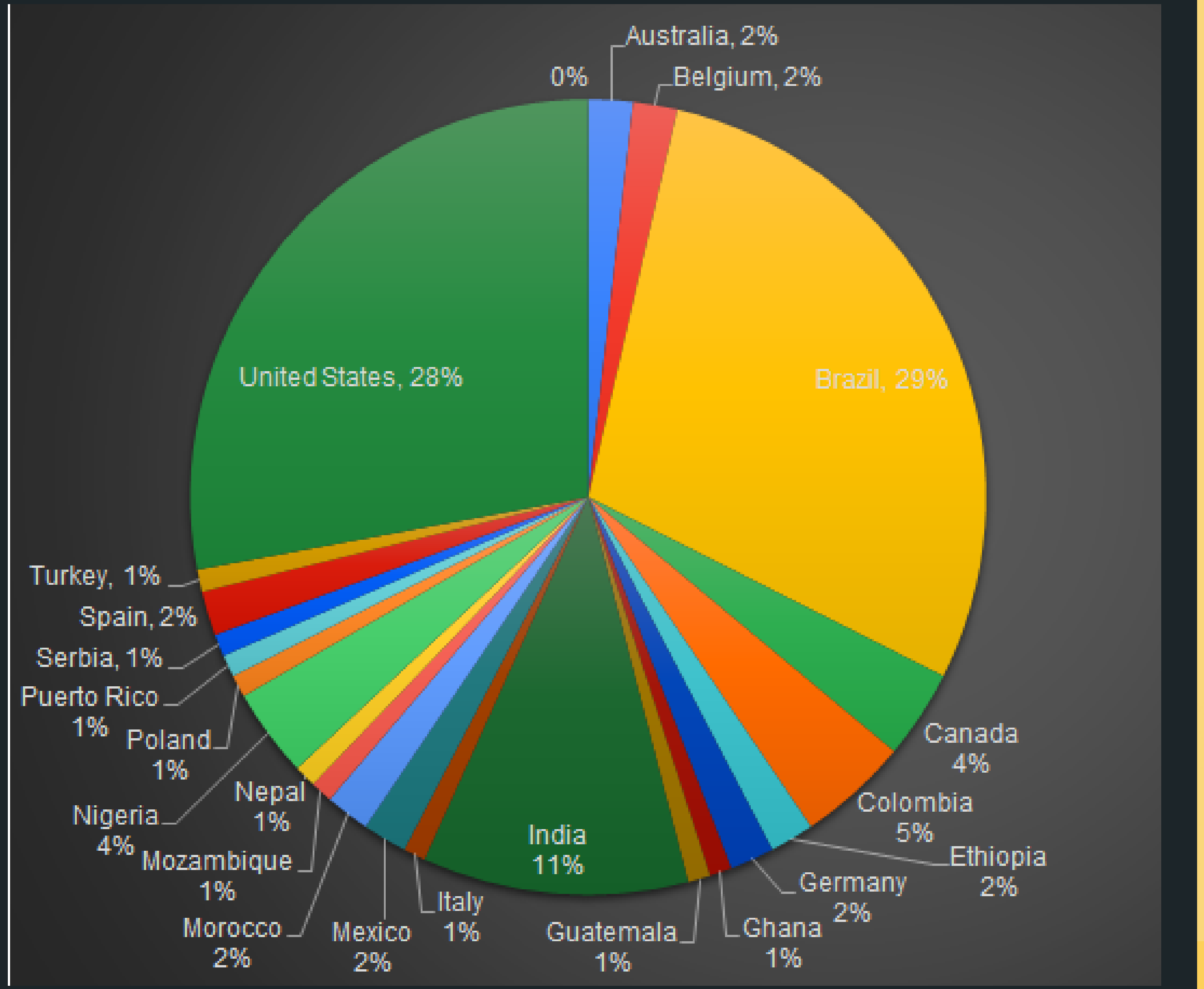
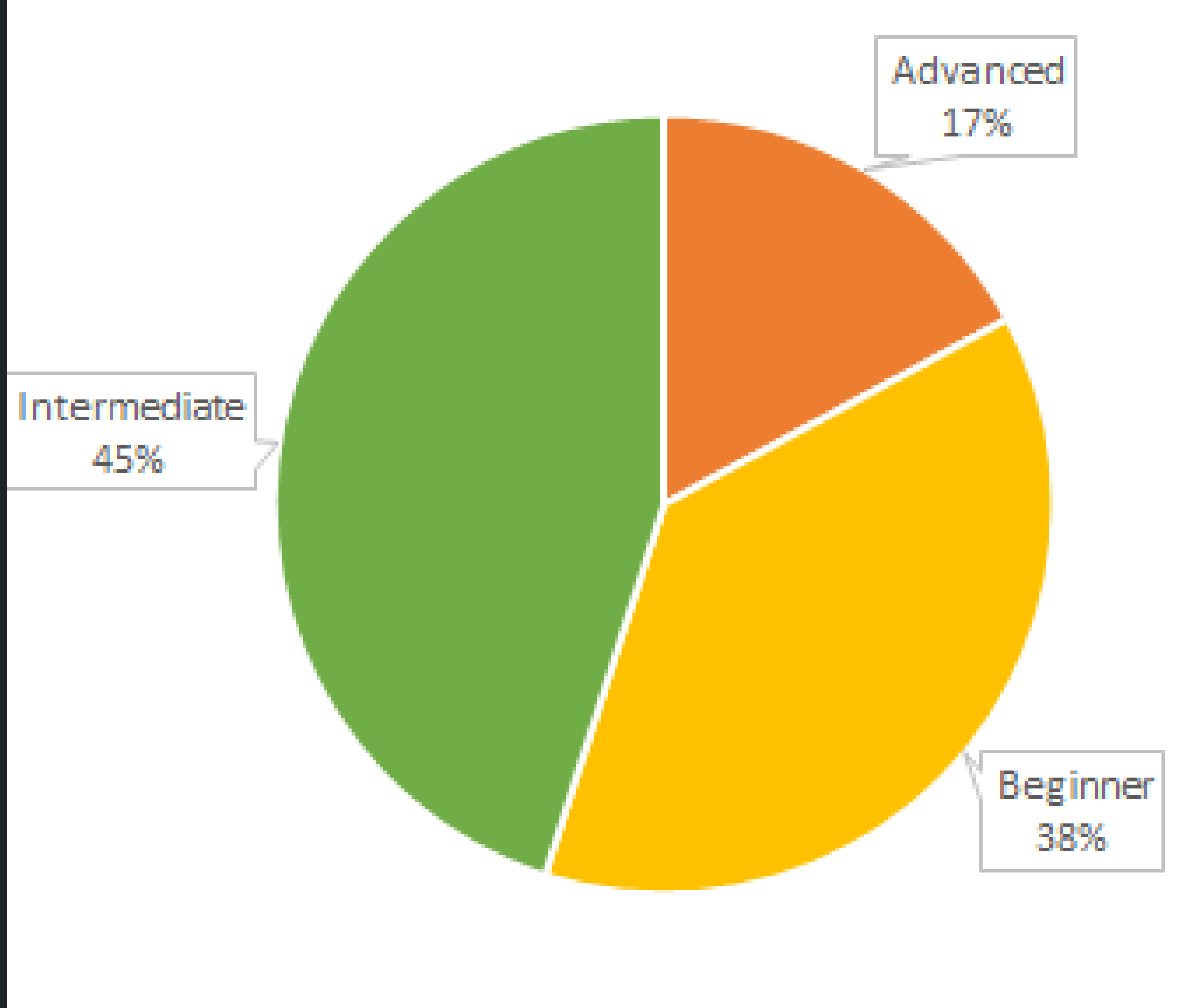

FielD·Hub
Field Design Solutions Software

SURVEY RESULTS



COUNTRY



DOE KNOWLEDGE

NDSU PLANT SCIENCES

Alliance

Bioversity International

CIAT

International Center for Tropical Agriculture

Since 1967 Science to cultivate change

THE PRESENTERS

FielD·Hub

Field Design Solutions Software

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R-Shiny Developer

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https://photos.ifas.ufl.edu/

THE PRESENTERS

FielD·Hub

Field Design Solutions Software

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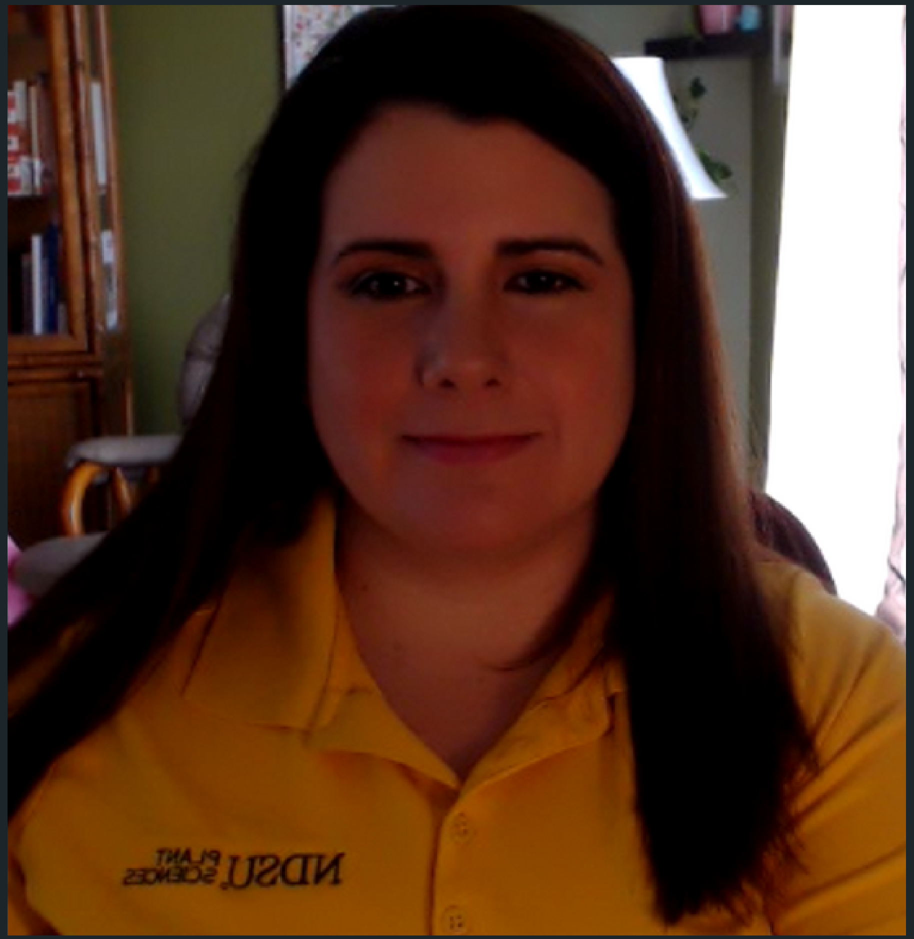


ANA MARIA HEILMAN

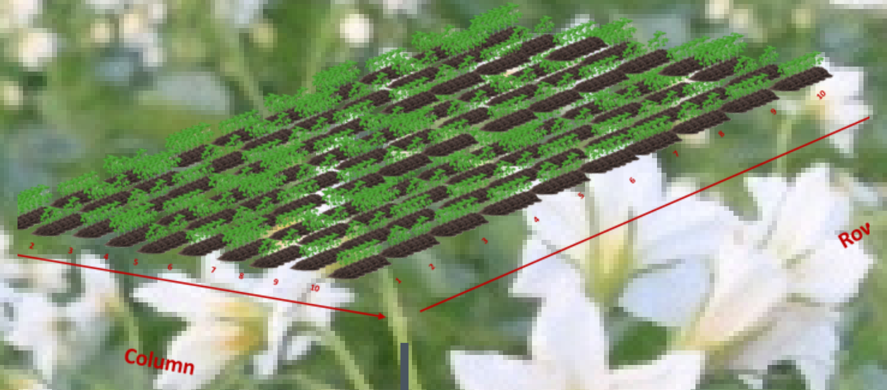
BPD MANAGER

MODULES **INPUTS** **DESIGN** **OUTPUTS**

Options: Augmented, spatial, and frequently used designs with a visual output capability built in.
Examples: Preloaded data option to demo functionality and output results.

Datasets: Input values and standardized forms.
Customized Options:
 Reactive interface responding to input values generate personalized output columns and views.

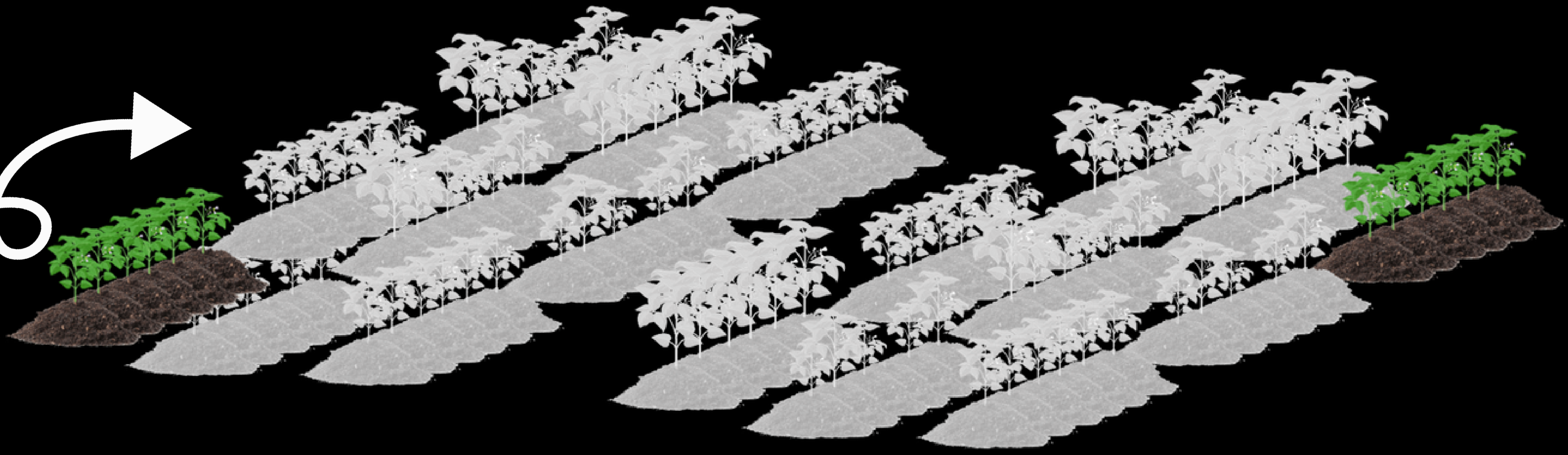
Experiments: Randomization and replication are two conditions followed by each experimental procedure.
Layout: Blocking and randomization of treatments produce standard arrangements and maps.



Maps: Spatial designs provide different map options with row and column coordinates.
Output Files: CSV.
Simulations: All designs have an option to generate values for a given response variable and design.

Optimize Results, Resources & the Experimental Analysis

FIELD DESIGN 101



HOW CAN YOU IMPROVE YOUR EXPERIMENT RESULTS?

FIELDHUB IN A NUTSHEL

APP DOWNLOAD

Download the Stable version using the R CRAN.

```
install.packages("FielDHub")
```

LAUNCH THE APP

Easy to run, just call the app using the following two lines of code using R Studio.

```
library(FielDHub)
run_app()
```

USE THE SHINY GUI

Point and click interface, plus its reactive interface makes it fast and convenient.

STANDALONE FUNCTIONS

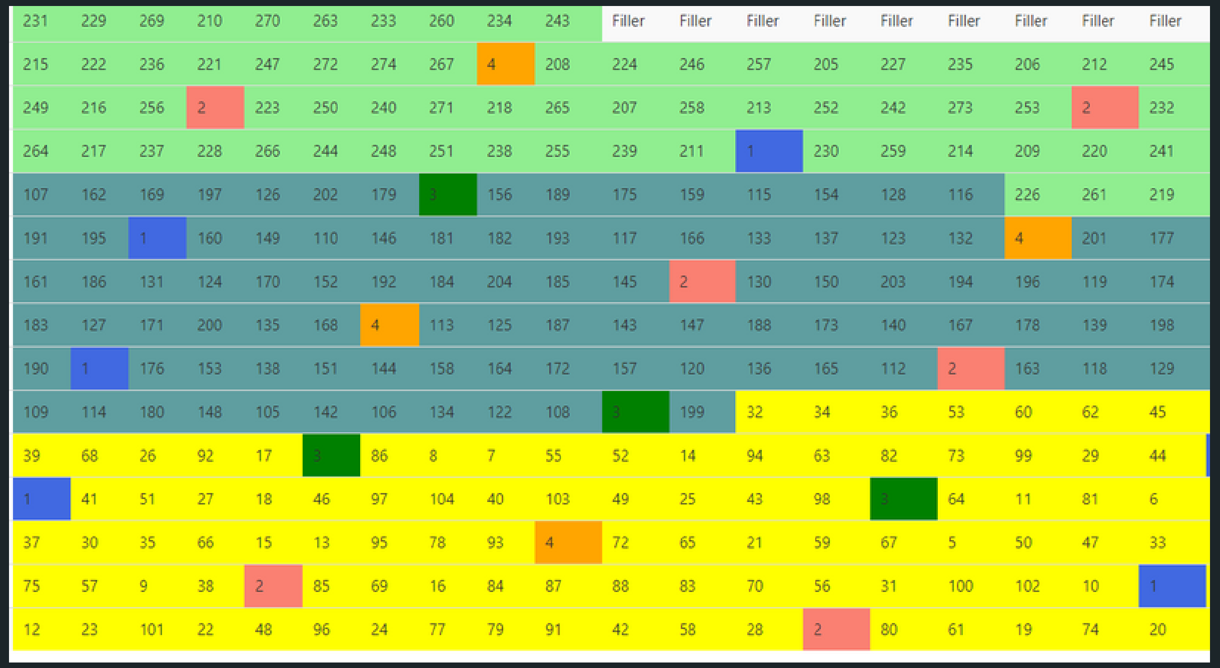
For intermediate or advance users that love coding, here is the option for you. Check it out!

EDUCATION & RESEARCH ORIENTED

Easy to use to demo randomization, simulation, and other statistics concepts.

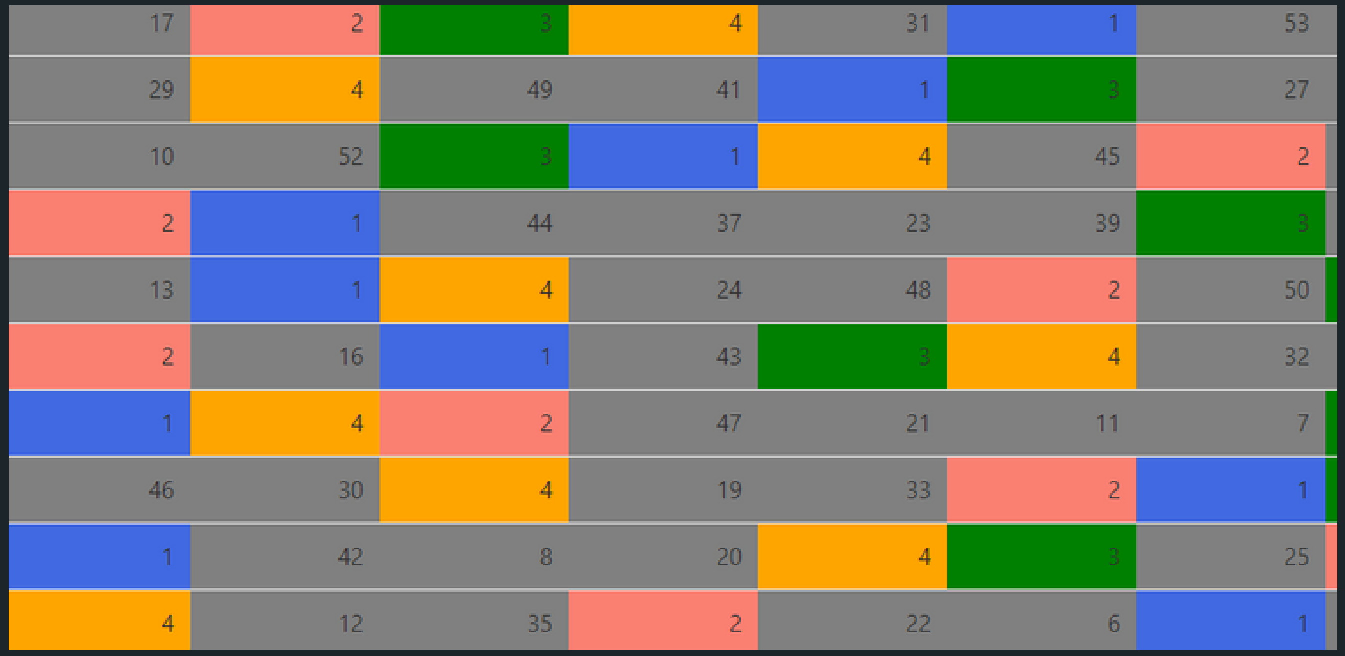
FielDHub: The DOE App

Complex Designs



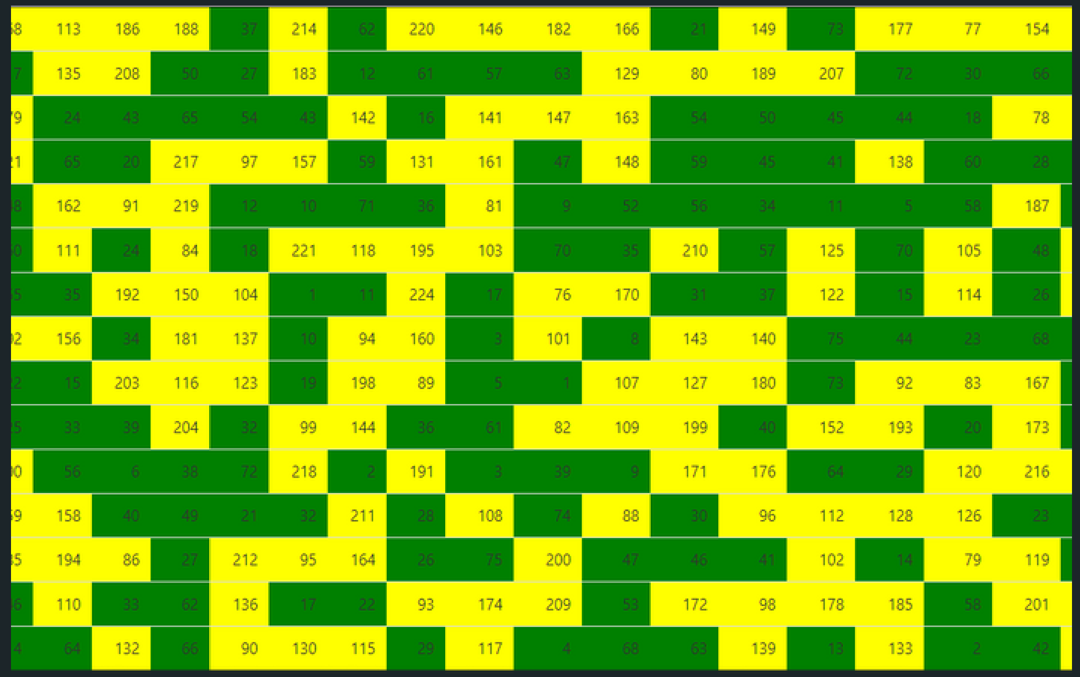
UNREPLICATED DESIGNS

Repeated checks on diagonals with experimental lines being unreplicated



AUGMENTED

Checks are replicated in each block and experimental lines can be replicated or unreplicated



P-REPS

A proportion of the test/experimental entries are replicated n times at each location

DOE LEARNING CENTER

FIELDHUB
V 0.1.0

Basic Review

GENERAL DESIGN CONCEPTS

OBJECTIVE OF AN EXPERIMENTAL DESIGN:

To evaluate and compare the response of several conditions or circumstances of interest.

- Treatments
- Experimental units
- Random or background noise
- Research hypothesis

RANDOMIZATION:

It ensures that treatments are assigned without bias to the different experimental units.

REPLICATION:

It allows us to increase the precision of the experiment by observing the effect of a treatment several times, and also by separating background noise from the real treatment effect.

BLOCKING:

It provides control, up to a certain degree, of environmental variation by grouping similar units together.

RANDOMIZED COMPLETE BLOCK DESIGN

RCBD

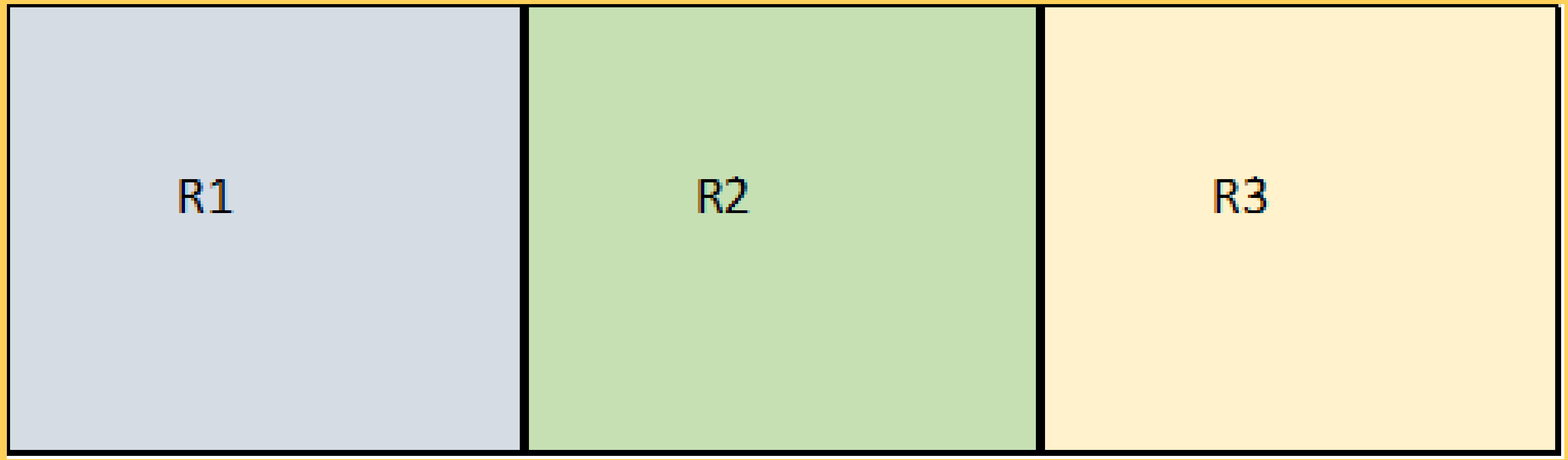
- Each of the v treatments occurs once in every block (or replicate), and the number of units per block, k, is constant and equal to the number of treatments ($v = k$).
- Advantage: balanced dataset, i.e. all treatment comparison has the same precision.

Note: Because all treatments are present in each block, this complete set is sometimes called full replicate.

RANDOMIZED COMPLETE BLOCK DESIGN

RCBD

- Consider a study where we want to design an experiment with v = 24 treatments, where each will be replicated r = 3 times. The field available has the following shape.



RANDOMIZED COMPLETE BLOCK DESIGN

RCBD

- Consider a study where we want to design an experiment with v = 24 treatments, where each will be replicated r = 3 times. The field available has the following shape.

And the generated design is:

1	17	9	4	18	8	14	19	9	11	8	18
15	10	16	18	3	10	9	6	2	7	23	12
11	3	5	24	22	21	7	16	3	17	15	10
8	12	19	22	24	1	13	15	20	4	13	19
20	21	23	2	4	12	23	11	14	5	1	16
14	6	13	7	5	2	20	17	24	22	21	6

In a Nutshell

DEMO FieldHub - RCBD

CLASSES OF IB DESIGNS

- Lattice designs: these designs are resolvable. Their advantage is that they require fewer replications than many of the balanced designs.
- Square Lattice designs: also resolvable designs but with the condition that the number of treatments v, follows v = s^2, that there are only 2 plots per block (k = 2) and the treatments are arranged in an s x s array.
- Alpha designs: resolvable designs with v = k x s treatments, for which there is no limitation on block size other than that v / k must be an integer.
- Cyclic designs: designs generated through the use of an initial block. They exist for any combination of design parameters where b x k = v x t.

INCOMPLETE BLOCK DESIGNS

ALPHA LATTICE: ALPHA(0,1)

- When several treatments are evaluated, blocks can become quite large, and experimental units within the block are no longer homogeneous.
- Smaller experiment must be planned and some treatments dropped, or, alternatively, only a subset of the treatments should be included in each block.
- Alpha design corresponds to resolvable designs that are obtained using cyclical methods.
- Usually they are not the best possible design, but because of the efficiency of its algorithm they can generate complex designs in a short period of time.
- Particularly recommended in cases where the number of treatments is large.

ALPHA LATTICE: ALPHA(0,1)

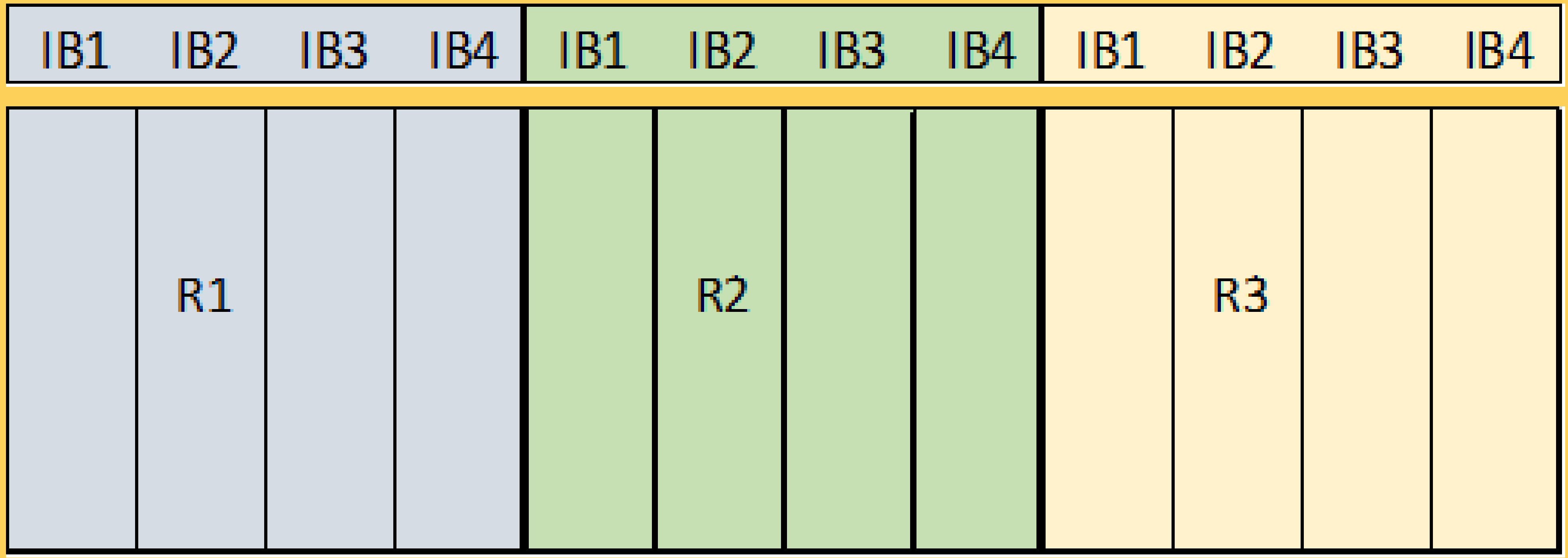
v = 24 number of treatments

k = 6 number of units per block

r = 3 number of replications of each treatment

b = 12 number of blocks (b = r x v / k)

c = 0,1 (0.65) number of times that a pair of treatments occurs together in the same block



INCOMPLETE BLOCK DESIGNS

ALPHA LATTICE: ALPHA(0,1)

IB1	IB2	IB3	IB4	IB1	IB2	IB3	IB4	IB1	IB2	IB3	IB4
8	20	24	12	22	9	11	10	22	3	16	4
10	15	2	22	19	5	15	7	14	24	2	13
5	18	23	4	4	13	16	17	5	9	23	8
11	14	19	17	23	24	8	20	20	18	15	17
7	1	6	16	3	12	6	1	19	21	12	6
3	21	13	9	21	14	18	2	11	7	10	1

INCOMPLETE BLOCK DESIGNS

In a Nutshell

DEMO FieldHub - Alpha Design (0,1)

AUGMENTED RCBD

- An Augmented Design is any standard design augmented with additional treatments in the complete block, incomplete block, row, the column, etc. (Federer, 1961).
- Checks are analyses to estimate the error variance, that is later used for comparing the treatment levels.
- Consider an example with: 4 checks and 3 replicates, that is augmented to three blocks of size 6x4.

4	2	4	3	3	4
1	3	2	1	1	2

AUGMENTED RCB DESIGN

AUGMENTED RCBD

- Consider an example with: 4 checks and 3 replicates, that is augmented to three blocks of size 6x4.

4	2	4	3	3	4
1	3	2	1	1	2

12 CHECK PLOTS (REPLICATED)

60 TEST PLOTS (UNREPLICATED)

4	42	41	19	63	4	2	23	3	10	21	54
59	18	17	44	35	6	51	47	1	25	30	13
57	7	2	36	60	64	52	27	55	53	56	16
20	12	50	3	43	29	3	46	24	38	4	2
5	26	62	22	45	37	49	61	39	14	28	58
11	1	31	32	34	48	1	9	15	8	33	40

AUGMENTED RCB DESIGN

In a Nutshell

DEMO FieldHub - Augmented RCBD

BASIC INFORMATION

- Designs where a large number of entries are unreplicated together with a group (usually 3 or 4) check genotypes that are replicated in order to capture and model potential field effects.
- They enable the evaluate a large number of genotypes (entries) on those cases with limited quantities of seed.
- Several arrangements exists: random, diagonal, optimized

UNREPLICATED DESIGN

UNREPLICATED DIAGONAL DESIGN

BASIC INFORMATION

- Consider an example with: 4 checks and 3 replicates, that is augmented to a single block of size 6x12.

  Total # of Plots: 72

  # of Checks: 4 (replicated 3 times)

  # of Test Entries: 60 (unreplicated)

46	3	18	51	49	9	36	1	20	55	21	16
1	23	24	56	57	8	3	53	38	31	40	14
7	25	44	61	5	2	30	54	37	26	22	2
60	17	15	47	2	34	41	62	33	59	3	29
42	28	52	4	13	39	6	50	19	4	48	58
45	12	4	32	64	35	63	11	1	43	27	10

In a Nutshell

DEMO FieldHub - Unreplicated Design

OPTIMIZED ARRANGEMENT (DISTANCE BETWEEN CHECKS IS MAXIMIZED)

Total # of Plots: 72

# of Checks: 4 (replicated 3 times)

Total Check Plots: 12 (4 x 3)

Check Reps: 3,3,3,3 (allows for unequal)

of Test Entries: 60 (unreplicated)

37	11	19	49	30	64	42	1	14	2	20	9
35	51	4	25	33	61	8	34	21	60	26	2
3	16	54	40	15	27	36	7	31	23	4	6
56	44	5	1	62	45	3	47	58	50	29	43
18	4	48	46	13	2	10	57	28	63	17	55
52	41	59	22	3	12	38	32	1	39	24	53

UNREPLICATED OPTIMIZED DESIGNS

In a Nutshell

DEMO FieldHub - Unreplicated Optimized

PARTIALLY REPLICATED (P-REPS)

BASIC INFORMATION

- Designs where the replicated entries (usually 2 or 3 replicates depending on seed availability) are used in place of the check genotypes, and the rest of the plots are considered for a number of unreplicated genotypes.

Total # of Plots: 72

# of Entries per replicated group: 24, 24

# of Replicates per group: 2, 1

35	27	24	38	1	3	8	1	6	18	41	42
40	24	19	9	45	20	8	48	22	16	13	23
7	5	14	37	44	29	26	20	46	10	19	18
21	4	30	2	16	3	36	10	11	12	32	15
17	34	28	22	12	4	14	47	43	31	7	23
21	6	2	5	11	33	9	17	15	39	13	25

In a Nutshell

DEMO FieldHub - P-Reps

DEMO FIELDHUB R SCRIPTING

Didier Murillo, R-Shiny Developer NDSU

DESIGN OF EXPERIMENTS APP

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STATISTICAL ANALYSIS

GENERAL COMMENTS

- Appropriate model associated with the randomization strategy is always the best alternative.
- Linear models need to be correctly specified:
  - Random effects for incomplete blocks
  - Spatial components are always preferred
- Additional flexibility exists for Multi-Environmental Trials, where unreplicated designs are useful for overall estimation for genetic effects, but these are not good for estimation of GxE.

STATISTICAL ANALYSIS

GENERAL COMMENTS

Resolvable IB design

$$y = \mu + rep + rep.block + entry + \varepsilon$$

- rep random or fixed full replicate effect
- rep.block random block effect within full replicate
- $\varepsilon \sim MVN(0, AR1 \times AR1)$

STATISTICAL ANALYSIS

GENERAL COMMENTS

To replicate or not to replicate

- Replication is a basic principle in DOE to have a reasonable estimate of background noise (also to model error trends)
- Poor (or no replication) translates into large SEs and CIs, and therefore it will ALWAYS affect statistical inference.
- Breeding decisions (selections) need to always consider balance accuracy of estimates with their cost and relevance.

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QUESTIONS?

Thank You