

### Augmented Designs

		Plot															
Rep		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1																	
2																	
3																	
4																	

### Augmented Designs

		Plot															
Rep		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1			C1			C4	C2			C3							C5
2		C3		C5				C4				C1			C2		
3							C2		C4	C1		C5				C3	
4				C2		C4						C5			C3		C1

## Augmented Designs Properties

$t$  = number of unreplicated treatments

$r$  = number of blocks

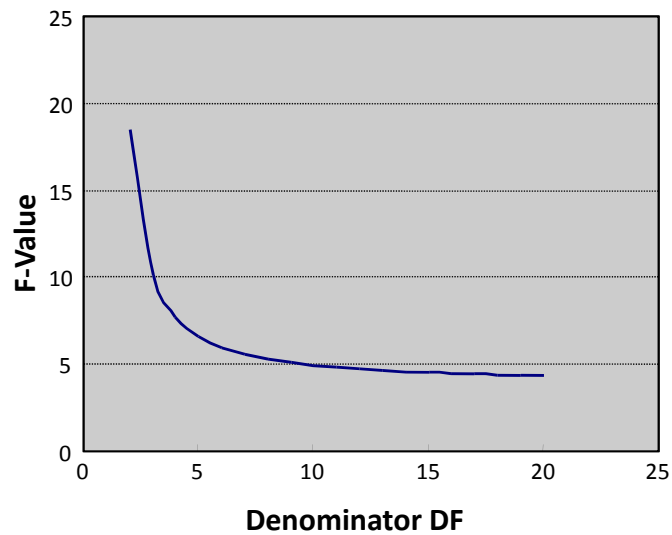
$n = t/r$  = number of unreplicated treatments per rep

$c$  = number of replicated checks

$p = c + n$  = number of plots per rep

$N = rc + t = r(c + n)$  = total number of plots

Critical F Values for Alpha 0.05  
Numerator df = 1



## Augmented Designs Number of Reps

$$\text{error df} = (r - 1)(c - 1)$$

Assuming a minimum of 10 df is need for error:

$$r \geq \frac{10}{c - 1} + 1$$

for  $c = 4$ :

$$r \geq \frac{10}{4 - 1} + 1 = 4.3$$

So 5 reps are required

## Augmented Designs Soybean Evaluation Example

40 Selections – limited seed quantity

Potential designs:

<b>r</b>	<b>n</b>	<b>c</b>	<b>N</b>
4	10	$10/(4 - 1) + 1 = 5$	$4(5) + 40 = 60$
5	8	$10/(5 - 1) + 1 = 4$	$5(4) + 40 = 60$

## Augmented Designs Soybean Evaluation Example

		Plot											
Rep		1	2	3	4	5	6	7	8	9	10	11	12
1				C2		C1					C4	C3	
2		C4				C2		C3		C1			
3			C2		C3				C4				C1
4			C2				C1		C3		C4		
5			C1			C2		C4				C3	

## Augmented Designs Soybean Evaluation Example

		Plot											
Rep		1	2	3	4	5	6	7	8	9	10	11	12
1		39	20	C2	34	C1	35	5	15	6	C4	C3	32
2		C4	16	29	7	C2	36	C3	26	C1	24	38	13
3		40	C2	8	C3	27	2	14	C4	19	11	30	C1
4		33	C2	10	25	18	C1	31	C3	1	C4	12	28
5		37	C1	21	4	C2	9	C4	17	22	23	C3	3

## Augmented Designs Analysis

### Steps:

1. Run ANOVA on checks
2. Calculate block adjustment factor  $\alpha$ :

$$a_j = \bar{x}_{\cdot j} - \bar{x}_{\cdot\cdot} \quad \sum_j a_j = 0$$

3. Adjust treatment means:

$$\hat{y}_{ij} = y_{ij} - a_j$$

## Augmented Designs Analysis

### Standard Errors

Differences in check means:

$$S_{\bar{d}} = \sqrt{\frac{2MSE}{r}}$$

Differences in adjusted treatment means  
from the same block:

$$S_{\bar{d}} = \sqrt{2MSE}$$

## Augmented Designs Analysis

### Standard Errors

Differences in adjusted treatment means  
from different blocks:

$$S_{\bar{d}} = \sqrt{\frac{2(c+1)MSE}{c}}$$

Difference between an adjusted treatment  
mean and check mean:

$$S_{\bar{d}} = \sqrt{\frac{(r+1)(c+1)MSE}{rc}}$$

## Augmented Designs Wheat Example

Peterson, 1994, p. 170

### Design:

t = 30 wheat selections

c = 3 checks

r = 6 reps

n = t/r = 5 selections / rep

p = c + n = 8 plots per rep

N = rc + t = 48 total plots

## Augmented Designs Wheat Example

### ANOVA

Source	DF	SS	MS	F	Pr > F
Block	5	6968486	1393697		
Check	2	20050	10025.39	0.11	0.8969
Error	10	911026	<b>91102.66</b>		
Total	17	7899563			

## Augmented Designs Wheat Example

### Block Adjustment Factors

Check	Block						Mean
	1	2	3	4	5	6	
<b>Cimmaron</b>	2592	3023	2918	2940	1398	3483	2725.7
<b>Stork</b>	2972	3122	2260	3348	1315	3538	2759.2
<b>Waha</b>	2608	2477	3107	2850	1625	3400	2677.8
<b>Mean</b>	2724.0	2874.0	2761.7	3046.0	1446.0	3473.7	2720.9
<b>a</b>	3.1	153.1	40.8	325.1	-1274.9	752.8	

## Augmented Designs Wheat Example

### Standard Errors

Differences in check means:

$$S_{\bar{d}} = \sqrt{\frac{2(91,103)}{6}} = 174$$

Differences in adjusted treatment means  
from the same block:

$$S_{\bar{d}} = \sqrt{2(91,103)} = 427$$

## Augmented Designs Wheat Example

### Standard Errors

Differences in adjusted treatment means  
from different blocks:

$$S_{\bar{d}} = \sqrt{\frac{2(3+1)91,103}{3}} = 493$$

Difference between an adjusted treatment  
mean and check mean:

$$S_{\bar{d}} = \sqrt{\frac{(6+1)(3+1)91,103}{6(3)}} = 376$$



## Augmented Designs SAS Analysis

```
proc mixed;  
  class rep trt;  
  model yld = rep trt;  
  lsmeans trt / pdiff;  
run;
```

## Augmented Designs SAS Analysis

```
proc mixed data=a;  
  class block select;  
  model yield = block select;  
  estimate 'Sel in same Block' select -1 0 0 1;  
  estimate 'Sel in dif Block' select -1 1;  
  estimate 'Check means' select 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0  
    0 0 0 0 0 0 0 0 0 0 0 0 0 0 -1 1;  
  estimate 'Check v. Sel means' select 0 0 0 0 0 0 0 0 0 0 0 0 0 0  
    0 0 0 0 0 0 0 0 0 0 0 0 0 0 -1 1;  
run;
```

### SAS Analysis

#### Type 3 Tests of Fixed Effects

Effect	Num DF	Den DF	F Value	Pr > F
block	5	10	15.30	0.0002
select	32	10	1.40	0.2930

#### Estimates

Label	Estimate	Standard Error	DF	t Value	Pr >  t
Sel in same Block	-628.00	426.86	10	-1.47	0.1720
Sel in dif Block	307.67	492.89	10	0.62	0.5465
Check means	33.50	174.26	10	0.19	0.8514
Check v. Sel means	782.78	362.76	10	2.16	0.0563