

## Study Design

BMS 13.0-14.0 Manual

- About
- Randomized Complete Block Design

Resolvable Incomplete Block Design (Alpha Lattice)

Row-And-Column Design

Augmented Randomized Block Design

P-Rep Design (Beta)

Error Message Troubleshooting
- Entry List Order (Non-Randomized)

Import Custom Design

Template

Ontology Mapping
- Related

## About

The BMS will generate several different study designs. Randomized designs are created via ASreml design engine, a proprietary element of the BMS. When you run a design, the system checks the license via internet. If you experience an error message about a missing license, please contact your system administrator. Checks can be included in study designs (see more about checks under [Study Germplasm](#)). The BMS will accept any design via import of design .csv file (see more below).

BREEDING ACTIVITIES

Manage Germplasm

Manage Studies

Manage Samples

INFORMATION MANAGEMENT

STATISTICAL ANALYSIS

PROGRAM ADMINISTRATION

VIGNA VIVA

Site AdminMy Programs?Shawn

MANAGE STUDIES

v12 Sub-Obs Calc Stage

Save

Return to Manage Studies

Actions

SettingsGermplasm & ChecksTreatment FactorsEnvironmentsExperimental DesignObservations

Experimental Design

CHOOSE A DESIGN TYPE

Select the design type you would like to use for this study:

Or import an experimental design.

SPECIFY PLOT NUMBERING

Specify the starting plot number: 1

Please Choose

Please Choose

Randomized Complete Block Design

Resolvable Incomplete Block Design

Row-and-Column

Augmented Randomized Block design

Entry list order

P-Rep Design

### Design Summary Table

Design	Randomized	Checks	Additional Constraints
Randomized Complete Block	yes	Checks are replicated & randomized like test entries.	-
Resolvable Incomplete Block (alpha lattice)	yes	Checks are replicated & randomized like test entries.	<ul style="list-style-type: none"> <li>Number of germplasm cannot be prime.</li> <li>Block size must be greater than 1 and a common denominator of the number of germplasm.</li> </ul>
Row & Column	yes	Checks are replicated & randomized like test entries.	<ul style="list-style-type: none"> <li>Number of germplasm cannot be prime.</li> <li>The number of rows per replication multiplied by the columns per replication must equal the number of germplasm per replication.</li> </ul>
Augmented Randomized Block	yes	Checks are replicated. Test entries are not.	<ul style="list-style-type: none"> <li>At least one check must be specified.</li> <li>Block number must be a common denominator of the number of test entries.</li> </ul>
P-Rep	yes	Checks are replicated. Only a specified portion of test entries are replicated.	<ul style="list-style-type: none"> <li>At least one check must be specified.</li> <li>The number of blocks must be a common denominator of the number of plots.</li> </ul>
Entry List Order	no	Checks positions can be specified in uniform positions.	-

## Randomized Complete Block Design

The simplest blocked design is the Randomized Complete Block (RCB) design. In this design 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 ( $v = k$ ). These characteristics result in a balanced dataset, and therefore, any treatment comparison has the same precision. Treatment factors can be added to RCB designs (see more [Treatment Factors](#)).

- Select Randomized Complete Block design as the experimental design. Enter the number of desired replications and select Generate Design.

The screenshot shows the 'MANAGE STUDIES' interface for 'MC PROGRAM'. The 'Design Types' tab is active, showing 'BASIC DETAILS'. The 'Experimental Design' section is expanded, displaying the following configuration:

- CHOOSE A DESIGN TYPE:** A dropdown menu is set to 'Randomized Complete Block De...'. A help icon (?) is visible.
- SPECIFY PLOT NUMBERING:** A field for 'Specify the starting plot number:' is set to '1'.
- SPECIFY DESIGN PARAMETERS:** A field for 'Number of replications:' is set to '3'. A 'Generate Design' button is located below this field.
- SUMMARY OF DESIGN DETAILS:**
  - Number of environments: 2
  - Number of treatments: 247
  - Replicate factor: REP\_NO
  - Plot factor: PLOT\_NO
- Treatment factors:** A table is shown with the following data:

NAME	DESCRIPTION	# LEVELS
ENTRY_NO	Germplasm entry - enumerated (number)	247

After receiving a success message, the Measurements table is now populated with a randomized complete block design.

BREEDING ACTIVITIES

Manage Germplasm

Manage Samples

Manage Studies

INFORMATION MANAGEMENT

STATISTICAL ANALYSIS

PROGRAM ADMINISTRATION

MC PROGRAM

Site Admin

My Programs

admin

MANAGE STUDIES

Design Types

Save

Return to Manage Studies

Actions

Settings

Germplasm & Checks

Environments

Experimental Design

Measurements

Define Measurement Details

Add

TRAITS

Name

Description

Input Variables

Please save the study to be able to edit measurements

Records per page: 100

Showing 1 to 100 of 1,482 entries

TRIAL_INSTANCE	ENTRY_TYPE	GID	DESIGNATION	ENTRY_NO	REP_NO	PLOT_NO
1	T	12179	UGW16179	179	1	1
1	T	12196	UGW16196	196	1	2
1	T	12111	UGW16111	111	1	3
1	T	12090	UGW16090	90	1	4
1	T	12106	UGW16106	106	1	5
1	T	12004	UGW16004	4	1	6
1	T	12028	UGW16028	28	1	7
1	T	12016	UGW16016	16	1	8
1	T	12074	UGW16074	74	1	9
1	T	12077	UGW16077	77	1	10
1	T	12054	UGW16054	54	1	11
1	T	12057	UGW16057	57	1	12
1	T	12093	UGW16093	93	1	13
1	T	12142	UGW16142	142	1	14
1	T	12182	UGW16182	182	1	15
1	T	12185	UGW16185	185	1	16
1	T	12118	UGW16118	118	1	17
1	T	12192	UGW16192	192	1	18
1	T	12147	UGW16147	147	1	19

1

2

3

4

5

# Resolvable Incomplete Block Design (Alpha Lattice)

In a resolvable Incomplete block design plots are grouped into blocks that are not large enough to contain all germplasm (treatments). Resolvable blocks are created by grouping incomplete blocks together, so that each treatment is replicated exactly once in each group or set. Number of germplasm cannot be prime. Block size must be greater than 1 and a common denominator of the number of germplasm.

- Select Resolvable Incomplete Block Design as the experimental design. Enter the number of desired replications. Enter the blocks size.

BREEDING ACTIVITIES

Manage Germplasm

Manage Samples

Manage Studies

INFORMATION MANAGEMENT

STATISTICAL ANALYSIS

PROGRAM ADMINISTRATION

MC PROGRAM

Site Admin

My Programs

admin

MANAGE STUDIES

Design Types

Save

Return to Manage Studies

Actions

Settings

Germplasm & Checks

Environments

Experimental Design

Measurements

Experimental Design

CHOOSE A DESIGN TYPE

Select the design type you would like to use for this study:

Resolvable Incomplete Block Des...

Or import an experimental design.

SPECIFY PLOT NUMBERING

Specify the starting plot number:

1

SPECIFY DESIGN PARAMETERS

Number of replications:

2

Block size:

13

Show advanced options

Generate Design

SUMMARY OF DESIGN DETAILS

Number of environments: 2

Number of treatments: 247

Number of blocks per replication : 19

Treatment factor: ENTRY\_NO

Replicate factor: REP\_NO

Block factor: BLOCK\_NO

Plot factor: PLOT\_NO

After receiving a success message, the Measurements table is now populated with a resolvable complete block design.

BREEDING ACTIVITIES

Manage Germplasm

Manage Samples

Manage Studies

INFORMATION MANAGEMENT

STATISTICAL ANALYSIS

PROGRAM ADMINISTRATION

MC PROGRAM

Site Admin

My Programs

admin

MANAGE STUDIES

Design Types

Save

Return to Manage Studies

BASIC DETAILS

Actions

Settings

Germplasm & Checks

Environments

Experimental Design

Measurements

Define Measurement Details

Add

Please save the study to be able to edit measurements

Records per page: 100 Showing 1 to 100 of 988 entries

TRIAL_INSTANCE	ENTRY_TYPE	GID	DESIGNATION	ENTRY_NO	REP_NO	BLOCK_NO	PLOT_NO
1	T	12214	UGW16214	214	1	1	1
1	T	12035	UGW16035	35	1	1	2
1	T	12143	UGW16143	143	1	1	3
1	T	12113	UGW16113	113	1	1	4
1	T	12114	UGW16114	114	1	1	5
1	T	12171	UGW16171	171	1	1	6
1	T	12121	UGW16121	121	1	1	7
1	T	12012	UGW16012	12	1	1	8
1	T	12010	UGW16010	10	1	1	9
1	T	12211	UGW16211	211	1	1	10
1	T	12205	UGW16205	205	1	1	11
1	T	12148	UGW16148	148	1	1	12
1	T	12045	UGW16045	45	1	1	13
1	T	12087	UGW16087	87	1	2	14
1	T	12055	UGW16055	55	1	2	15
1	T	12042	UGW16042	42	1	2	16
1	T	12149	UGW16149	149	1	2	17
1	T	12085	UGW16085	85	1	2	18

<

1

2

3

4

5

>

## Row-And-Column Design

When the heterogeneity is known or suspected in two directions (rows and columns), Row-and-Column (RC) designs can be used to group experimental units in two directions. The purpose of a RC design is to eliminate equally from the errors all differences among rows and among columns. Under these situations, the experimental material should be arranged and the experiment conducted so that the differences among rows and columns represent major sources of variation. **The number of germplasm cannot be prime. The number of rows per replication multiplied by the columns per replication must equal the number of germplasm per replication.**

- Select Row-And-Column Design as the experimental design. Enter the number of desired replications. Enter the number of row and columns within the replications. Generate Design.

BREEDING ACTIVITIES

Manage Germplasm

Manage Samples

Manage Studies

INFORMATION MANAGEMENT

STATISTICAL ANALYSIS

PROGRAM ADMINISTRATION

MC PROGRAM

Site Admin My Programs ? admin

MANAGE STUDIES

Design Types

Save

Return to Manage Studies

Actions

BASIC DETAILS

Settings Germplasm & Checks Environments Experimental Design Measurements

Experimental Design

CHOOSE A DESIGN TYPE

Select the design type you would like to use for this study: Row-and-Column

Or import an experimental design.

SPECIFY PLOT NUMBERING

Specify the starting plot number: 1

SPECIFY DESIGN PARAMETERS

Number of replications: 2

Number of rows in replications: 13

Number of columns in replications: 19

Show advanced options

Generate Design

SUMMARY OF DESIGN DETAILS

Number of environments: 2

Number of treatments: 247

Treatment factor: ENTRY\_NO

Replicate factor: REP\_NO

Row factor: ROW

Column factor: COL

After receiving a success message, the Measurements table is now populated with a Row-and-Column design.

BREEDING ACTIVITIES

Manage Germplasm

Manage Samples

Manage Studies

INFORMATION MANAGEMENT

STATISTICAL ANALYSIS

PROGRAM ADMINISTRATION

MC PROGRAM

Site Admin My Programs ? admin

MANAGE STUDIES

Design Types

Save

Return to Manage Studies

Actions

Settings Germplasm & Checks Environments Experimental Design Measurements

Define Measurement Details

Add

Please save the study to be able to edit measurements

Records per page: 100 Showing 1 to 100 of 988 entries

TRIAL_INSTANCE	ENTRY_TYPE	GID	DESIGNATION	ENTRY_NO	REP_NO	PLOT_NO	ROW	COL
1	T	12166	UGW16166	166	1	1	1	1
1	T	12176	UGW16176	176	1	2	1	2
1	T	12225	UGW16225	225	1	3	1	3
1	T	12160	UGW16160	160	1	4	1	4
1	T	12128	UGW16128	128	1	5	1	5
1	T	12103	UGW16103	103	1	6	1	6
1	T	12116	UGW16116	116	1	7	1	7
1	T	12205	UGW16205	205	1	8	1	8
1	T	12238	UGW16238	238	1	9	1	9
1	T	12148	UGW16148	148	1	10	1	10
1	T	12090	UGW16090	90	1	11	1	11
1	T	12163	UGW16163	163	1	12	1	12
1	T	12089	UGW16089	89	1	13	1	13
1	T	12227	UGW16227	227	1	14	1	14
1	T	12219	UGW16219	219	1	15	1	15
1	T	12131	UGW16131	131	1	16	1	16
1	T	12069	UGW16069	69	1	17	1	17
1	T	12101	UGW16101	101	1	18	1	18

1 2 3 4 5

## Augmented Randomized Block Design

Augmented Randomized Block Design is constructed using control or "check" entries for which there are sufficient seed to allow several replications (see more about checks under [Study Germplasm](#)). The number of available experimental plots in each replication may vary, but all of the checks are included at least once; the remaining plots are assigned to the new or "test" entries. Performance of the checks can be used to adjust the performance of the test entries to make them comparable across replications and to provide an estimate of experimental error so that valid statistical tests can be performed. **At least one check must be specified. Block number must be a common denominator of the number of test entries.**

- Specify Augmented Randomized Block Design and enter the number of desired blocks. Generate design.

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**MANAGE STUDIES** ?

Design Types Save

Return to Manage Studies Actions

Settings Germplasm & Checks Environments Experimental Design Measurements

Experimental Design

CHOOSE A DESIGN TYPE

Select the design type you would like to use for this study: Augmented Randomized Block d... ?

Or import an experimental design.

SPECIFY PLOT NUMBERING

Specify the starting plot number: 1

SPECIFY DESIGN PARAMETERS

Number of blocks: 35

Generate Design

SUMMARY OF DESIGN DETAILS

Number of environments: 2

Number of treatments: 247

Number of Test entries: 245

Number of Check entries: 2

Number of Test entries per block: 7

Number of plots per block: 9

Total number of plots: 315

Treatment factor: ENTRY\_NO

Block factor: BLOCK\_NO

Plot factor: PLOT\_NO

In this example, there are 2 check entries and 245 test entries. Factors of 245 (1,5,7,35,49) are options for block number in the experimental design.

After receiving a success message, the Measurements table is now populated with an augmented randomized block design.

## P-Rep Design (Beta)

**V13 P-rep functionality is under development. Proceed with caution using this functionality.**

Partially Replicated or P-Rep designs fully replicate check entries and a proportion of test entries in every study instance. Checks and test entries must first be specified under the Germplasm & Checks tab (see [Add Checks](#)). **At least one check must be specified. The number of blocks must be a common denominator of the number of plots.**

- Enter the percentage of test entries to replicate and the number of replications. Notice that the number of plots is calculated automatically. Enter the number of blocks and generate the design.

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**MANAGE STUDIES** ?

v12 Sub-Obs Calc Stage Save

Return to Manage Studies Actions

Settings Germplasm & Checks Treatment Factors Environments Experimental Design Observations

Experimental Design

CHOOSE A DESIGN TYPE

Select the design type you would like to use for this study: P-Rep Design ?

Or import an experimental design.

SPECIFY PLOT NUMBERING

Specify the starting plot number: 1

SPECIFY DESIGN PARAMETERS

% of test entries to replicate: 20 ?

Number of replications: 3 ?

Number of blocks: 4

Generate Design

SUMMARY OF DESIGN DETAILS

Number of environments: 3

Number of treatments: 100

Number of Test entries: 90

Number of Check entries: 10

Number of entries per block: 39

Total number of plots: 156

Treatment factor: ENTRY\_NO

Block factor: BLOCK\_NO

Plot factor: PLOT\_NO

- Review the P-rep design in the Observations table.



BREEDING ACTIVITIES

Manage Germplasm

Manage Studies

Manage Samples

INFORMATION MANAGEMENT

STATISTICAL ANALYSIS

PROGRAM ADMINISTRATION

VIGNA VIVA

Site Admin

My Programs

Shawn

MANAGE STUDIES

v12 Sub-Obs Calc Stage

Save

Return to Manage Studies

Actions

Settings

Germplasm & Checks

Treatment Factors

Environments

Experimental Design

Observations

Define Observation Details

Observations

Select Environment: 1 - Int Institute of Tropical Agriculture

Records per page: 100

Showing 1 to 100 of 156 entries

Show Categorical Description

ENTRY_TYPE	GID	DESIGNATION	ENTRY_NO	PLOT_NO	BLOCK_NO	Plt_Date	FlwT_Date	FlwT_Day	YLDPLOT
Test entry	1000114	DF16	25	1	1				
Test entry	1000112	DF14	24	2	1				
Test entry	1000116	DF18	28	3	1				
Test entry	1000154	DF56	66	4	1				
Check entry	1000097	CK-1	1	5	1				
Test entry	1000179	DF81	91	6	1				
Test entry	1000143	DF45	55	7	1				
Test entry	1000178	DF80	90	8	1				
Test entry	1000108	DF10	20	9	1				
Check entry	1000072	BMS-1	3	10	1				
Test entry	1000118	DF20	30	11	1				
Test entry	1000164	DF66	76	12	1				
Test entry	1000123	DF25	35	13	1				
Test entry	1000141	DF43	53	14	1				

## Error Message Troubleshooting

Error messages appear on the page and in popups to assist you when design parameters break the rules of the design.

- Adjust the design parameters to proceed. This may involve reconfiguring the germplasm list. For example, some designs cannot be generated when the number of test entries per replicate is a prime number.

BREEDING ACTIVITIES

Manage Germplasm

Manage Studies

Manage Samples

INFORMATION MANAGEMENT

STATISTICAL ANALYSIS

PROGRAM ADMINISTRATION

RICE TEST

Site Admin

My Programs

admin

BASIC DETAILS

Settings

Germplasm & Checks

Treatment Factors

Environments

Experimental Design

Observations

Experimental Design

CHOOSE A DESIGN TYPE

Select the design type you would like to use for this study: Resolvable Incomplete Block Des...

Or import an experimental design.

SPECIFY PLOT NUMBERING

Specify the starting plot number: 1

SPECIFY DESIGN PARAMETERS

Number of replications: 3

Block size: 4

Show advanced options

Generate Design

SUMMARY OF DESIGN DETAILS

Number of environments: 7

Number of treatments: 17

Number of blocks per replication : Invalid block size

Treatment factor: ENTRY\_NO

Replicate factor: REP\_NO

Block factor: BLOCK\_NO

Plot factor: PLOT\_NO

ERROR

The block size must be a factor of the number of treatments.

The number of treatments (test entries) is a prime number, 17. A resolvable incomplete block design can not be generated until the germplasm list is adjusted to a number that is divisible by a number other than 1 and 17.

## Entry List Order (Non-Randomized)

In this design type the system will just take the entry list and assign one plot for each entry in the order established in the list by default.

- Specify "Entry List Order". If your germplasm list has checks (see more about checks under [Study Germplasm](#)), you will be asked to specify.
  - Starting position: where the first check will be inserted (default is plot #1).
  - Spacing: the number of test entries between check insertion points
  - Manner of insertion:
    - Insert each check in turn: will add one check, per insertion point.
    - Insert all checks at each position: will add the complete list of checks at a given insertion point

BREEDING ACTIVITIES

Manage Germplasm

Manage Samples

Manage Studies

INFORMATION MANAGEMENT

STATISTICAL ANALYSIS

PROGRAM ADMINISTRATION

MC PROGRAM

Site AdminMy Programs?admin

MANAGE STUDIES

Design Types

Save

Return to Manage Studies

Actions

BASIC DETAILS

SettingsGermplasm & ChecksEnvironmentsExperimental DesignMeasurements

Experimental Design

CHOOSE A DESIGN TYPE

Select the design type you would like to use for this study:Entry list order

Or import an experimental design.

SPECIFY PLOT NUMBERING

Specify the starting plot number:1

SPECIFY DESIGN PARAMETERS

Specify checks

Starting Position \*1

Spacing \*10

Manner of InsertionInsert each check in turn

Generate Design

SUMMARY OF DESIGN DETAILS

Number of environments: 2

Treatment factor: ENTRY\_NO

Plot factor: PLOT\_NO

After receiving a success message, the Measurements table is now populated with your test and check entries.

BREEDING ACTIVITIES

Manage Germplasm

Manage Samples

Manage Studies

INFORMATION MANAGEMENT

STATISTICAL ANALYSIS

PROGRAM ADMINISTRATION

MC PROGRAM

Site AdminMy Programs?admin

MANAGE STUDIES

Design Types

Save

Return to Manage Studies

Actions

BASIC DETAILS

SettingsGermplasm & ChecksEnvironmentsExperimental DesignMeasurements

Define Measurement Details

Add

Please save the study to be able to edit measurements

Records per page: 100Showing 1 to 100 of 540 entries

TRIAL_INSTANCE	ENTRY_TYPE	GID	DESIGNATION	ENTRY_NO	PLOT_NO
1	C	12001	UGW16001	1	1
1	T	12003	UGW16003	3	2
1	T	12004	UGW16004	4	3
1	T	12005	UGW16005	5	4
1	T	12006	UGW16006	6	5
1	T	12007	UGW16007	7	6
1	T	12008	UGW16008	8	7
1	T	12009	UGW16009	9	8
1	T	12010	UGW16010	10	9
1	T	12011	UGW16011	11	10
1	T	12012	UGW16012	12	11
1	C	12002	UGW16002	2	12
1	T	12013	UGW16013	13	13
1	T	12014	UGW16014	14	14
1	T	12015	UGW16015	15	15
1	T	12016	UGW16016	16	16
1	T	12017	UGW16017	17	17
1	T	12018	UGW16018	18	18

12345>

# Import Custom Design

This feature allows you to import custom trial design files (.csv) generated outside of the BMS. Randomizations created outside of the BMS may not be supported by BMS statistical analyzes, but users have the flexibility to use external statistics applications if desired.

## Template

- Export Design Template.



The exported design template (.csv) contains the 3 mandatory column headings

- TRIAL\_INSTANCE: Number corresponding to specific trial environments, like a particular location or season.
- ENTRY\_NO: Number corresponding to specific germplasm. The number of entries in the trial design file must equal the number of entries in the trial germplasm list.
- PLOT\_NO: Plot number

	A	B	C	D	E	F	G	H	I	J	K
1	TRIAL_INSTANCE	ENTRY_NO	PLOT_NO								
2											
3											
4											

- Edit the design template. Some experimental designs will require the addition of other optional columns.

	A	B	C	D	E	Join selected cells, or separate joined cells into single cells						I	J	K	L
1	TRIAL_INSTANCE	ENTRY_NO	REP_NO	BLOCK_NO	PLOT_NO										
2	1	28	1	1	1										
3	1	8	1	1	2										
4	1	13	1	1	3										
5	1	18	1	1	4										
6	1	43	1	1	5										
7	1	25	1	1	6										
8															

- Select Import an Experimental Design.

The screenshot shows the 'MANAGE STUDIES' interface within the 'MC PROGRAM'. The left sidebar contains a navigation menu with categories: BREEDING ACTIVITIES (Manage Germplasm, Manage Samples, Manage Studies), INFORMATION MANAGEMENT, STATISTICAL ANALYSIS, and PROGRAM ADMINISTRATION. The 'Manage Studies' option is selected. The main content area has a 'Design Types' header with a 'Save' button. Below this is a 'BASIC DETAILS' section with tabs for Settings, Germplasm & Checks, Environments, Experimental Design, and Measurements. The 'Experimental Design' tab is active, showing a 'CHOOSE A DESIGN TYPE' section with a dropdown menu set to 'Please Choose'. Below this is a 'SPECIFY PLOT NUMBERING' section with a text input field containing '1'. An 'Actions' dropdown menu is open, showing options: Save Study, Design and planning options, Data collection options, Close study, and Delete study. A 'Return to Manage Studies' link is in the top right.

- Specify the design file and Continue.

The screenshot shows the 'MANAGE TRIALS' interface within the 'MAIZE TUTORIAL'. The left sidebar is similar to the first screenshot, with 'Manage Trials' selected. The main content area has a 'Create Trial' header with a 'Save' button. Below this is a 'BASIC DETAILS' section with fields for Trial name, Description, and Objective. An 'Import Experimental Design' dialog box is open, showing a 'SELECT DESIGN FILE TO IMPORT' section with instructions: 'The design file must contain columns representing the environment designation, entry number, and plot number. Additional columns are optional, and you will be able to map them on the next screen.' Below this is a 'Please specify the format you are importing:' dropdown set to 'CSV'. There are 'Browse', 'Cancel', and 'Continue' buttons. The background interface shows the 'Experimental Design' tab active, with a 'CHOOSE A DESIGN TYPE' section and a 'SPECIFY PLOT NUMBERING' section.

## Ontology Mapping

Terms that are identical to the ontology will map perfectly. If the column headers are spelled differently, the system will attempt to map to match the existing ontology. You may be required to Re-map and/or add new ontology terms to achieve correct mapping.

BREEDING ACTIVITIES

Manage Germplasm

Manage Nurseries

Manage Trials

INFORMATION MANAGEMENT

STATISTICAL ANALYSIS

PROGRAM ADMINISTRATION

TUTORIAL

Site Admin

My Programs

Shawn

MANAGE TRIALS

Import Experimental Design

MAP COLUMN HEADERS TO VARIABLES

Drag unmapped headers on the left into one of the three groups on the right. You will be prompted to match the header to an existing variable in the ontology, and you will have the opportunity to create new variables if needed.

Un-Mapped

Environmental Factors

TRIAL\_INSTANCE → TRIAL\_INSTANCE (Required)

Property: Trial instance

Scale: Number

Method: Enumerated

Re-map

Design Factors

REP\_NO → REP\_NO

Property: Replication factor

Scale: Number

Method: Enumerated

Re-map

BLOCK\_NO → BLOCK\_NO

Property: Blocking factor

Scale: Number

Method: Enumerated

Re-map

PLOT\_NO → PLOT\_NO (Required)

Property: Field plot

Scale: Number

Method: Enumerated

Re-map

Germplasm Factors

ENTRY\_NO → ENTRY\_NO (Required)

Property: Germplasm entry

Scale: Number

Method: Enumerated

Re-map

Cancel

Next

WARNING

Please note that the analysis results for designs generated outside the BMS may be unreliable, and that analysis in the BMS may not be possible for some design types.

- Review imported design details and select Finish.

BREEDING ACTIVITIES

Manage Germplasm

Manage Samples

Manage Studies

INFORMATION MANAGEMENT

STATISTICAL ANALYSIS

PROGRAM ADMINISTRATION

MC PROGRAM

Site Admin

My Programs

admin

MANAGE STUDIES

Design Types

BASIC DETAILS

Settings

Germplasm & Checks

Environ

Define Germplasm Details

GERMPLASM DESCRIPTORS

Name

Description

ENTRY\_TYPE

GID

DESIGNATION

ENTRY\_NO

PLOT\_ID

Study List

Total Entries: 247

View Header

Import Experimental Design

REVIEW DESIGN DETAILS

Type of design: Externally Generated Design

Showing 1 to 100 of 247 entries

TRIAL_INSTANCE	ENTRY_NO	ENTRY_TYPE	GID	DESIGNATION	PLOT_ID	PLOT_NO	SUB_BLOCK
1	1	Test entry	12001	UGW16001		247	1
1	2	Test entry	12002	UGW16002		246	1
1	3	Test entry	12003	UGW16003		245	1
1	4	Test entry	12004	UGW16004		244	1
1	5	Test entry	12005	UGW16005		243	1
1	6	Test entry	12006	UGW16006		242	1
1	7	Test entry	12007	UGW16007		241	1
1	8	Test entry	12008	UGW16008		240	1
1	9	Test entry	12009	UGW16009		239	1
1	10	Test entry	12010	UGW16010		238	1
1	11	Test entry	12011	UGW16011		237	1
1	12	Test entry	12012	UGW16012		236	1
1	13	Test entry	12013	UGW16013		235	1
1	14	Test entry	12014	UGW16014		234	1
1	15	Test entry	12015	UGW16015		233	1
1	16	Test entry	12016	UGW16016		232	1
1	17	Test entry	12017	UGW16017		231	1
1	18	Test entry	12018	UGW16018		230	1
1	19	Test entry	12019	UGW16019		229	1
1	20	Test entry	12020	UGW16020		228	1
1	21	Test entry	12021	UGW16021		227	1

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