A Two-Phase Potato Storage Experiment

(Prof. Roger Payne, IACR-Rothamsted, kindly provided this experiment.) This two-phase experiment consists of field and storage phases. In the field phase four cultivars of potatoes and three fungicides are investigated using a randomized complete block design with three blocks each with 12 plots. At the storage phase, the produce from each of the 36 plots is divided into four samples for storage on four pallets and the produce on a pallet is to be stored for one of four different lengths of time. Altogether, there are 12 pallets on each of 12 benches. The task is to randomize the 144 samples so that the three blocks by four cultivars are randomized to the 12 benches and the three fungicides with their four samples for that bench are randomized to the 12 pallets within each bench. Finally the four times of storage are randomized to the pallets within each bench-fungicide combination. Formally, we identify sets of plots within each block that have the same cultivar and set up a pseudofactor that indexes these sets. Similarly we create a pseudofactor that indexes the sets of plots in each block that received the different fungicides. It turns out that the two pseudofactors have the same levels for each analysis as Cultivars and Fungicides, respectively. However, most importantly, the pseudofactors differ from the factors in being nested within Blocks. The pseudofactors are used in achieving the desired randomization of the 144 samples to the 144 benches as descried below.

Like the two-phase experiment wheat variery trial, this experiment involves r-inclusive randomizations. In this case, r-inclusive randomizations need to be employed because plots within blocks: (i) had treatments randomized to it in the first randomization; and, (ii) is to be randomized to benches and to positions within benches in the second randomization. This experiment also has in common with the two-phase corn gernination experiment that treatments are introduced in both the first and second phases. The sets for this experiment are pallets, samples, treatments and times and the tiers are $\mathcal{F}_{\text{pallets}} = \{\text{Benches}, \text{Pallets}\}$, $\mathcal{F}_{\text{samples}} = \{\text{Blocks}, \text{Plots}, \text{Samples}\}$, $\mathcal{F}_{\text{treatments}} = \{\text{Cultivars}, \text{Fungicides}\}$ and $\mathcal{F}_{\text{times}} = \{\text{Times}\}$. There are three randomizations: treatments to samples, samples to pallets and times to pallets. They are illustrated in the randomization diagram for this experiment given in Figure 1. The first and second randomizations are r-inclusive and the second and third are u-inclusive. The randomization of samples to pallets involves both treatments and samples factors and so the randomized factors for the second randomization involve both tiers from the first randomization. The randomization of the times is to the pallets within each bench-fungicide combination, so the unrandomized factors for the third randomization come from $\mathcal{F}_{\text{treatments}}$ and $\mathcal{F}_{\text{pallets}}$.

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Note the two pseudofactors, P_C and P_F, in Figure 1. They are nested within Blocks and index the partitions of the Plots with Blocks that correspond to Cultivars and Fungicides, respectively. In randomizing the samples to pallets, the levels of Benches and Pallets are listed in standard order and the levels of the rest of the factors in the experiment are listed in standard order according to the levels of Blocks, Samples and the pseudofactors.
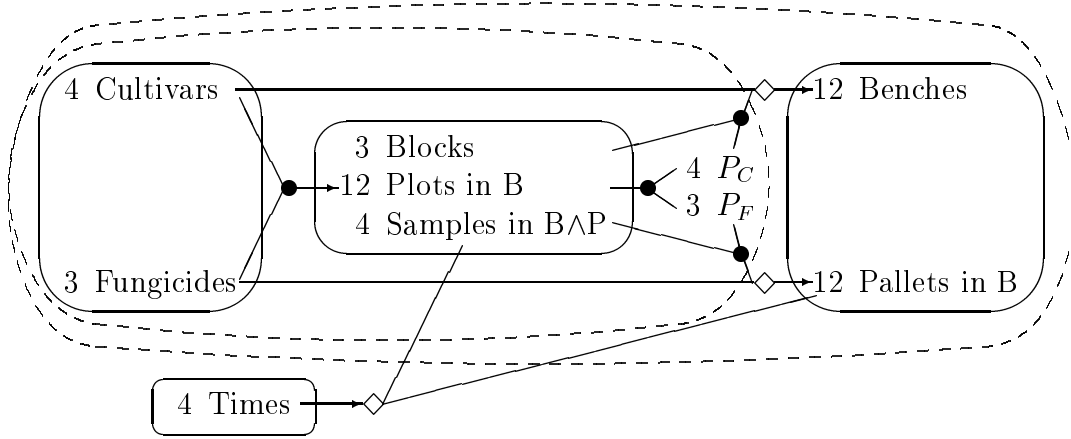

Figure 1: Unrandomized- and randomized-inclusive randomizations in the potato storage experiment