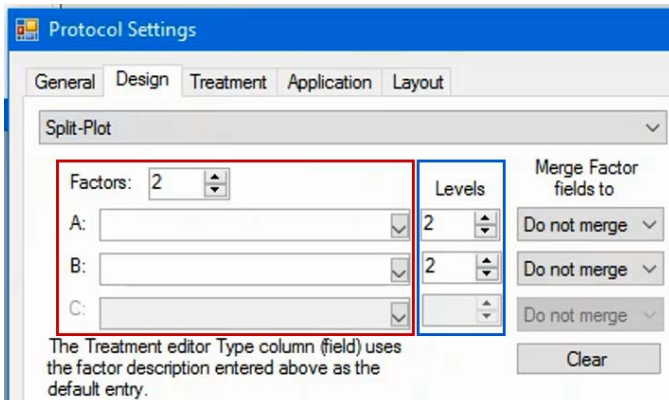
There are two important, but sometimes confusing, terms associated with multi-factor studies.

"Factors" are the main categories, or groups, that are being studied, such as product rate, irrigation timing, or tillage method.

"Levels" are the different items to test within each category or Factor, like the specific tillage methods or herbicides to test.
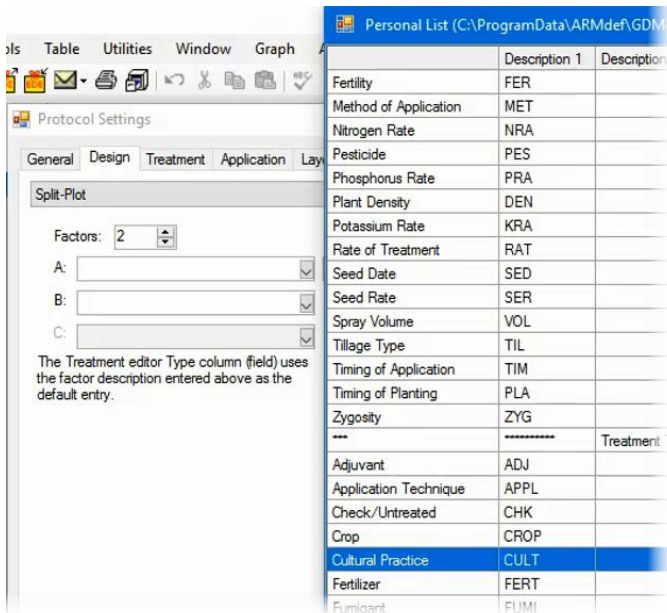
The drop-down list for Factor Description contains two sections. The first contains common factor descriptions.

The second half of the list contains the available Treatment Type values from the Treatments editor. ARM will auto-fill the Treatment Type field on the Treatments editor if one of these items are selected.

Since Tillage Method is the main factor, we will select 'Cultural Practice' for Factor A.
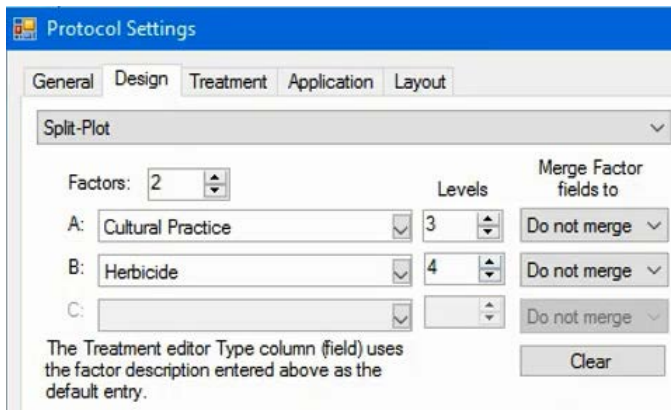
Then specify the number of distinct items or Levels that will be tested within the factor. In this example, there are 3 different Tillage methods we are interested in.

There are 4 different Herbicides that are to be tested within each tillage method.

The rest of the Settings can be changed as needed, once the protocol has been established, so press OK to close the Settings dialog.

Press OK on the New Protocol dialog to create the protocol.

On the Treatments editor, there are 3 sections to enter treatment information.

The first section defines the levels of Factor A, which will be our Tillage Methods. Each level has its own treatment number, but these numbers serve only to separate the levels. ARM will reassign all treatment numbers during randomization.

The second section defines the levels for Factor B, which will be our Herbicides. Note that the Type field has been filled in by default, based on the Factor Description entered in Settings, and the treatment numbers start over at 1 for each section.

To view the Rate Unit validation list, press the F9 key, or select the dropdown button in the field.

Type the letters 'L B' to automatically scroll the list to the unit that begin with those characters. Then select the desired unit and click OK.

Then, fill in the rest of the Factor B levels.

Use the single quote keyboard shortcut to copy the value in the cell immediately above.

The third section defines comparison treatments.

Comparison treatments are not part of the multi-factor design, and are ignored for a Factorial AOV summary report. Example comparison treatments are a commercial standard product included as a reference, or an untreated check.

Split-Plot trial

Now let's view a Split-Plot trial, to see how the treatments are randomized and built. We have created a trial from the previous protocol, and are viewing the Treatments editor.

In a Factorial trial, there are two special treatment columns.

The **Factor ID** column lists which *Factor* or *group* the particular treatment line comes from. In ARM, factors are identified by Letters. Factor A is the main unit, and Factor B is the sub-unit, in a Split-Plot.

The **Level Number** column lists which *level* or *item* is being tested within the factor. In ARM, levels are identified by numbers. Level 1 is the first item specified for that Factor back in the protocol, Level 2 is the second, and so on.

To see how the full treatment list is built when creating a trial, let's compare with what was entered in the protocol.

Each level of Factor A is paired with each level of Factor B - a multiplicative effect that yields 3 times 4, or 12 treatments in the trial.

Treatment 1 contains the first level of Factor A and the first level from Factor B. Treatment 2 contains level 1 of Factor A, but level 2 from Factor B. Treatments 3 and 4 follow the same pattern, using the third and fourth herbicides, respectively.
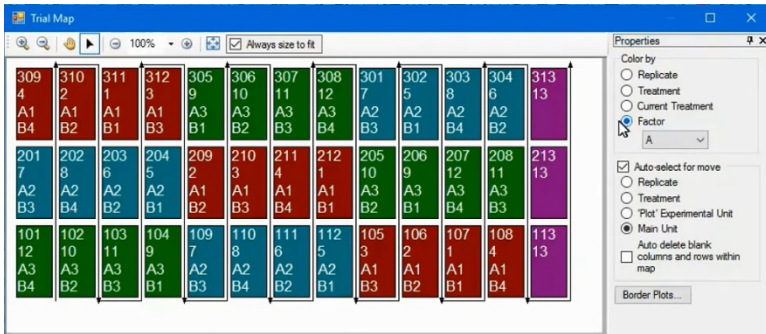

Next, treatment 5 contains Tillage Method number 2 and the first Herbicide. Then treatments 6 through 8 are built with the second level of Factor A, and the remaining levels of Factor B.
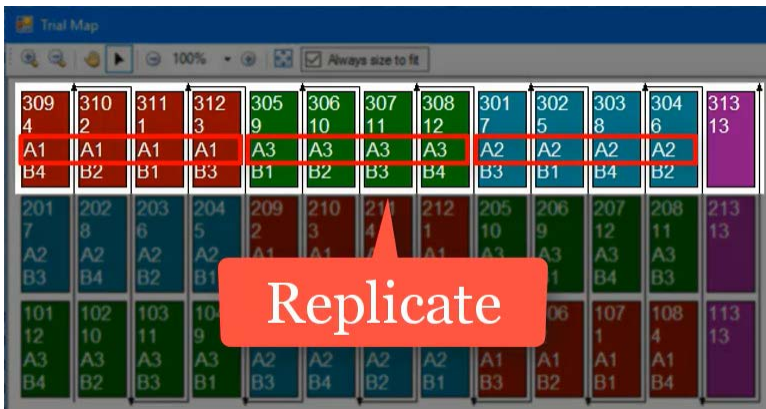
Treatments 9-12 contain the third level of Factor A with each level of Factor B.

Finally, any Comparison treatments are found at the bottom of the treatment list.

To see what separates the Split-Plot design from a regular Factorial study, open the Trial Map.

Select Color by - Factor A to color the main units on the Trial Map.

In a Split-Plot trial, the main units (labeled as Factor A) are randomized within the replicate,

then the subunits (labeled as Factor B) are randomized within each main unit.
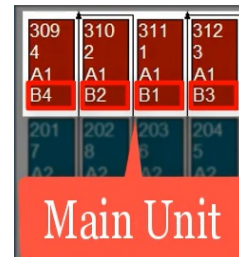
If all treatments should be randomly distributed throughout each replicate, then use the Factorial design instead.

Note that the comparison treatment was simply inserted at the end of each replicate.