ΑΡΙΣΤΟΤΕΛΕΙΟ ΠΑΝΕΠΙΣΤΗΜΙΟ ΘΕΣΣΑΛΟΝΙΚΗΣ

ΓΕΩΠΟΝΙΚΗ ΣΧΟΛΗ Α.Π.Θ.

ANOVA Tables for Various Experiments

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Factor Structures

Crossed and Nested Factors (1)

Two factors are **crossed** if every level of one factor is combined with every level of the other factor. The individual factors are called **main effects**, while the crossed factors form an **interaction effect**.

Crossed and Nested Factors (2)

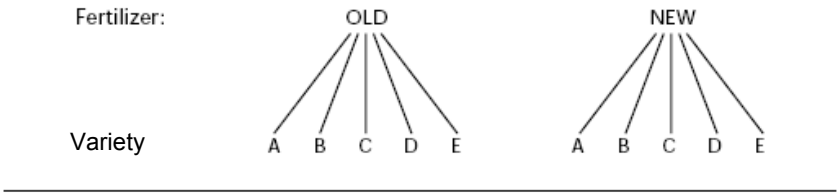


FIGURE 1 *Design structure of an experiment with two factors crossed with one another.*

Figure 1 is called a **stick diagram**. The lines, or sticks, indicate therelationships between the levels of the two factors.

Crossed and Nested Factors (3)

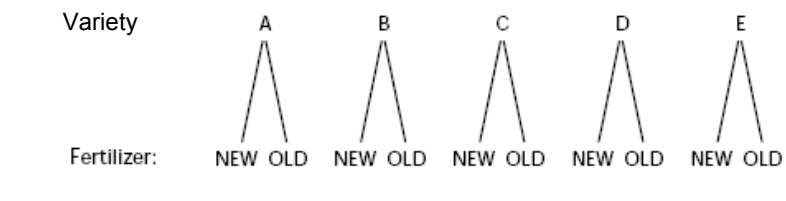


FIGURE 2 *Alternative stick diagram for the two-factor crossed experiment.*

Crossed and Nested Factors (4)

A factor is **nested** when each level of the nested factor occurs with only one or a combination of levels of the other factor or factors.

Crossed and Nested Factors (5)

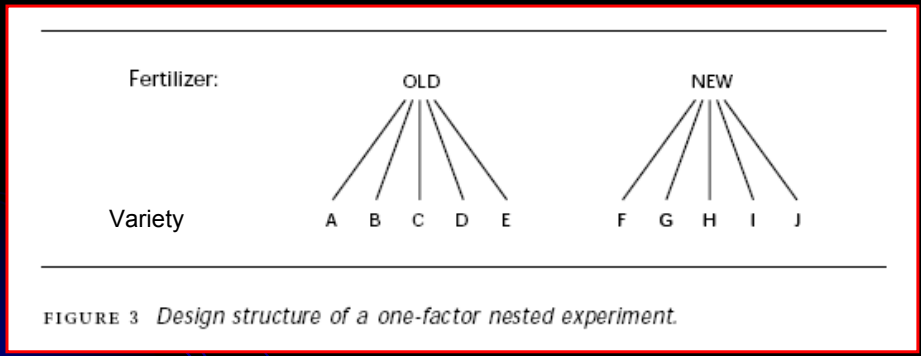


FIGURE 3 *Design structure of a one-factor nested experiment.*

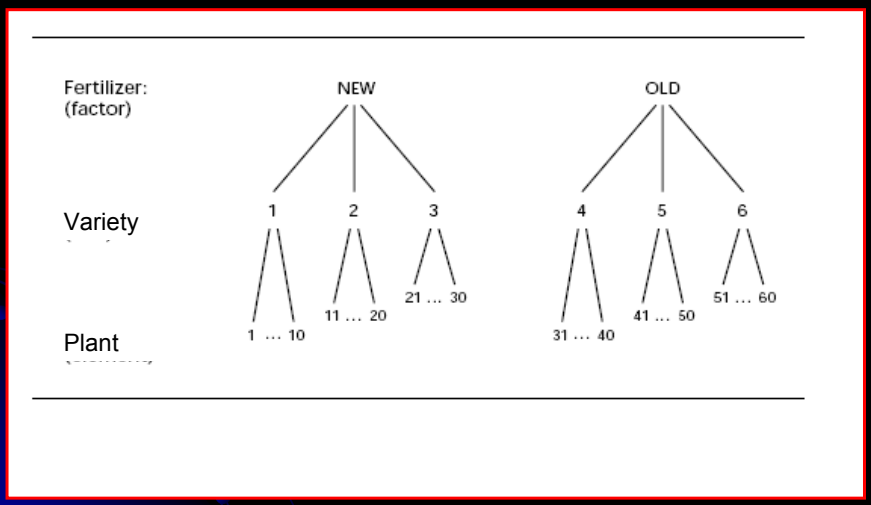
Crossed and Nested Factors (6)

- The nested factor "variety" would never occur by itself in an ANOVA table; rather it would always be denoted in the nested notation **variety(fertilizer)**.
- The nested factor is usually random, but unlike the crossed relationship, the nested relationship is not symmetrical. In a stick diagram, the nested factor is always drawn below the main factor.
- A nested factor never forms an interaction effect with the main factor(s) within which it is nested.

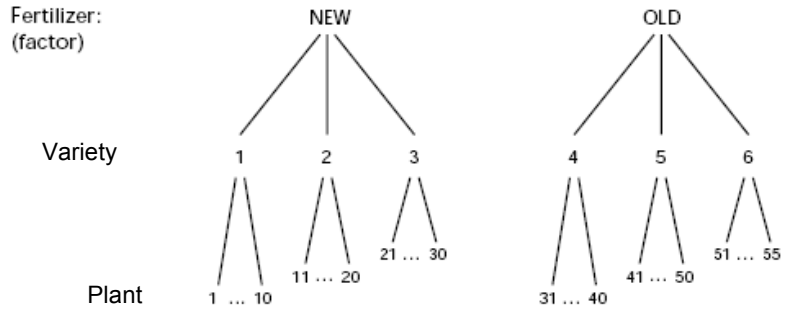
Crossed and Nested Factors (7)

- It can, however, be crossed with other factors. For example, the factor relationship: temperature*variaty(fertilizer) is valid.
- It indicates that each level of the temperature factor combines with each level of the variety factor which is nested within the fertilizer factor.
- If the temperature factor has three levels (e.g., high, medium, and low), then there are thirty ($3 \times 10 = 30$) combinations of temperature, variety, and fertilizer.
- On the other hand, the factor relationship fertilizer*variety(fertilizer) is not valid because the variety factor cannot be nested with, and crossed with, the fertilizer factor at the same time.

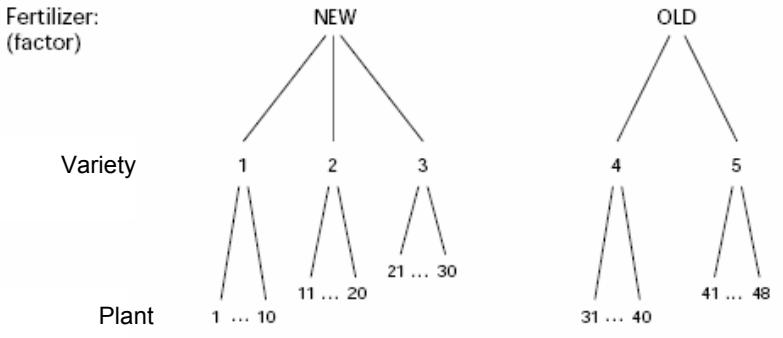
Example (1): Balanced Design



Example (2): Single Unbalanced Design



Example (3): Double Unbalanced Design



Degrees of Freedom

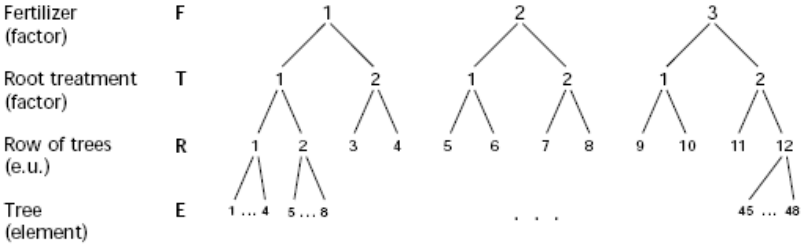
- A source containing a single factor has degrees of freedom one less than its number of levels.
- A source containing nested factors has degrees of freedom equal to the product of the number of levels of each factor inside the parentheses, and the number of levels minus one of each factor outside the parentheses.
- A source containing crossed factors has degrees of freedom equal to the product of the number of levels minus one of each factor in the source.
- The total degrees of freedom in a model is one less than the total number of observations.

Some Examples

TABLE 1 *Hypothetical sources of variation and their degrees of freedom*

Source	*df*	Comments
A	$a - 1$	single factor
B(A)	$(b - 1)(a)$	B nested within A
A*B	$(a - 1)(b - 1)$	A crossed with B
D*B(A)	$(d - 1)(b - 1)(a)$	D crossed with B nested within A
B(AD)	$(b - 1)(a)(d)$	B nested within A and D

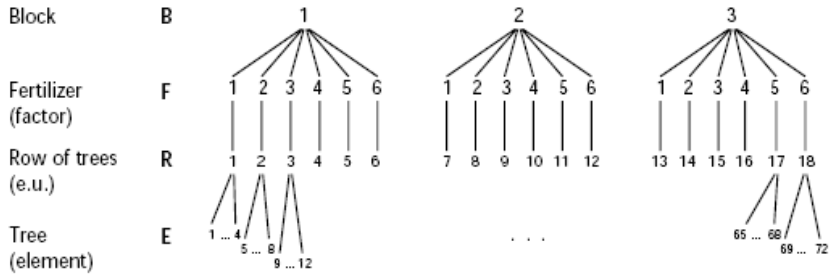
Problem (1): Define the structure of the experiment



Sources of Variation for Problem (1)

Source	*df*
Fertilizer, F	$3 - 1 = 2$
Root treatment, T	$2 - 1 = 1$
F*T	$(3 - 1)(2 - 1) = 2$
Row, R (FT)	$(2 - 1)(3)(2) = 6$
Tree, E (RFT)	$(4 - 1)(2)(3)(2) = 36$
Total	$(3)(2)(2)(4) - 1 = 47$

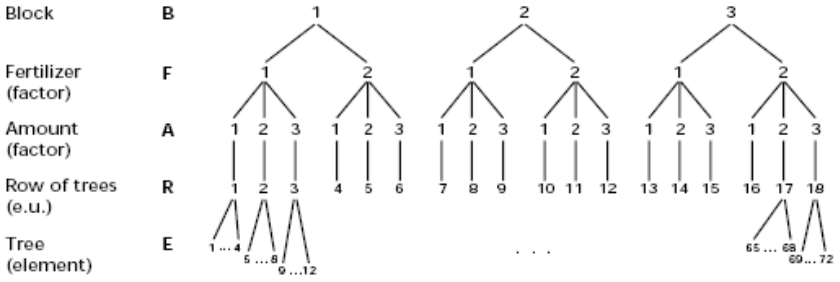
Problem (2): Define the structure of the experiment



Sources of Variation for Problem (2)

Source of variation	*df*
Block, B	b − 1 = 2
Fertilizer, F	f − 1 = 5
B*F	(b − 1) (f − 1) = 10
Row of trees, R (BF)	(r − 1) bf = 0
Tree, E (BFR)	(e − 1) bfr = 54
Total	bfre − 1 = 71

Problem (3): Define the structure of the experiment

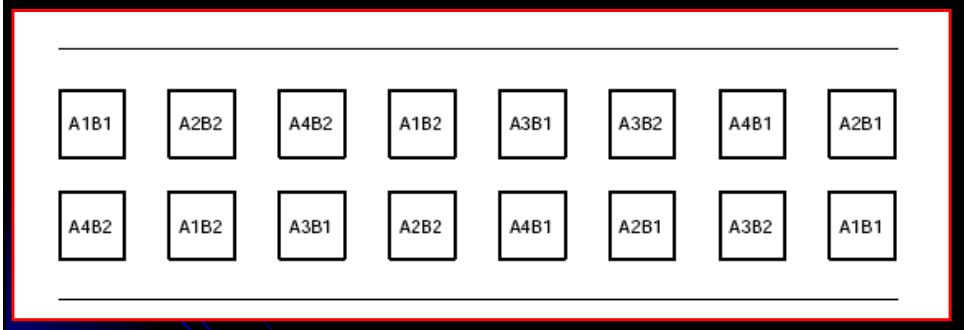


Sources of Variation for Problem (3)

Source of variation	*df*
Block, B	b – 1 = 2
Fertilizer, F	f – 1 = 1
Amount, A	a – 1 = 2
A*F	(a – 1)(f – 1) = 2
B*F	(b – 1)(f – 1) = 2
B*A	(b – 1)(a – 1) = 4
B*F*A	(b – 1)(f – 1)(a – 1) = 4
Row of trees, R (BFA)	(r – 1) bfa = 0
Tree, E (BFAR)	(e – 1) bfar = 54
Total	bfare – 1 = 71

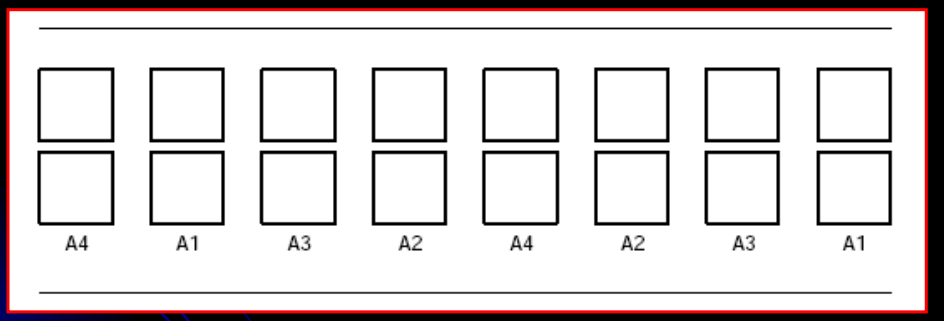
Split Plot Designs

A completely randomized factorial arrangement



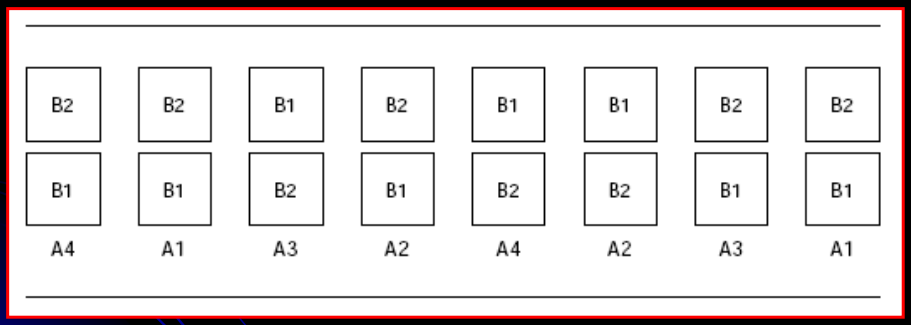
Main Plots for Factor A

Main-plots of a completely randomized split-plot design. Each pair of squares is an experimental unit for factor A

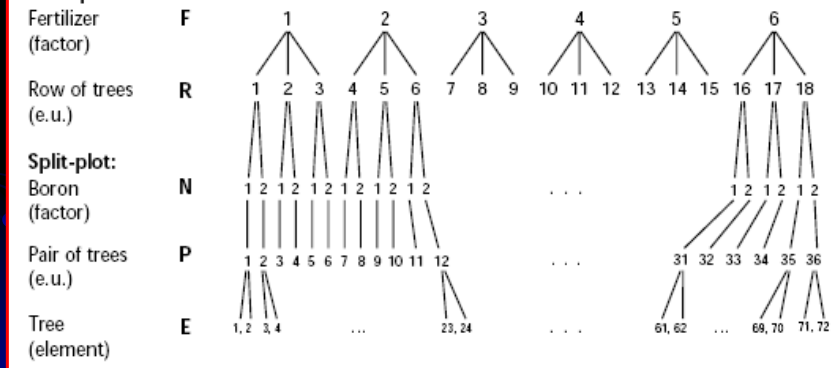


Factor B is a Split on Factor A

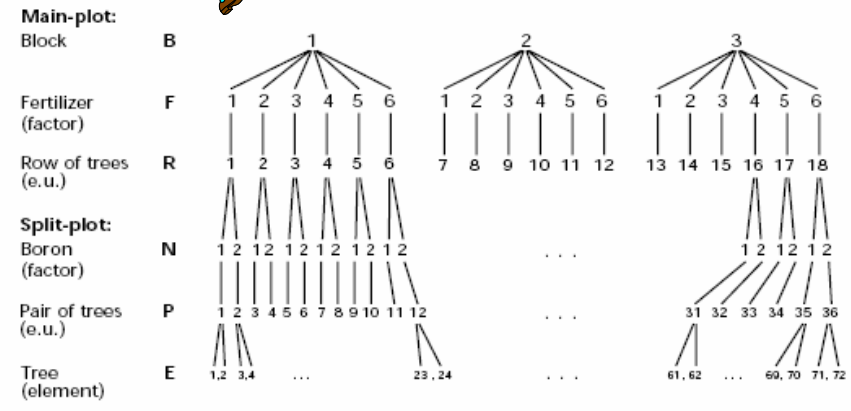
A completely randomized split-plot layout



Design structure for a completely randomized split-plot design



Problem (4): Define the structure of the experiment



Sources of Variation for Problem (4)

Source of variation	*df*
Main-plot	
Block, B	b − 1 = 2
Fertilizer, F	f − 1 = 5
B*F	(b − 1) (f − 1) = 10
Row of trees, R (BF)	(r − 1) bf = 0
Split-plot	
Boron, N	n − 1 = 1
F*N	(f − 1) (n − 1) = 5
B*N	(b − 1) (n − 1) = 2
B*F*N	(b − 1) (f − 1) (n − 1) = 10
N*R (BF)	(n − 1) (r − 1) bf = 0
Pair of trees, P (BFRN)	(p − 1) frn = 0
Tree, E (BFRNP)	(e − 1) frnp = 36
Total	frnpe − 1 = 71

ANOVA Tables

Two Factor Completely Randomized Design

FACTOR: ANOVA Table for this model

K Value	Source	Degrees of Freedom	Is this what you had in mind? Y/N
2	Factor A	a-1	
4	Factor B	b-1	
6	AB	(a-1)(b-1)	
-7	Error	ab(r-1)	

Completely Randomized Design for Factor A, Factor B is a Split Plot

FACTOR: ANOVA Table for this model

K Value	Source	Degrees of Freedom	Is this what you had in mind? Y/N
2	Factor A	a-1	
-3	Error	a(r-1)	
4	Factor B	b-1	
6	AB	(a-1)(b-1)	
-7	Error	a(r-1)(b-1)	

Three Factor Completely Randomized Design

FACTOR: ANOVA Table for this model

K Value	Source	Degrees of Freedom	Is this what you had in mind? Y/N
2	Factor A	a-1	
4	Factor B	b-1	
6	AB	(a-1)(b-1)	
8	Factor C	c-1	
10	AC	(a-1)(c-1)	
12	BC	(b-1)(c-1)	
14	ABC	(a-1)(b-1)(c-1)	
-15	Error	abc(r-1)	

Completely Randomized Design for Factor A, Factors B and C are Split Plots on A

FACTOR: ANOVA Table for this model

K Value	Source	Degrees of Freedom	Is this what you had in mind? Y/N
2	Factor A	a-1	
-3	Error	a(r-1)	
4	Factor B	b-1	
6	AB	(a-1)(b-1)	
8	Factor C	c-1	
10	AC	(a-1)(c-1)	
12	BC	(b-1)(c-1)	
14	ABC	(a-1)(b-1)(c-1)	
-15	Error	a(r-1)(bc-1)	

Completely Randomized Design for Factors A and B, Factor C is a Split Plot on A and B

FACTOR: ANOVA Table for this model

K Value	Source	Degrees of Freedom	Is this what you had in mind? Y/N
2	Factor A	a-1	
4	Factor B	b-1	
6	AB	(a-1)(b-1)	
-7	Error	ab(r-1)	
8	Factor C	c-1	
10	AC	(a-1)(c-1)	
12	BC	(b-1)(c-1)	
14	ABC	(a-1)(b-1)(c-1)	
-15	Error	ab(r-1)(c-1)	

Four Factor Completely Randomized Design

FACTOR: ANOVA Table for this model

K Value	Source	Degrees of Freedom	Is this what you had in mind? Y/N
2	Factor A	a-1	
4	Factor B	b-1	
6	AB	(a-1)(b-1)	
8	Factor C	c-1	
10	AC	(a-1)(c-1)	
12	BC	(b-1)(c-1)	
14	ABC	(a-1)(b-1)(c-1)	
16	Factor D	d-1	
18	AD	(a-1)(d-1)	
20	BD	(b-1)(d-1)	
22	ABD	(a-1)(b-1)(d-1)	
24	CD	(c-1)(d-1)	
26	ACD	(a-1)(c-1)(d-1)	
28	BCD	(b-1)(c-1)(d-1)	
30	ABCD	(a-1)(b-1)(c-1)(d-1)	
-31	Error	abcd(r-1)	

One Factor Randomized Complete Block Design

FACTOR: ANOVA Table for this model

K Value	Source	Degrees of Freedom	Is this what you had in mind? Y/N
1	Replication	r-1	
2	Factor A	a-1	
-3	Error	(r-1)(a-1)	

Two Factor Randomized Complete Block Design

FACTOR: ANOVA Table for this model

K Value	Source	Degrees of Freedom	Is this what you had in mind? Y/N
1	Replication	r-1	
2	Factor A	a-1	
4	Factor B	b-1	
6	AB	(a-1)(b-1)	
-7	Error	(ab-1)(r-1)	

Randomized Complete Block Design for Factor A, with Factor B a Split Plot on A

FACTOR: ANOVA Table for this model

K Value	Source	Degrees of Freedom	Is this what you had in mind? Y/N
1	Replication	r-1	
2	Factor A	a-1	
-3	Error	(r-1)(a-1)	
4	Factor B	b-1	
6	AB	(a-1)(b-1)	
-7	Error	a(r-1)(b-1)	

Three Factor Randomized Complete Block Design

FACTOR: ANOVA Table for this model

K Value	Source	Degrees of Freedom	Is this what you had in mind? Y/N
1	Replication	r-1	
2	Factor A	a-1	
4	Factor B	b-1	
6	AB	(a-1)(b-1)	
8	Factor C	c-1	
10	AC	(a-1)(c-1)	
12	BC	(b-1)(c-1)	
14	ABC	(a-1)(b-1)(c-1)	
-15	Error	(r-1)(abc-1)	

Randomized Complete Block Design for Factor A, with Factors B and C as Split Plots on A

FACTOR: ANOVA Table for this model

K Value	Source	Degrees of Freedom	Is this what you had in mind? Y/N
1	Replication	r-1	
2	Factor A	a-1	
-3	Error	(r-1)(a-1)	
4	Factor B	b-1	
6	AB	(a-1)(b-1)	
8	Factor C	c-1	
10	AC	(a-1)(c-1)	
12	BC	(b-1)(c-1)	
14	ABC	(a-1)(b-1)(c-1)	
-15	Error	a(r-1)(bc-1)	

Randomized Complete Block Design for Factors A and B with Factor C as a Split Plot on A and B

FACTOR: ANOVA Table for this model

K Value	Source	Degrees of Freedom	Is this what you had in mind? Y/N
1	Replication	r-1	
2	Factor A	a-1	
4	Factor B	b-1	
6	AB	(a-1)(b-1)	
-7	Error	(ab-1)(r-1)	
8	Factor C	c-1	
10	AC	(a-1)(c-1)	
12	BC	(b-1)(c-1)	
14	ABC	(a-1)(b-1)(c-1)	
-15	Error	ab(r-1)(c-1)	

Randomized Complete Block Design for Factor A, with Factor B as a Split Plot on A and Factor C as a Split Plot on B

FACTOR: ANOVA Table for this model

K Value	Source	Degrees of Freedom	Is this what you had in mind? Y/N
1	Replication	r-1	
2	Factor A	a-1	
-3	Error	(r-1)(a-1)	
4	Factor B	b-1	
6	AB	(a-1)(b-1)	
-7	Error	a(r-1)(b-1)	
8	Factor C	c-1	
10	AC	(a-1)(c-1)	
12	BC	(b-1)(c-1)	
14	ABC	(a-1)(b-1)(c-1)	
-15	Error	ab(r-1)(c-1)	

Four Factor Randomized Complete Block Design

FACTOR: ANOVA Table for this model

K Value	Source	Degrees of Freedom	Is this what you had in mind? Y/N
1	Replication	r-1	
2	Factor A	a-1	
4	Factor B	b-1	
6	AB	(a-1)(b-1)	
8	Factor C	c-1	
10	AC	(a-1)(c-1)	
12	BC	(b-1)(c-1)	
14	ABC	(a-1)(b-1)(c-1)	
16	Factor D	d-1	
18	AD	(a-1)(d-1)	
20	BD	(b-1)(d-1)	
22	ABD	(a-1)(b-1)(d-1)	
24	CD	(c-1)(d-1)	
26	ACD	(a-1)(c-1)(d-1)	
28	BCD	(b-1)(c-1)(d-1)	
30	ABCD	(a-1)(b-1)(c-1)(d-1)	
-31	Error	By Subtraction	

One Factor Randomized Complete Block Design Combined over Locations (or Combined over Years)

FACTOR: ANOVA Table for this model

K Value	Source	Degrees of Freedom	Is this what you had in mind? Y/N
1	Location	l-1	
-3	Error	l(r-1)	
4	Factor A	a-1	
5	LA	(l-1)(a-1)	
-7	Error	l(r-1)(a-1)	

One Factor Randomized Complete Block Design Combined over Locations and Years, with new Locations each Year

FACTOR: ANOVA Table for this model

K Value	Source	Degrees of Freedom	Is this what you had in mind? Y/N
1	Year	y-1	
3	L(Y)	y(l-1)	
7	R(LY)	yl(r-1)	
8	Factor A	a-1	
9	YA	(y-1)(a-1)	
11	LA(Y)	y(l-1)(a-1)	
-15	Error	**yl(r-1)(a-1)**	

Randomized Complete Block Design Combined over Locations and Years, with the same Locations each Year but Randomized

FACTOR: ANOVA Table for this model

K Value	Source	Degrees of Freedom	Is this what you had in mind? Y/N
1	Year	y-1	
2	Location	l-1	
3	YL	(y-1)(l-1)	
7	R(LY)	yl(r-1)	
8	Factor A	a-1	
9	YA	(y-1)(a-1)	
10	LA	(l-1)(a-1)	
11	YLA	(y-1)(l-1)(a-1)	
-15	Error	yl(r-1)(a-1)	

Randomized Complete Block Design Combined over Locations and Years, same Locations and Randomization each Year (Perennial Crops)

FACTOR: ANOVA Table for this model

K Value	Source	Degrees of Freedom	Is this what you had in mind? Y/N
1	Location	l-1	
3	R(L)	l(r-1)	
4	Year	y-1	
5	LY	(l-1)(y-1)	
7	RY(L)	l(r-1)(y-1)	
8	Factor A	a-1	
9	LA	(l-1)(a-1)	
12	YA	(y-1)(a-1)	
13	LYA	(l-1)(y-1)(a-1)	
-15	Error	ly(r-1)(a-1)	

Two Factor Randomized Complete Block Design Combined over Locations (or Combined over Years)

FACTOR: ANOVA Table for this model

K Value	Source	Degrees of Freedom	Is this what you had in mind? Y/N
1	Location	l-1	
3	R(L)	l(r-1)	
4	Factor A	a-1	
5	LA	(l-1)(a-1)	
8	Factor B	b-1	
9	LB	(l-1)(b-1)	
12	AB	(a-1)(b-1)	
13	LAB	(l-1)(a-1)(b-1)	
-15	Error	l(r-1)(a-1)(b-1)	

Two Factor Randomized Complete Block Design with Split Plot Combined over Locations

FACTOR: ANOVA Table for this model

K Value	Source	Degrees of Freedom	Is this what you had in mind? Y/N
1	Location	l-1	
3	R(L)	l(r-1)	
4	Factor A	a-1	
5	LA	(l-1)(a-1)	
-7	Error	l(r-1)(a-1)	
8	Factor B	b-1	
9	LB	(l-1)(b-1)	
12	AB	(a-1)(b-1)	
13	LAB	(l-1)(a-1)(b-1)	
-15	Error	la(r-1)(b-1)	

Two Factor Randomized Complete Block Design Combined over Locations and Years, New Location each Year

FACTOR: ANOVA Table for this model

K Value	Source	Degrees of Freedom	Is this what you had in mind? Y/N
1	Year	y-1	
3	L(Y)	y(l-1)	
7	R(LY)	yl(r-1)	
8	Factor A	a-1	
9	YA	(y-1)(a-1)	
11	LA(Y)	y(l-1)(a-1)	
16	Factor B	b-1	
17	YB	(y-1)(b-1)	
19	LB(Y)	y(l-1)(b-1)	
24	AB	(a-1)(b-1)	
25	YAB	(y-1)(a-1)(b-1)	
27	LAB(Y)	y(l-1)(a-1)(b-1)	
-31	Error	yl(r-1)(ab-1)	

Two Factor Randomized Complete Block Design Combined over Locations and Years, same Location but Randomized each Year

FACTOR: ANOVA Table for this model

K Value	Source	Degrees of Freedom	Is this what you had in mind? Y/N
1	Year	y-1	
2	Location	l-1	
3	YL	(y-1)(l-1)	
7	R(LY)	yl(r-1)	
8	Factor A	a-1	
9	YA	(y-1)(a-1)	
10	LA	(l-1)(a-1)	
11	YLA	(y-1)(l-1)(a-1)	
16	Factor B	b-1	
17	YB	(y-1)(b-1)	
18	LB	(l-1)(b-1)	
19	YLB	(y-1)(l-1)(b-1)	
24	AB	(a-1)(b-1)	
25	YAB	(y-1)(a-1)(b-1)	
26	LAB	(l-1)(a-1)(b-1)	
27	YLAB	(y-1)(l-1)(a-1)(b-1)	
-31	Error	yl(r-1)(ab-1)	

Two Factor Randomized Complete Block Design Combined over Locations and Years, same Location and Randomization each Year

FACTOR: ANOVA Table for this model

K Value	Source	Degrees of Freedom	Is this what you had in mind? Y/N
1	Location	l-1	
3	R(L)	l(r-1)	
4	Year	y-1	
5	LY	(l-1)(y-1)	
7	RY(L)	l(r-1)(y-1)	
8	Factor A	a-1	
9	LA	(l-1)(a-1)	
12	YA	(y-1)(a-1)	
13	LYA	(l-1)(y-1)(a-1)	
16	Factor B	b-1	
17	LB	(l-1)(b-1)	
20	YB	(y-1)(b-1)	
21	LYB	(l-1)(y-1)(b-1)	
24	AB	(a-1)(b-1)	
25	LAB	(l-1)(a-1)(b-1)	
28	YAB	(y-1)(a-1)(b-1)	
29	LYAB	(l-1)(y-1)(a-1)(b-1)	
-31	Error	By Subtraction	

Two Factor Randomized Complete Block Design with Split, Combined over Locations and Years, New Location each Year

FACTOR: ANOVA Table for this model

K Value	Source	Degrees of Freedom	Is this what you had in mind? Y/N
1	Year	y-1	
3	L(Y)	y(l-1)	
7	R(LY)	yl(r-1)	
8	Factor A	a-1	
9	YA	(y-1)(a-1)	
11	LA(Y)	y(l-1)(a-1)	
-15	Error	y(r-1)(a-1)	
16	Factor B	b-1	
17	YB	(y-1)(b-1)	
19	LB(Y)	y(l-1)(b-1)	
24	AB	(a-1)(b-1)	
25	YAB	(y-1)(a-1)(b-1)	
27	LAB(Y)	y(l-1)(a-1)(b-1)	
-31	Error	y(r-1)(lab-a-1)	

Two Factor Randomized Complete Block Design with Split, Combined over Locations and Years, same Location but Randomized each Year

FACTOR: ANOVA Table for this model

K Value	Source	Degrees of Freedom	Is this what you had in mind? Y/N
1	Year	y-1	
2	Location	l-1	
3	YL	(y-1)(l-1)	
7	R(LY)	yl(r-1)	
8	Factor A	a-1	
9	YA	(y-1)(a-1)	
10	LA	(l-1)(a-1)	
11	YLA	(y-1)(l-1)(a-1)	
-15	Error	yl(r-1)(a-1)	
16	Factor B	b-1	
17	YB	(y-1)(b-1)	
18	LB	(l-1)(b-1)	
19	YLB	(y-1)(l-1)(b-1)	
24	AB	(a-1)(b-1)	
25	YAB	(y-1)(a-1)(b-1)	
26	LAB	(l-1)(a-1)(b-1)	
27	YLAB	(y-1)(l-1)(a-1)(b-1)	
-31	Error	yl(ra-1)(b-1)	

Two Factor Randomized Complete Block Design with Split, Combined over Locations and Years, same Location and Randomization each Year

FACTOR: ANOVA Table for this model

K Value	Source	Degrees of Freedom	Is this what you had in mind? Y/N
1	Location	l-1	
3	R(L)	l(r-1)	
4	Year	y-1	
5	LY	(l-1)(y-1)	
7	RY(L)	l(r-1)(y-1)	
8	Factor A	a-1	
9	LA	(l-1)(a-1)	
12	YA	(y-1)(a-1)	
13	LYA	(l-1)(y-1)(a-1)	
-15	Error	ly(r-1)(a-1)	
16	Factor B	b-1	
17	LB	(l-1)(b-1)	
20	YB	(y-1)(b-1)	
21	LYB	(l-1)(y-1)(b-1)	
24	AB	(a-1)(b-1)	
25	LAB	(l-1)(a-1)(b-1)	
28	YAB	(y-1)(a-1)(b-1)	
29	LYAB	(l-1)(y-1)(a-1)(b-1)	
-31	Error	By Subtraction	

Two Factor Randomized Complete Block Design using Strip Plots

FACTOR: ANOVA Table for this model

K Value	Source	Degrees of Freedom	Is this what you had in mind? Y/N
1	Replication	r-1	
2	Horizontal Factor A	a-1	
-3	Error (a)	(r-1)(a-1)	
4	Vertical Factor B	b-1	
-5	Error (b)	(r-1)(b-1)	
6	AB	(a-1)(b-1)	
-7	Error (c)	(r-1)(a-1)(b-1)	

Three Factor Randomized Complete Block Design with the Treatments Arranged in Strips

FACTOR: ANOVA Table for this model

K Value	Source	Degrees of Freedom	Is this what you had in mind? Y/N
1	Replication	r-1	
2	Horizontal Factor A	a-1	
-3	Error (a)	(r-1)(a-1)	
4	Vertical Factor B	b-1	
-5	Error (b)	(r-1)(b-1)	
6	AB	(a-1)(b-1)	
-7	Error (c)	(r-1)(a-1)(b-1)	
8	Subplot Factor C	c-1	
10	AC	(a-1)(c-1)	
12	BC	(b-1)(c-1)	
14	ABC	(a-1)(b-1)(c-1)	
-15	Error (d)	ab(r-1)(c-1)	

Four Factor Randomized Complete Block Design with Factors B, C, and D as Split Plots on Factor A

FACTOR: ANOVA Table for this model

K Value	Source	Degrees of Freedom	Is this what you had in mind? Y/N
1	Replication	r-1	
2	Factor A	a-1	
-3	Error	(r-1)(a-1)	
4	Factor B	b-1	
6	AB	(a-1)(b-1)	
8	Factor C	c-1	
10	AC	(a-1)(c-1)	
12	BC	(b-1)(c-1)	
14	ABC	(a-1)(b-1)(c-1)	
16	Factor D	d-1	
18	AD	(a-1)(d-1)	
20	BD	(b-1)(d-1)	
22	ABD	(a-1)(b-1)(d-1)	
24	CD	(c-1)(d-1)	
26	ACD	(a-1)(c-1)(d-1)	
28	BCD	(b-1)(c-1)(d-1)	
30	ABCD	(a-1)(b-1)(c-1)(d-1)	
-31	Error	By Subtraction	

Four Factor Randomized Complete Block Design with Factor B as a Split Plot on Factor A and Factors C and D as Split Plots on Factor B

FACTOR: ANOVA Table for this model

K Value	Source	Degrees of Freedom	Is this what you had in mind? Y/N
1	Replication	r-1	
2	Factor A	a-1	
-3	Error	(r-1)(a-1)	
4	Factor B	b-1	
6	AB	(a-1)(b-1)	
-7	Error	a(r-1)(b-1)	
8	Factor C	c-1	
10	AC	(a-1)(c-1)	
12	BC	(b-1)(c-1)	
14	ABC	(a-1)(b-1)(c-1)	
16	Factor D	d-1	
18	AD	(a-1)(d-1)	
20	BD	(b-1)(d-1)	
22	ABD	(a-1)(b-1)(d-1)	
24	CD	(c-1)(d-1)	
26	ACD	(a-1)(c-1)(d-1)	
28	BCD	(b-1)(c-1)(d-1)	
30	ABCD	(a-1)(b-1)(c-1)(d-1)	
-31	Error	By Subtraction	

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