```
1          ************************************************************;
2          *** Example of a Repeated Measures Design                ***;
3          *** From Snedecor & Cochran, 1960 (pg 379) with modifications ***;
4          ************************************************************;
5          OPTIONS PS=256 LS=121 NOCENTER NODATE PAGENO=1 NONUMBER;
6          DATA HARVEST (KEEP=CUTTING BLOCK YEAR HARVEST); INFILE CARDS MISSOVER;
7             ARRAY C YIELD1-YIELD4;
8             INPUT BLOCK $ YEAR $ YIELD1-YIELD4;
9             DO I = 1 TO 4;
10               IF I = 1 THEN CUTTING = '6/1 ';
11               IF I = 2 THEN CUTTING = '6/15';
12               IF I = 3 THEN CUTTING = '7/1 ';
13               IF I = 4 THEN CUTTING = '7/15';
14               HARVEST = C{I}; OUTPUT;  END;
15               TITLE1 'EXST7015: Total Asparagus weight harvested before 6/1
(measures vigor)';
16               TITLE2 'Repeated measure is 4 years of the study';
17         CARDS;
NOTE: The data set WORK.HARVEST has 64 observations and 4 variables.
NOTE: DATA statement used:
      real time           0.07 seconds
      cpu time            0.07 seconds
17       !        RUN;
34         ;
35         PROC PRINT; TITLE3 'RAW DATA LISTING'; RUN;
NOTE: There were 64 observations read from the data set WORK.HARVEST.
NOTE: The PROCEDURE PRINT printed page 1.
NOTE: PROCEDURE PRINT used:
      real time           0.03 seconds
      cpu time            0.03 seconds
```

EXST7015: Total Asparagus weight harvested before 6/1 (measures vigor)
Repeated measure is 4 years of the study
RAW DATA LISTING

Obs	BLOCK	YEAR	CUTTING	HARVEST	33	3	0	6/1	219
1	1	0	6/1	230	34	3	0	6/15	151
2	1	0	6/15	212	35	3	0	7/1	177
3	1	0	7/1	183	36	3	0	7/15	107
4	1	0	7/15	148	37	3	1	6/1	357
5	1	1	6/1	324	38	3	1	6/15	278
6	1	1	6/15	415	39	3	1	7/1	298
7	1	1	7/1	320	40	3	1	7/15	192
8	1	1	7/15	246	41	3	2	6/1	496
9	1	2	6/1	512	42	3	2	6/15	399
10	1	2	6/15	584	43	3	2	7/1	427
11	1	2	7/1	456	44	3	2	7/15	271
12	1	2	7/15	304	45	3	3	6/1	344
13	1	3	6/1	399	46	3	3	6/15	254
14	1	3	6/15	386	47	3	3	7/1	239
15	1	3	7/1	255	48	3	3	7/15	90
16	1	3	7/15	144	49	4	0	6/1	200
17	2	0	6/1	216	50	4	0	6/15	150
18	2	0	6/15	190	51	4	0	7/1	209
19	2	0	7/1	186	52	4	0	7/15	168
20	2	0	7/15	126	53	4	1	6/1	362
21	2	1	6/1	317	54	4	1	6/15	336
22	2	1	6/15	296	55	4	1	7/1	328
23	2	1	7/1	295	56	4	1	7/15	226
24	2	1	7/15	201	57	4	2	6/1	540
25	2	2	6/1	448	58	4	2	6/15	485
26	2	2	6/15	471	59	4	2	7/1	462
27	2	2	7/1	387	60	4	2	7/15	312
28	2	2	7/15	289	61	4	3	6/1	381
29	2	3	6/1	361	62	4	3	6/15	279
30	2	3	6/15	280	63	4	3	7/1	244
31	2	3	7/1	187	64	4	3	7/15	168
32	2	3	7/15	83					

```
36          PROC MIXED DATA=HARVEST CL; CLASSES BLOCK YEAR CUTTING;
37              TITLE3 'Split plot Analysis of Variance with PROC MIXED and AR(1) covariance';
38            MODEL HARVEST = CUTTING YEAR CUTTING*YEAR / htype=3 outp=ResidDataP;
39              RANDOM BLOCK BLOCK*CUTTING;
40              REPEATED YEAR / SUBJECT=BLOCK*CUTTING TYPE=AR(1);
41              lsmeans cutting*year / slice=year;
42              lsmeans cutting year cutting*year / pdiff adjust=tukey;
43          RUN;
NOTE: Convergence criteria met.
NOTE: The data set WORK.RESIDDATAP has 64 observations and 11 variables.
NOTE: The PROCEDURE MIXED printed pages 2-3.
NOTE: PROCEDURE MIXED used:
      real time           0.54 seconds
      cpu time            0.54 seconds
43       !      QUIT;OPTIONS PS=50 LS=80;

EXST7015: Total Asparagus weight harvested before 6/1 (measures vigor)
Repeated measure is 4 years of the study
Split plot Analysis of Variance with PROC MIXED and AR(1) covariance

The Mixed Procedure

                  Model Information

Data Set                     WORK.HARVEST
Dependent Variable           HARVEST
Covariance Structures        Variance Components,
                             Autoregressive
Subject Effect               BLOCK*CUTTING
Estimation Method            REML
Residual Variance Method     Profile
Fixed Effects SE Method      Model-Based
Degrees of Freedom Method    Containment

Class Level Information
Class      Levels    Values
BLOCK           4    1 2 3 4
YEAR            4    0 1 2 3
CUTTING         4    6/1 6/15 7/1 7/15

Dimensions
Covariance Parameters            4
Columns in X                    25
Columns in Z                    20
Subjects                         1
Max Obs Per Subject             64
Observations Used               64
Observations Not Used            0
Total Observations              64

Iteration History
Iteration    Evaluations    -2 Res Log Like       Criterion
        0              1       506.34762590
        1              3       470.97346057      0.00021691
        2              2       470.94926182      0.00004073
        3              1       470.94074781      0.00000105
        4              1       470.94054268      0.00000000
                  Convergence criteria met.
```

Covariance Parameter Estimates

Cov Parm	Subject	Estimate	Alpha	Lower	Upper
BLOCK		421.43	0.05	105.67	31077
BLOCK*CUTTING		126.08	0.05	11.1978	9.021E30
AR(1)	BLOCK*CUTTING	0.5612	0.05	-0.03582	1.1582
Residual		765.31	0.05	277.67	6046.99

Fit Statistics

-2 Res Log Likelihood	470.9
AIC (smaller is better)	478.9
AICC (smaller is better)	479.9
BIC (smaller is better)	476.5

Type 3 Tests of Fixed Effects

Effect	Num DF	Den DF	F Value	Pr > F
CUTTING	3	9	36.20	<.0001
YEAR	3	36	431.61	<.0001
YEAR*CUTTING	9	36	8.91	<.0001

Least Squares Means

Effect	YEAR	CUTTING	Estimate	Standard Error	DF	t Value	Pr > |t|
YEAR*CUTTING	0	6/1	216.25	18.1164	36	11.94	<.0001
YEAR*CUTTING	0	6/15	175.75	18.1164	36	9.70	<.0001
YEAR*CUTTING	0	7/1	188.75	18.1164	36	10.42	<.0001
YEAR*CUTTING	0	7/15	137.25	18.1164	36	7.58	<.0001
YEAR*CUTTING	1	6/1	340.00	18.1164	36	18.77	<.0001
YEAR*CUTTING	1	6/15	331.25	18.1164	36	18.28	<.0001
YEAR*CUTTING	1	7/1	310.25	18.1164	36	17.13	<.0001
YEAR*CUTTING	1	7/15	216.25	18.1164	36	11.94	<.0001
YEAR*CUTTING	2	6/1	499.00	18.1164	36	27.54	<.0001
YEAR*CUTTING	2	6/15	484.75	18.1164	36	26.76	<.0001
YEAR*CUTTING	2	7/1	433.00	18.1164	36	23.90	<.0001
YEAR*CUTTING	2	7/15	294.00	18.1164	36	16.23	<.0001
YEAR*CUTTING	3	6/1	371.25	18.1164	36	20.49	<.0001
YEAR*CUTTING	3	6/15	299.75	18.1164	36	16.55	<.0001
YEAR*CUTTING	3	7/1	231.25	18.1164	36	12.76	<.0001
YEAR*CUTTING	3	7/15	121.25	18.1164	36	6.69	<.0001
CUTTING		6/1	356.63	15.6289	9	22.82	<.0001
CUTTING		6/15	322.88	15.6289	9	20.66	<.0001
CUTTING		7/1	290.81	15.6289	9	18.61	<.0001
CUTTING		7/15	192.19	15.6289	9	12.30	<.0001
YEAR	0		179.50	12.6913	36	14.14	<.0001
YEAR	1		299.44	12.6913	36	23.59	<.0001
YEAR	2		427.69	12.6913	36	33.70	<.0001
YEAR	3		255.88	12.6913	36	20.16	<.0001
YEAR*CUTTING	0	6/1	216.25	18.1164	36	11.94	<.0001
YEAR*CUTTING	0	6/15	175.75	18.1164	36	9.70	<.0001
YEAR*CUTTING	0	7/1	188.75	18.1164	36	10.42	<.0001
YEAR*CUTTING	0	7/15	137.25	18.1164	36	7.58	<.0001
YEAR*CUTTING	1	6/1	340.00	18.1164	36	18.77	<.0001
YEAR*CUTTING	1	6/15	331.25	18.1164	36	18.28	<.0001
YEAR*CUTTING	1	7/1	310.25	18.1164	36	17.13	<.0001
YEAR*CUTTING	1	7/15	216.25	18.1164	36	11.94	<.0001
YEAR*CUTTING	2	6/1	499.00	18.1164	36	27.54	<.0001
YEAR*CUTTING	2	6/15	484.75	18.1164	36	26.76	<.0001
YEAR*CUTTING	2	7/1	433.00	18.1164	36	23.90	<.0001
YEAR*CUTTING	2	7/15	294.00	18.1164	36	16.23	<.0001
YEAR*CUTTING	3	6/1	371.25	18.1164	36	20.49	<.0001
YEAR*CUTTING	3	6/15	299.75	18.1164	36	16.55	<.0001
YEAR*CUTTING	3	7/1	231.25	18.1164	36	12.76	<.0001
YEAR*CUTTING	3	7/15	121.25	18.1164	36	6.69	<.0001

Differences of Least Squares Means

Effect	YEAR	CUTTING	_YEAR	_CUTTING	Estimate	Standard Error	DF	t Value	Pr > |t|	Adjustment	Adj P
CUTTING		6/1		6/15	33.7500	16.6677	9	2.02	0.0735	Tukey-Kramer	0.2482
CUTTING		6/1		7/1	65.8125	16.6677	9	3.95	0.0034	Tukey-Kramer	0.0146
CUTTING		6/1		7/15	164.44	16.6677	9	9.87	<.0001	Tukey-Kramer	<.0001
CUTTING		6/15		7/1	32.0625	16.6677	9	1.92	0.0866	Tukey-Kramer	0.2841
CUTTING		6/15		7/15	130.69	16.6677	9	7.84	<.0001	Tukey-Kramer	0.0001
CUTTING		7/1		7/15	98.6250	16.6677	9	5.92	0.0002	Tukey-Kramer	0.0010
YEAR	0		1		-119.94	6.4790	36	-18.51	<.0001	Tukey-Kramer	<.0001
YEAR	0		2		-248.19	8.0954	36	-30.66	<.0001	Tukey-Kramer	<.0001
YEAR	0		3		-76.3750	8.8744	36	-8.61	<.0001	Tukey-Kramer	<.0001
YEAR	1		2		-128.25	6.4790	36	-19.79	<.0001	Tukey-Kramer	<.0001
YEAR	1		3		43.5625	8.0954	36	5.38	<.0001	Tukey-Kramer	<.0001
YEAR	2		3		171.81	6.4790	36	26.52	<.0001	Tukey-Kramer	<.0001
YEAR*CUTTING	0	6/1	0	6/15	40.5000	21.1114	36	1.92	0.0630	Tukey-Kramer	0.8508
YEAR*CUTTING	0	6/1	0	7/1	27.5000	21.1114	36	1.30	0.2010	Tukey-Kramer	0.9932
YEAR*CUTTING	0	6/1	0	7/15	79.0000	21.1114	36	3.74	0.0006	Tukey-Kramer	0.0425
YEAR*CUTTING	0	6/1	1	6/1	-123.75	12.9580	36	-9.55	<.0001	Tukey-Kramer	<.0001
YEAR*CUTTING	0	6/1	1	6/15	-115.00	21.1114	36	-5.45	<.0001	Tukey-Kramer	0.0004
YEAR*CUTTING	0	6/1	1	7/1	-94.0000	21.1114	36	-4.45	<.0001	Tukey-Kramer	0.0065
YEAR*CUTTING	0	6/1	1	7/15	-368E-15	21.1114	36	-0.00	1.0000	Tukey-Kramer	1.0000
YEAR*CUTTING	0	6/1	2	6/1	-282.75	16.1907	36	-17.46	<.0001	Tukey-Kramer	<.0001
YEAR*CUTTING	0	6/1	2	6/15	-268.50	21.1114	36	-12.72	<.0001	Tukey-Kramer	<.0001
YEAR*CUTTING	0	6/1	2	7/1	-216.75	21.1114	36	-10.27	<.0001	Tukey-Kramer	<.0001
YEAR*CUTTING	0	6/1	2	7/15	-77.7500	21.1114	36	-3.68	0.0008	Tukey-Kramer	0.0492
YEAR*CUTTING	0	6/1	3	6/1	-155.00	17.7489	36	-8.73	<.0001	Tukey-Kramer	<.0001
YEAR*CUTTING	0	6/1	3	6/15	-83.5000	21.1114	36	-3.96	0.0003	Tukey-Kramer	0.0248
YEAR*CUTTING	0	6/1	3	7/1	-15.0000	21.1114	36	-0.71	0.4820	Tukey-Kramer	1.0000
YEAR*CUTTING	0	6/1	3	7/15	95.0000	21.1114	36	4.50	<.0001	Tukey-Kramer	0.0057
YEAR*CUTTING	0	6/15	0	7/1	-13.0000	21.1114	36	-0.62	0.5419	Tukey-Kramer	1.0000
YEAR*CUTTING	0	6/15	0	7/15	38.5000	21.1114	36	1.82	0.0765	Tukey-Kramer	0.8916
YEAR*CUTTING	0	6/15	1	6/1	-164.25	21.1114	36	-7.78	<.0001	Tukey-Kramer	<.0001
YEAR*CUTTING	0	6/15	1	6/15	-155.50	12.9580	36	-12.00	<.0001	Tukey-Kramer	<.0001
YEAR*CUTTING	0	6/15	1	7/1	-134.50	21.1114	36	-6.37	<.0001	Tukey-Kramer	<.0001
YEAR*CUTTING	0	6/15	1	7/15	-40.5000	21.1114	36	-1.92	0.0630	Tukey-Kramer	0.8508
YEAR*CUTTING	0	6/15	2	6/1	-323.25	21.1114	36	-15.31	<.0001	Tukey-Kramer	<.0001
YEAR*CUTTING	0	6/15	2	6/15	-309.00	16.1907	36	-19.08	<.0001	Tukey-Kramer	<.0001
YEAR*CUTTING	0	6/15	2	7/1	-257.25	21.1114	36	-12.19	<.0001	Tukey-Kramer	<.0001
YEAR*CUTTING	0	6/15	2	7/15	-118.25	21.1114	36	-5.60	<.0001	Tukey-Kramer	0.0002
YEAR*CUTTING	0	6/15	3	6/1	-195.50	21.1114	36	-9.26	<.0001	Tukey-Kramer	<.0001
YEAR*CUTTING	0	6/15	3	6/15	-124.00	17.7489	36	-6.99	<.0001	Tukey-Kramer	<.0001
YEAR*CUTTING	0	6/15	3	7/1	-55.5000	21.1114	36	-2.63	0.0125	Tukey-Kramer	0.4112
YEAR*CUTTING	0	6/15	3	7/15	54.5000	21.1114	36	2.58	0.0141	Tukey-Kramer	0.4406
YEAR*CUTTING	0	7/1	0	7/15	51.5000	21.1114	36	2.44	0.0198	Tukey-Kramer	0.5329
YEAR*CUTTING	0	7/1	1	6/1	-151.25	21.1114	36	-7.16	<.0001	Tukey-Kramer	<.0001
YEAR*CUTTING	0	7/1	1	6/15	-142.50	21.1114	36	-6.75	<.0001	Tukey-Kramer	<.0001
YEAR*CUTTING	0	7/1	1	7/1	-121.50	12.9580	36	-9.38	<.0001	Tukey-Kramer	<.0001
YEAR*CUTTING	0	7/1	1	7/15	-27.5000	21.1114	36	-1.30	0.2010	Tukey-Kramer	0.9932
YEAR*CUTTING	0	7/1	2	6/1	-310.25	21.1114	36	-14.70	<.0001	Tukey-Kramer	<.0001
YEAR*CUTTING	0	7/1	2	6/15	-296.00	21.1114	36	-14.02	<.0001	Tukey-Kramer	<.0001
YEAR*CUTTING	0	7/1	2	7/1	-244.25	16.1907	36	-15.09	<.0001	Tukey-Kramer	<.0001
YEAR*CUTTING	0	7/1	2	7/15	-105.25	21.1114	36	-4.99	<.0001	Tukey-Kramer	0.0014
YEAR*CUTTING	0	7/1	3	6/1	-182.50	21.1114	36	-8.64	<.0001	Tukey-Kramer	<.0001
YEAR*CUTTING	0	7/1	3	6/15	-111.00	21.1114	36	-5.26	<.0001	Tukey-Kramer	0.0006
YEAR*CUTTING	0	7/1	3	7/1	-42.5000	17.7489	36	-2.39	0.0220	Tukey-Kramer	0.5629
YEAR*CUTTING	0	7/1	3	7/15	67.5000	21.1114	36	3.20	0.0029	Tukey-Kramer	0.1478
YEAR*CUTTING	0	7/15	1	6/1	-202.75	21.1114	36	-9.60	<.0001	Tukey-Kramer	<.0001
YEAR*CUTTING	0	7/15	1	6/15	-194.00	21.1114	36	-9.19	<.0001	Tukey-Kramer	<.0001
YEAR*CUTTING	0	7/15	1	7/1	-173.00	21.1114	36	-8.19	<.0001	Tukey-Kramer	<.0001
YEAR*CUTTING	0	7/15	1	7/15	-79.0000	12.9580	36	-6.10	<.0001	Tukey-Kramer	<.0001
YEAR*CUTTING	0	7/15	2	6/1	-361.75	21.1114	36	-17.14	<.0001	Tukey-Kramer	<.0001
YEAR*CUTTING	0	7/15	2	6/15	-347.50	21.1114	36	-16.46	<.0001	Tukey-Kramer	<.0001
YEAR*CUTTING	0	7/15	2	7/1	-295.75	21.1114	36	-14.01	<.0001	Tukey-Kramer	<.0001
YEAR*CUTTING	0	7/15	2	7/15	-156.75	16.1907	36	-9.68	<.0001	Tukey-Kramer	<.0001
YEAR*CUTTING	0	7/15	3	6/1	-234.00	21.1114	36	-11.08	<.0001	Tukey-Kramer	<.0001
YEAR*CUTTING	0	7/15	3	6/15	-162.50	21.1114	36	-7.70	<.0001	Tukey-Kramer	<.0001
YEAR*CUTTING	0	7/15	3	7/1	-94.0000	21.1114	36	-4.45	<.0001	Tukey-Kramer	0.0065
YEAR*CUTTING	0	7/15	3	7/15	16.0000	17.7489	36	0.90	0.3733	Tukey-Kramer	0.9999
YEAR*CUTTING	1	6/1	1	6/15	8.7500	21.1114	36	0.41	0.6810	Tukey-Kramer	1.0000
YEAR*CUTTING	1	6/1	1	7/1	29.7500	21.1114	36	1.41	0.1674	Tukey-Kramer	0.9858
YEAR*CUTTING	1	6/1	1	7/15	123.75	21.1114	36	5.86	<.0001	Tukey-Kramer	0.0001
YEAR*CUTTING	1	6/1	2	6/1	-159.00	12.9580	36	-12.27	<.0001	Tukey-Kramer	<.0001
YEAR*CUTTING	1	6/1	2	6/15	-144.75	21.1114	36	-6.86	<.0001	Tukey-Kramer	<.0001
YEAR*CUTTING	1	6/1	2	7/1	-93.0000	21.1114	36	-4.41	<.0001	Tukey-Kramer	0.0074
YEAR*CUTTING	1	6/1	2	7/15	46.0000	21.1114	36	2.18	0.0360	Tukey-Kramer	0.7048
YEAR*CUTTING	1	6/1	3	6/1	-31.2500	16.1907	36	-1.93	0.0615	Tukey-Kramer	0.8452
YEAR*CUTTING	1	6/1	3	6/15	40.2500	21.1114	36	1.91	0.0646	Tukey-Kramer	0.8563
YEAR*CUTTING	1	6/1	3	7/1	108.75	21.1114	36	5.15	<.0001	Tukey-Kramer	0.0009
YEAR*CUTTING	1	6/1	3	7/15	218.75	21.1114	36	10.36	<.0001	Tukey-Kramer	<.0001
YEAR*CUTTING	1	6/15	1	7/1	21.0000	21.1114	36	0.99	0.3265	Tukey-Kramer	0.9996
YEAR*CUTTING	1	6/15	1	7/15	115.00	21.1114	36	5.45	<.0001	Tukey-Kramer	0.0004
YEAR*CUTTING	1	6/15	2	6/1	-167.75	21.1114	36	-7.95	<.0001	Tukey-Kramer	<.0001
YEAR*CUTTING	1	6/15	2	6/15	-153.50	12.9580	36	-11.85	<.0001	Tukey-Kramer	<.0001
YEAR*CUTTING	1	6/15	2	7/1	-101.75	21.1114	36	-4.82	<.0001	Tukey-Kramer	0.0023
YEAR*CUTTING	1	6/15	2	7/15	37.2500	21.1114	36	1.76	0.0861	Tukey-Kramer	0.9133
YEAR*CUTTING	1	6/15	3	6/1	-40.0000	21.1114	36	-1.89	0.0662	Tukey-Kramer	0.8617

YEAR*CUTTING	1	6/15	3	6/15	31.5000	16.1907	36	1.95	0.0595	Tukey-Kramer	0.8377
YEAR*CUTTING	1	6/15	3	7/1	100.00	21.1114	36	4.74	<.0001	Tukey-Kramer	0.0029
YEAR*CUTTING	1	6/15	3	7/15	210.00	21.1114	36	9.95	<.0001	Tukey-Kramer	<.0001
YEAR*CUTTING	1	7/1	1	7/15	94.0000	21.1114	36	4.45	<.0001	Tukey-Kramer	0.0065
YEAR*CUTTING	1	7/1	2	6/1	-188.75	21.1114	36	-8.94	<.0001	Tukey-Kramer	<.0001
YEAR*CUTTING	1	7/1	2	6/15	-174.50	21.1114	36	-8.27	<.0001	Tukey-Kramer	<.0001
YEAR*CUTTING	1	7/1	2	7/1	-122.75	12.9580	36	-9.47	<.0001	Tukey-Kramer	<.0001
YEAR*CUTTING	1	7/1	2	7/15	16.2500	21.1114	36	0.77	0.4465	Tukey-Kramer	1.0000
YEAR*CUTTING	1	7/1	3	6/1	-61.0000	21.1114	36	-2.89	0.0065	Tukey-Kramer	0.2683
YEAR*CUTTING	1	7/1	3	6/15	10.5000	21.1114	36	0.50	0.6220	Tukey-Kramer	1.0000
YEAR*CUTTING	1	7/1	3	7/1	79.0000	16.1907	36	4.88	<.0001	Tukey-Kramer	0.0019
YEAR*CUTTING	1	7/1	3	7/15	189.00	21.1114	36	8.95	<.0001	Tukey-Kramer	<.0001
YEAR*CUTTING	1	7/15	2	6/1	-282.75	21.1114	36	-13.39	<.0001	Tukey-Kramer	<.0001
YEAR*CUTTING	1	7/15	2	6/15	-268.50	21.1114	36	-12.72	<.0001	Tukey-Kramer	<.0001
YEAR*CUTTING	1	7/15	2	7/1	-216.75	21.1114	36	-10.27	<.0001	Tukey-Kramer	<.0001
YEAR*CUTTING	1	7/15	2	7/15	-77.7500	12.9580	36	-6.00	<.0001	Tukey-Kramer	<.0001
YEAR*CUTTING	1	7/15	3	6/1	-155.00	21.1114	36	-7.34	<.0001	Tukey-Kramer	<.0001
YEAR*CUTTING	1	7/15	3	6/15	-83.5000	21.1114	36	-3.96	0.0003	Tukey-Kramer	0.0248
YEAR*CUTTING	1	7/15	3	7/1	-15.0000	21.1114	36	-0.71	0.4820	Tukey-Kramer	1.0000
YEAR*CUTTING	1	7/15	3	7/15	95.0000	16.1907	36	5.87	<.0001	Tukey-Kramer	0.0001
YEAR*CUTTING	2	6/1	2	6/15	14.2500	21.1114	36	0.67	0.5040	Tukey-Kramer	1.0000
YEAR*CUTTING	2	6/1	2	7/1	66.0000	21.1114	36	3.13	0.0035	Tukey-Kramer	0.1710
YEAR*CUTTING	2	6/1	2	7/15	205.00	21.1114	36	9.71	<.0001	Tukey-Kramer	<.0001
YEAR*CUTTING	2	6/1	3	6/1	127.75	12.9580	36	9.86	<.0001	Tukey-Kramer	<.0001
YEAR*CUTTING	2	6/1	3	6/15	199.25	21.1114	36	9.44	<.0001	Tukey-Kramer	<.0001
YEAR*CUTTING	2	6/1	3	7/1	267.75	21.1114	36	12.68	<.0001	Tukey-Kramer	<.0001
YEAR*CUTTING	2	6/1	3	7/15	377.75	21.1114	36	17.89	<.0001	Tukey-Kramer	<.0001
YEAR*CUTTING	2	6/15	2	7/1	51.7500	21.1114	36	2.45	0.0192	Tukey-Kramer	0.5250
YEAR*CUTTING	2	6/15	2	7/15	190.75	21.1114	36	9.04	<.0001	Tukey-Kramer	<.0001
YEAR*CUTTING	2	6/15	3	6/1	113.50	21.1114	36	5.38	<.0001	Tukey-Kramer	0.0005
YEAR*CUTTING	2	6/15	3	6/15	185.00	12.9580	36	14.28	<.0001	Tukey-Kramer	<.0001
YEAR*CUTTING	2	6/15	3	7/1	253.50	21.1114	36	12.01	<.0001	Tukey-Kramer	<.0001
YEAR*CUTTING	2	6/15	3	7/15	363.50	21.1114	36	17.22	<.0001	Tukey-Kramer	<.0001
YEAR*CUTTING	2	7/1	2	7/15	139.00	21.1114	36	6.58	<.0001	Tukey-Kramer	<.0001
YEAR*CUTTING	2	7/1	3	6/1	61.7500	21.1114	36	2.92	0.0059	Tukey-Kramer	0.2516
YEAR*CUTTING	2	7/1	3	6/15	133.25	21.1114	36	6.31	<.0001	Tukey-Kramer	<.0001
YEAR*CUTTING	2	7/1	3	7/1	201.75	12.9580	36	15.57	<.0001	Tukey-Kramer	<.0001
YEAR*CUTTING	2	7/1	3	7/15	311.75	21.1114	36	14.77	<.0001	Tukey-Kramer	<.0001
YEAR*CUTTING	2	7/15	3	6/1	-77.2500	21.1114	36	-3.66	0.0008	Tukey-Kramer	0.0521
YEAR*CUTTING	2	7/15	3	6/15	-5.7500	21.1114	36	-0.27	0.7869	Tukey-Kramer	1.0000
YEAR*CUTTING	2	7/15	3	7/1	62.7500	21.1114	36	2.97	0.0052	Tukey-Kramer	0.2306
YEAR*CUTTING	2	7/15	3	7/15	172.75	12.9580	36	13.33	<.0001	Tukey-Kramer	<.0001
YEAR*CUTTING	3	6/1	3	6/15	71.5000	21.1114	36	3.39	0.0017	Tukey-Kramer	0.0982
YEAR*CUTTING	3	6/1	3	7/1	140.00	21.1114	36	6.63	<.0001	Tukey-Kramer	<.0001
YEAR*CUTTING	3	6/1	3	7/15	250.00	21.1114	36	11.84	<.0001	Tukey-Kramer	<.0001
YEAR*CUTTING	3	6/15	3	7/1	68.5000	21.1114	36	3.24	0.0025	Tukey-Kramer	0.1338
YEAR*CUTTING	3	6/15	3	7/15	178.50	21.1114	36	8.46	<.0001	Tukey-Kramer	<.0001
YEAR*CUTTING	3	7/1	3	7/15	110.00	21.1114	36	5.21	<.0001	Tukey-Kramer	0.0007

Tests of Effect Slices

Effect	YEAR	Num DF	Den DF	F Value	Pr > F
YEAR*CUTTING	0	3	36	4.84	0.0062
YEAR*CUTTING	1	3	36	14.50	<.0001
YEAR*CUTTING	2	3	36	39.25	<.0001
YEAR*CUTTING	3	3	36	50.81	<.0001

```
44         proc univariate data=ResidDataP plot normal; var resid;
45           TITLE3 'Univariate analysis for PROC MIXED - Nested Error'; run;
NOTE: The PROCEDURE UNIVARIATE printed pages 4-7.
NOTE: PROCEDURE UNIVARIATE used:
      real time           0.03 seconds
      cpu time            0.03 seconds
EXST7015: Total Asparagus weight harvested before 6/1 (measures vigor)
Repeated measure is 4 years of the study
Univariate analysis for PROC MIXED - Nested Error
```

The UNIVARIATE Procedure
Variable: Resid

Moments

N	64	Sum Weights	64
Mean	0	Sum Observations	0
Std Deviation	22.0769009	Variance	487.389552
Skewness	0.3114769	Kurtosis	1.4598985
Uncorrected SS	30705.5418	Corrected SS	30705.5418
Coeff Variation	.	Std Error Mean	2.75961261

Basic Statistical Measures

Location		Variability	
Mean	0.000000	Std Deviation	22.07690
Median	1.285035	Variance	487.38955
Mode	.	Range	129.16819
		Interquartile Range	20.82758

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	0	Pr > |t|	1.0000
Sign	M	2	Pr >= |M|	0.7080
Signed Rank	S	-9	Pr >= |S|	0.9526

Tests for Normality

Test	--Statistic---		-----p Value------	
Shapiro-Wilk	W	0.966233	Pr < W	0.0769
Kolmogorov-Smirnov	D	0.093618	Pr > D	>0.1500
Cramer-von Mises	W-Sq	0.135493	Pr > W-Sq	0.0380
Anderson-Darling	A-Sq	0.798106	Pr > A-Sq	0.0385

The UNIVARIATE Procedure
Variable: Resid
Quantiles (Definition 5)

Quantile	Estimate
100% Max	66.37476
99%	66.37476
95%	33.43647
90%	26.63720
75% Q3	9.89557
50% Median	1.28503
25% Q1	-10.93201
10%	-28.06856
5%	-30.29342
1%	-62.79342
0% Min	-62.79342

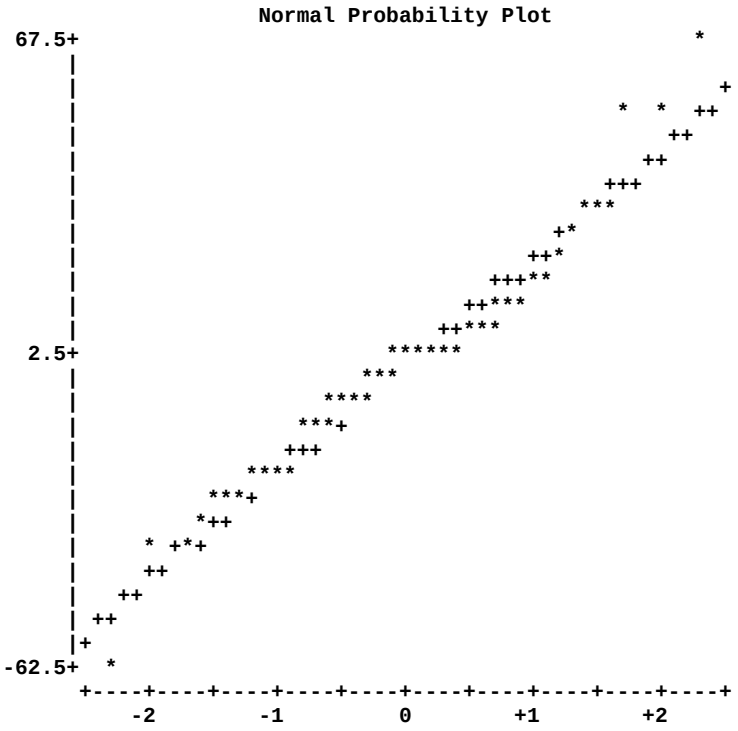
Extreme Observations

------Lowest-----		-----Highest-----	
Value	Obs	Value	Obs
-62.7934	42	33.2337	57
-37.3201	25	33.4365	64
-35.7125	5	50.8748	6
-30.2934	38	53.3748	14
-29.8186	27	66.3748	10

EXST7015: Total Asparagus weight harvested before 6/1 (measures vigor)
Repeated measure is 4 years of the study
Univariate analysis for PROC MIXED - Nested Error

The UNIVARIATE Procedure
Variable: Resid

```
Stem Leaf                     #  Boxplot
   6 6                        1     0
   6
   5
   5 13                       2     0
   4
   4
   3
   3 133                      3     |
   2 7                        1     |
   2 1                        1     |
   1 779                      3     |
   1 001334                   6  +-----+
   0 557789                   6  |     |
   0 11222223344             11  *--+--*
  -0 442210                   6  |     |
  -0 997765                   6  |     |
  -1 32110                    5  +-----+
  -1                             |
  -2 43333                    5  |
  -2 885                      3  |
  -3 00                       2  |
  -3 76                       2  |
  -4
  -4
  -5
  -5
  -6 3                        1     0
     ----+----+----+----+
 Multiply Stem.Leaf by 10**+1
```

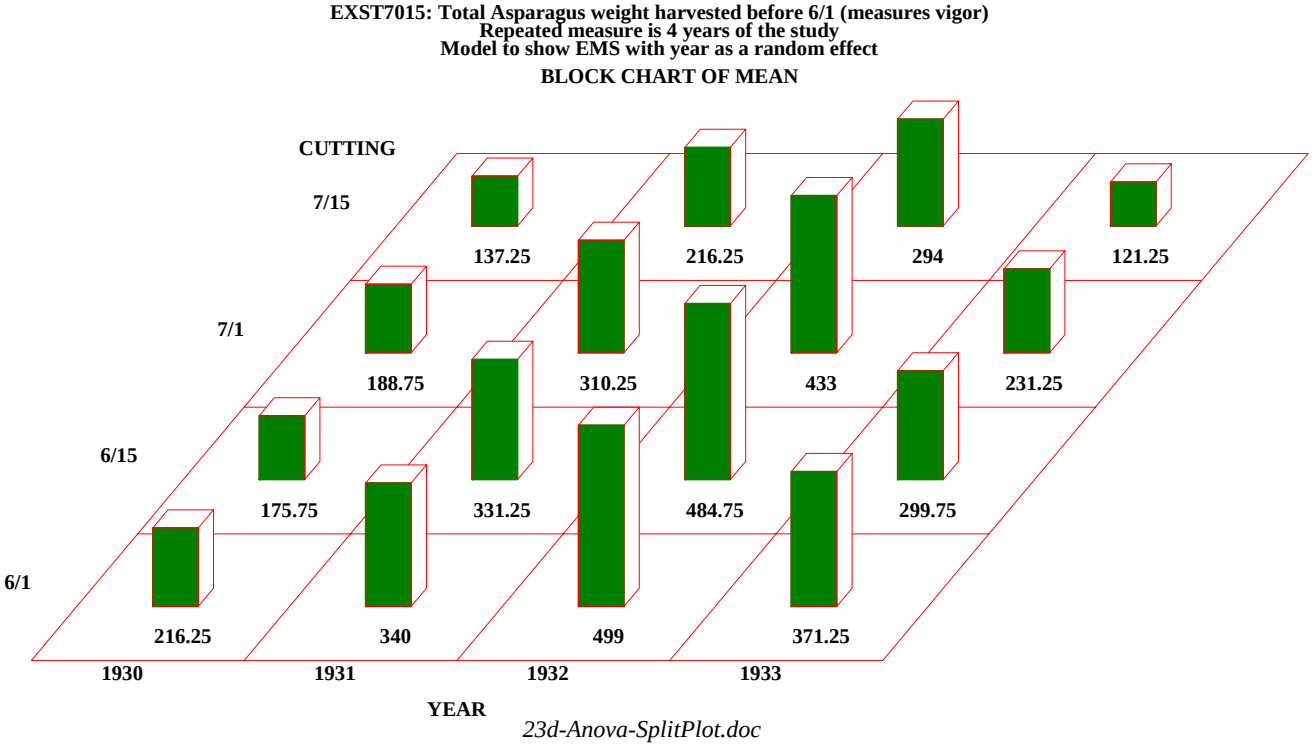


```
47         PROC GLM; CLASSES BLOCK YEAR CUTTING;
48           TITLE3 'Split plot Analysis of Variance with PROC GLM';
49           TITLE4 'The correct analysis : cutting and year (age) as fixed';
50           MODEL HARVEST = BLOCK CUTTING BLOCK*CUTTING YEAR CUTTING*YEAR;
51             TEST H=BLOCK CUTTING E=BLOCK*CUTTING;
52             RANDOM BLOCK BLOCK*CUTTING / TEST; RUN;
NOTE: TYPE I EMS not available without the E1 option.
53           TITLE3 'Model to show EMS with year as a random effect';
54             TEST H=YEAR E=CUTTING*YEAR;
55             RANDOM BLOCK BLOCK*CUTTING YEAR YEAR*CUTTING / TEST;
56         RUN;
NOTE: TYPE I EMS not available without the E1 option.
56       !      QUIT;
NOTE: The PROCEDURE GLM printed pages 8-14.
NOTE: PROCEDURE GLM used:
      real time           0.11 seconds
      cpu time            0.11 seconds


EXST7015: Total Asparagus weight harvested before 6/1 (measures vigor)
Repeated measure is 4 years of the study
Split plot Analysis of Variance with PROC GLM
The correct analysis : cutting and year (age) as fixed

The GLM Procedure
         Class Level Information
Class         Levels    Values
BLOCK              4    1 2 3 4
YEAR               4    0 1 2 3
CUTTING            4    6/1 6/15 7/1 7/15
Number of observations    64

Dependent Variable: HARVEST
                                      Sum of
Source                     DF        Squares    Mean Square   F Value   Pr > F
Model                      27    863306.3750     31974.3102     74.33   <.0001
Error                      36     15486.6250       430.1840
Corrected Total            63    878793.0000

R-Square     Coeff Var      Root MSE    HARVEST Mean
0.982377      7.136646      20.74088        290.6250

Source                     DF      Type I SS    Mean Square   F Value   Pr > F
BLOCK                       3     30169.6250     10056.5417     23.38   <.0001
CUTTING                     3    241376.6250     80458.8750    187.03   <.0001
BLOCK*CUTTING               9     21860.7500      2428.9722      5.65   <.0001
YEAR                        3    518721.8750    172907.2917    401.94   <.0001
YEAR*CUTTING                9     51177.5000      5686.3889     13.22   <.0001

Source                     DF    Type III SS    Mean Square   F Value   Pr > F
BLOCK                       3     30169.6250     10056.5417     23.38   <.0001
CUTTING                     3    241376.6250     80458.8750    187.03   <.0001
BLOCK*CUTTING               9     21860.7500      2428.9722      5.65   <.0001
YEAR                        3    518721.8750    172907.2917    401.94   <.0001
YEAR*CUTTING                9     51177.5000      5686.3889     13.22   <.0001

Tests of Hypotheses Using the Type III MS for BLOCK*CUTTING as an Error Term
Source                     DF    Type III SS    Mean Square   F Value   Pr > F
BLOCK                       3     30169.6250     10056.5417      4.14   0.0423
CUTTING                     3    241376.6250     80458.8750     33.12   <.0001
```

```
EXST7015: Total Asparagus weight harvested before 6/1 (measures vigor)
Repeated measure is 4 years of the study
Split plot Analysis of Variance with PROC GLM
The correct analysis : cutting and year (age) as fixed

The GLM Procedure

Source                 Type III Expected Mean Square
BLOCK                  Var(Error) + 4 Var(BLOCK*CUTTING) + 16 Var(BLOCK)
CUTTING                Var(Error) + 4 Var(BLOCK*CUTTING) +
Q(CUTTING,YEAR*CUTTING)
BLOCK*CUTTING          Var(Error) + 4 Var(BLOCK*CUTTING)
YEAR                   Var(Error) + Q(YEAR,YEAR*CUTTING)
YEAR*CUTTING           Var(Error) + Q(YEAR*CUTTING)

Tests of Hypotheses for Mixed Model Analysis of Variance
Dependent Variable: HARVEST
   Source                     DF   Type III SS   Mean Square  F Value  Pr > F
   BLOCK                       3         30170         10057     4.14  0.0423
*  CUTTING                     3        241377         80459    33.12  <.0001
   Error                       9         21861   2428.972222
Error: MS(BLOCK*CUTTING)
* This test assumes one or more other fixed effects are zero.

   Source                     DF   Type III SS   Mean Square  F Value  Pr > F
   BLOCK*CUTTING               9         21861   2428.972222     5.65  <.0001
*  YEAR                        3        518722        172907   401.94  <.0001
   YEAR*CUTTING                9         51178   5686.388889    13.22  <.0001
   Error: MS(Error)           36         15487    430.184028
* This test assumes one or more other fixed effects are zero.


EXST7015: Total Asparagus weight harvested before 6/1 (measures vigor)
Repeated measure is 4 years of the study
Model to show EMS with year as a random effect

Source                 Type III Expected Mean Square
BLOCK                  Var(Error) + 4 Var(BLOCK*CUTTING) + 16 Var(BLOCK)
CUTTING                Var(Error) + 4 Var(YEAR*CUTTING) + 4 Var(BLOCK*CUTTING) +
Q(CUTTING)
BLOCK*CUTTING          Var(Error) + 4 Var(BLOCK*CUTTING)
YEAR                   Var(Error) + 4 Var(YEAR*CUTTING) + 16 Var(YEAR)
YEAR*CUTTING           Var(Error) + 4 Var(YEAR*CUTTING)

Tests of Hypotheses for Mixed Model Analysis of Variance
Dependent Variable: HARVEST
Source                     DF    Type III SS    Mean Square   F Value   Pr > F
BLOCK                       3          30170          10057      4.14   0.0423
Error                       9          21861    2428.972222
Error: MS(BLOCK*CUTTING)

Source                     DF    Type III SS    Mean Square   F Value   Pr > F
CUTTING                     3         241377          80459     10.47   0.0007
Error                  13.886         106713    7685.177083
Error: MS(BLOCK*CUTTING) + MS(YEAR*CUTTING) - MS(Error)

Source                     DF    Type III SS    Mean Square   F Value   Pr > F
BLOCK*CUTTING               9          21861    2428.972222      5.65   <.0001
YEAR*CUTTING                9          51178    5686.388889     13.22   <.0001
Error: MS(Error)           36          15487     430.184028
```

```
Source                     DF    Type III SS    Mean Square   F Value   Pr > F
YEAR                        3         518722         172907     30.41   <.0001
Error                       9          51178    5686.388889
Error: MS(YEAR*CUTTING)

Source                     DF    Type III SS    Mean Square   F Value   Pr > F
YEAR                        3    518721.8750    172907.2917     30.41   <.0001
```

```
59         GOPTIONS DEVICE=CGMflwa GSFMODE=REPLACE GSFNAME=OUT NOPROMPT
noROTATE
60            ftext='TimesRoman' ftitle='TimesRoman' htext=1 htitle=1
60       ! ctitle=black ctext=black;
61
62         GOPTIONS GSFNAME=OUT3;  FILENAME OUT3
62       ! 'C:\Geaghan\EXST\EXST7015New\Fall2002\SAS\24s-Anova-SplitPlot-
harvest
62       ! .CGM';
63         GOPTIONS VPOS=48 HPOS=90;
64         PROC GCHART DATA=HARVEST;
65            BLOCK YEAR / GROUP=CUTTING SUMVAR=HARVEST DISCRETE TYPE=MEAN;
RUN;
NOTE: Foreground color BLACK same as background. Part of your graph may not
be visible.
NOTE:  20 RECORDS WRITTEN TO
C:\Geaghan\EXST\EXST7015New\Fall2002\SAS\24s-Anova-SplitPlot-harvest.CGM
66         quit;
NOTE: There were 64 observations read from the data set WORK.HARVEST.
NOTE: PROCEDURE GCHART used:
      real time           0.19 seconds
      cpu time            0.11 seconds
67
68         GOPTIONS DEVICE=CGMflwa GSFMODE=REPLACE GSFNAME=OUT NOPROMPT
noROTATE
69            ftext='TimesRoman' ftitle='TimesRoman' htext=1 htitle=1
69       ! ctitle=black ctext=black;
```



```
76          **EXAMPLE 10*****************************************;
77          *** Example of a Split - split Plot Design          ***;
78          *** From Snedecor & Cochran, 1960 (pg 374)          ***;
79          ************************************************************************;
80          ** Yield of Corn in bu/acre in a Split plot design. Main plot is a RBD,**;
81          ** Treatments are irrigation. Sub-plot treatment is stand density, and **;
82          ** Sub-sub plot is fertilizer level.  Stand (10, 13 and 16 thousand)   **;
83          ** and fertilizer (60, 120 and 180) are equally spaced treatments      **;
84          ************************************************************************;
85          OPTIONS PS=61 LS=121 NOCENTER NODATE PAGENO=1;
86          DATA SPLIT (KEEP=IRRIGATE BLOCK STAND YIELD FERT); INFILE CARDS MISSOVER;
87             ARRAY B {4} BLK1-BLK4;
88             INPUT IRRIGATE $ 1-8 STAND FERT BLK1-BLK4;
89             DO BLOCK = 1 TO 4;
90                YIELD = B{BLOCK}; OUTPUT; END;
91            TITLE1 'EXST7015: Yield of Corn in a Split-split plot design. Main plot is RBD';
92          CARDS;
NOTE: The data set WORK.SPLIT has 72 observations and 5 variables.
NOTE: DATA statement used:
      real time           0.04 seconds
      cpu time            0.04 seconds
92        !        RUN;
111         ;
112         PROC PRINT; TITLE2 'RAW DATA LISTING'; RUN;
NOTE: There were 72 observations read from the data set WORK.SPLIT.
NOTE: The PROCEDURE PRINT printed pages 1-2.
NOTE: PROCEDURE PRINT used:
      real time           0.02 seconds
      cpu time            0.02 seconds
```

EXST7015: Yield of Corn in a Split-split plot design. Main plot is RBD
RAW DATA LISTING

Obs	IRRIGATE	STAND	FERT	BLOCK	YIELD	Obs	IRRIGATE	STAND	FERT	BLOCK	YIELD
1	No Irrig	1	1	1	90	37	Irrigate	1	1	1	80
2	No Irrig	1	1	2	83	38	Irrigate	1	1	2	102
3	No Irrig	1	1	3	85	39	Irrigate	1	1	3	60
4	No Irrig	1	1	4	86	40	Irrigate	1	1	4	73
5	No Irrig	1	2	1	95	41	Irrigate	1	2	1	87
6	No Irrig	1	2	2	80	42	Irrigate	1	2	2	109
7	No Irrig	1	2	3	88	43	Irrigate	1	2	3	104
8	No Irrig	1	2	4	78	44	Irrigate	1	2	4	114
9	No Irrig	1	3	1	107	45	Irrigate	1	3	1	100
10	No Irrig	1	3	2	95	46	Irrigate	1	3	2	105
11	No Irrig	1	3	3	88	47	Irrigate	1	3	3	114
12	No Irrig	1	3	4	89	48	Irrigate	1	3	4	114
13	No Irrig	2	1	1	92	49	Irrigate	2	1	1	121
14	No Irrig	2	1	2	98	50	Irrigate	2	1	2	99
15	No Irrig	2	1	3	112	51	Irrigate	2	1	3	90
16	No Irrig	2	1	4	79	52	Irrigate	2	1	4	109
17	No Irrig	2	2	1	89	53	Irrigate	2	2	1	110
18	No Irrig	2	2	2	98	54	Irrigate	2	2	2	94
19	No Irrig	2	2	3	104	55	Irrigate	2	2	3	118
20	No Irrig	2	2	4	86	56	Irrigate	2	2	4	131
21	No Irrig	2	3	1	92	57	Irrigate	2	3	1	119
22	No Irrig	2	3	2	106	58	Irrigate	2	3	2	123
23	No Irrig	2	3	3	91	59	Irrigate	2	3	3	113
24	No Irrig	2	3	4	87	60	Irrigate	2	3	4	126
25	No Irrig	3	1	1	81	61	Irrigate	3	1	1	78
26	No Irrig	3	1	2	74	62	Irrigate	3	1	2	136
27	No Irrig	3	1	3	82	63	Irrigate	3	1	3	119
28	No Irrig	3	1	4	85	64	Irrigate	3	1	4	116
29	No Irrig	3	2	1	92	65	Irrigate	3	2	1	98
30	No Irrig	3	2	2	81	66	Irrigate	3	2	2	133
31	No Irrig	3	2	3	78	67	Irrigate	3	2	3	122
32	No Irrig	3	2	4	89	68	Irrigate	3	2	4	136
33	No Irrig	3	3	1	93	69	Irrigate	3	3	1	122
34	No Irrig	3	3	2	74	70	Irrigate	3	3	2	132
35	No Irrig	3	3	3	94	71	Irrigate	3	3	3	136
36	No Irrig	3	3	4	83	72	Irrigate	3	3	4	133

```
113        PROC MIXED DATA=SPLIT CL; CLASSES BLOCK IRRIGATE STAND FERT;
114          TITLE2 'Split/Split plot Analysis of Variance with PROC MIXED';
115          MODEL YIELD = IRRIGATE STAND IRRIGATE*STAND
116              FERT FERT*IRRIGATE FERT*STAND FERT*IRRIGATE*STAND / htype=3;
117          RANDOM BLOCK BLOCK*IRRIGATE BLOCK*IRRIGATE*STAND;
118          REPEATED FERT / SUBJECT=BLOCK*IRRIGATE*stand TYPE=CS;
119            lsmeans IRRIGATE STAND FERT IRRIGATE*STAND IRRIGATE*FERT / pdiff adjust=tukey;
120            lsmeans IRRIGATE*FERT / slice=fert;
121            lsmeans IRRIGATE*FERT / slice=IRRIGATE;
122            lsmeans IRRIGATE*STAND / slice=stand;
123            lsmeans IRRIGATE*STAND / slice=IRRIGATE;
124        RUN;
NOTE: Convergence criteria met but final hessian is not positive definite.
NOTE: Estimated G matrix is not positive definite.
NOTE: The PROCEDURE MIXED printed pages 3-7.
NOTE: PROCEDURE MIXED used:
      real time           0.68 seconds
      cpu time            0.68 seconds
124      !      QUIT;


EXST7015: Yield of Corn in a Split-split plot design. Main plot is RBD
Split/Split plot Analysis of Variance with PROC MIXED

The Mixed Procedure
                  Model Information
Data Set                      WORK.SPLIT
Dependent Variable            YIELD
Covariance Structures         Variance Components,
                              Compound Symmetry
Subject Effect                BLOCK*IRRIGATE*STAND
Estimation Method             REML
Residual Variance Method      Profile
Fixed Effects SE Method       Model-Based
Degrees of Freedom Method     Containment

Class Level Information
Class       Levels    Values
BLOCK            4    1 2 3 4
IRRIGATE         2    Irrigate No Irrig
STAND            3    1 2 3
FERT             3    1 2 3

Dimensions
Covariance Parameters            5
Columns in X                    48
Columns in Z                    36
Subjects                         1
Max Obs Per Subject             72
Observations Used               72
Observations Not Used            0
Total Observations              72

Iteration History
Iteration    Evaluations    -2 Res Log Like       Criterion
        0              1       444.63866543
        1              4       437.70568840       .
        2              1       437.62747377      0.00221086
        3              1       437.62125094      0.00001508
        4              1       437.62120219      0.00000000
   Convergence criteria met but final hessian is not positive definite.
```

Covariance Parameter Estimates

Cov Parm	Subject	Estimate	Alpha	Lower	Upper
BLOCK		0	.	.	.
BLOCK*IRRIGATE		3.9295	0.05	0.3437	3.388E41
BLOCK*IRRIGATE*STAND		48.6576	0.05	18.2912	334.20
CS	BLOCK*IRRIGATE*STAND	-0.00008	0.05	-0.00011	-0.00004
Residual		86.3569	0.05	57.1088	145.71

Fit Statistics

-2 Res Log Likelihood	437.6
AIC (smaller is better)	445.6
AICC (smaller is better)	446.4
BIC (smaller is better)	443.2

Type 3 Tests of Fixed Effects

Effect	Num DF	Den DF	F Value	Pr > F
IRRIGATE	1	3	30.92	0.0115
STAND	2	12	3.78	0.0532
IRRIGATE*STAND	2	12	5.91	0.0163
FERT	2	36	11.45	0.0001
IRRIGATE*FERT	2	36	5.52	0.0081
STAND*FERT	4	36	0.88	0.4841
IRRIGATE*STAND*FERT	4	36	0.68	0.6107

Least Squares Means

Effect	IRRIGATE	STAND	FERT	Estimate	Standard Error	DF	t Value	Pr > |t|
IRRIGATE	Irrigate			110.44	2.7269	3	40.50	<.0001
IRRIGATE	No Irrig			89.0000	2.7269	3	32.64	<.0001
STAND		1		92.7500	3.1893	12	29.08	<.0001
STAND		2		103.63	3.1893	12	32.49	<.0001
STAND		3		102.79	3.1893	12	32.23	<.0001
FERT			1	92.9167	2.4732	36	37.57	<.0001
FERT			2	100.58	2.4732	36	40.67	<.0001
FERT			3	105.67	2.4732	36	42.72	<.0001
IRRIGATE*STAND	Irrigate	1		96.8333	4.5103	12	21.47	<.0001
IRRIGATE*STAND	Irrigate	2		112.75	4.5103	12	25.00	<.0001
IRRIGATE*STAND	Irrigate	3		121.75	4.5103	12	26.99	<.0001
IRRIGATE*STAND	No Irrig	1		88.6667	4.5103	12	19.66	<.0001
IRRIGATE*STAND	No Irrig	2		94.5000	4.5103	12	20.95	<.0001
IRRIGATE*STAND	No Irrig	3		83.8333	4.5103	12	18.59	<.0001
IRRIGATE*FERT	Irrigate		1	98.5833	3.4977	36	28.19	<.0001
IRRIGATE*FERT	Irrigate		2	113.00	3.4977	36	32.31	<.0001
IRRIGATE*FERT	Irrigate		3	119.75	3.4977	36	34.24	<.0001
IRRIGATE*FERT	No Irrig		1	87.2500	3.4977	36	24.95	<.0001
IRRIGATE*FERT	No Irrig		2	88.1667	3.4977	36	25.21	<.0001
IRRIGATE*FERT	No Irrig		3	91.5833	3.4977	36	26.18	<.0001
IRRIGATE*FERT	Irrigate		1	98.5833	3.4977	36	28.19	<.0001
IRRIGATE*FERT	Irrigate		2	113.00	3.4977	36	32.31	<.0001
IRRIGATE*FERT	Irrigate		3	119.75	3.4977	36	34.24	<.0001
IRRIGATE*FERT	No Irrig		1	87.2500	3.4977	36	24.95	<.0001
IRRIGATE*FERT	No Irrig		2	88.1667	3.4977	36	25.21	<.0001
IRRIGATE*FERT	No Irrig		3	91.5833	3.4977	36	26.18	<.0001

Tests of Effect Slices

Effect	IRRIGATE	STAND	FERT	Num DF	Den DF	F Value	Pr > F
IRRIGATE*FERT			1	1	36	5.25	0.0279
IRRIGATE*FERT			2	1	36	25.20	<.0001
IRRIGATE*FERT			3	1	36	32.43	<.0001
IRRIGATE*FERT	Irrigate			2	36	16.24	<.0001
IRRIGATE*FERT	No Irrig			2	36	0.72	0.4914
IRRIGATE*STAND		1		1	12	1.64	0.2246
IRRIGATE*STAND		2		1	12	8.19	0.0143
IRRIGATE*STAND		3		1	12	35.34	<.0001
IRRIGATE*STAND	Irrigate			2	12	8.22	0.0056
IRRIGATE*STAND	No Irrig			2	12	1.47	0.2678

Differences of Least Squares Means

Effect	IRRIGATE	STAND	FERT	_IRRIGATE	_STAND	_FERT	Estimate	Standard Error	DF	t Value	Pr > |t|
IRRIGATE	Irrigate			No Irrig			21.4444	3.8564	3	5.56	0.0115
STAND		1			2		-10.8750	4.4001	12	-2.47	0.0294
STAND		1			3		-10.0417	4.4001	12	-2.28	0.0415
STAND		2			3		0.8333	4.4001	12	0.19	0.8530
FERT			1			2	-7.6667	2.6826	36	-2.86	0.0070
FERT			1			3	-12.7500	2.6826	36	-4.75	<.0001
IRRIGATE*STAND	Irrigate	1		Irrigate	2		-15.9167	6.2227	12	-2.56	0.0251
IRRIGATE*STAND	Irrigate	1		Irrigate	3		-24.9167	6.2227	12	-4.00	0.0017
IRRIGATE*STAND	Irrigate	1		No Irrig	1		8.1667	6.3786	12	1.28	0.2246
IRRIGATE*STAND	Irrigate	1		No Irrig	2		2.3333	6.3786	12	0.37	0.7209
IRRIGATE*STAND	Irrigate	1		No Irrig	3		13.0000	6.3786	12	2.04	0.0642
IRRIGATE*STAND	Irrigate	2		Irrigate	3		-9.0000	6.2227	12	-1.45	0.1737
IRRIGATE*STAND	Irrigate	2		No Irrig	1		24.0833	6.3786	12	3.78	0.0026
IRRIGATE*STAND	Irrigate	2		No Irrig	2		18.2500	6.3786	12	2.86	0.0143
IRRIGATE*STAND	Irrigate	2		No Irrig	3		28.9167	6.3786	12	4.53	0.0007
IRRIGATE*STAND	Irrigate	3		No Irrig	1		33.0833	6.3786	12	5.19	0.0002
IRRIGATE*STAND	Irrigate	3		No Irrig	2		27.2500	6.3786	12	4.27	0.0011
IRRIGATE*STAND	Irrigate	3		No Irrig	3		37.9167	6.3786	12	5.94	<.0001
IRRIGATE*STAND	No Irrig	1		No Irrig	2		-5.8333	6.2227	12	-0.94	0.3670
IRRIGATE*STAND	No Irrig	1		No Irrig	3		4.8333	6.2227	12	0.78	0.4524
IRRIGATE*STAND	No Irrig	2		No Irrig	3		10.6667	6.2227	12	1.71	0.1122
IRRIGATE*FERT	Irrigate		1	Irrigate		2	-14.4167	3.7938	36	-3.80	0.0005
IRRIGATE*FERT	Irrigate		1	Irrigate		3	-21.1667	3.7938	36	-5.58	<.0001
IRRIGATE*FERT	Irrigate		1	No Irrig		1	11.3333	4.9464	36	2.29	0.0279
IRRIGATE*FERT	Irrigate		1	No Irrig		2	10.4167	4.9464	36	2.11	0.0423
IRRIGATE*FERT	Irrigate		1	No Irrig		3	7.0000	4.9464	36	1.42	0.1656
IRRIGATE*FERT	Irrigate		2	Irrigate		3	-6.7500	3.7938	36	-1.78	0.0836
IRRIGATE*FERT	Irrigate		2	No Irrig		1	25.7500	4.9464	36	5.21	<.0001
IRRIGATE*FERT	Irrigate		2	No Irrig		2	24.8333	4.9464	36	5.02	<.0001
IRRIGATE*FERT	Irrigate		2	No Irrig		3	21.4167	4.9464	36	4.33	0.0001
IRRIGATE*FERT	Irrigate		3	No Irrig		1	32.5000	4.9464	36	6.57	<.0001
IRRIGATE*FERT	Irrigate		3	No Irrig		2	31.5833	4.9464	36	6.39	<.0001
IRRIGATE*FERT	Irrigate		3	No Irrig		3	28.1667	4.9464	36	5.69	<.0001
IRRIGATE*FERT	No Irrig		1	No Irrig		2	-0.9167	3.7938	36	-0.24	0.8104
IRRIGATE*FERT	No Irrig		1	No Irrig		3	-4.3333	3.7938	36	-1.14	0.2609
IRRIGATE*FERT	No Irrig		2	No Irrig		3	-3.4167	3.7938	36	-0.90	0.3738

Differences of Least Squares Means

Effect	IRRIGATE	STAND	FERT	_IRRIGATE	_STAND	_FERT	Adjustment	Adj P
IRRIGATE	Irrigate			No Irrig			Tukey	0.0115
STAND		1			2		Tukey-Kramer	0.0704
STAND		1			3		Tukey-Kramer	0.0972
STAND		2			3		Tukey-Kramer	0.9805
FERT			1			2	Tukey-Kramer	0.0189
FERT			1			3	Tukey-Kramer	<.0001
FERT			2			3	Tukey-Kramer	0.1548
IRRIGATE*STAND	Irrigate	1		Irrigate	2		Tukey-Kramer	0.1819
IRRIGATE*STAND	Irrigate	1		Irrigate	3		Tukey-Kramer	0.0168
IRRIGATE*STAND	Irrigate	1		No Irrig	1		Tukey-Kramer	0.7899
IRRIGATE*STAND	Irrigate	1		No Irrig	2		Tukey-Kramer	0.9989
IRRIGATE*STAND	Irrigate	1		No Irrig	3		Tukey-Kramer	0.3771
IRRIGATE*STAND	Irrigate	2		Irrigate	3		Tukey-Kramer	0.7011
IRRIGATE*STAND	Irrigate	2		No Irrig	1		Tukey-Kramer	0.0248
IRRIGATE*STAND	Irrigate	2		No Irrig	2		Tukey-Kramer	0.1133
IRRIGATE*STAND	Irrigate	2		No Irrig	3		Tukey-Kramer	0.0069
IRRIGATE*STAND	Irrigate	3		No Irrig	1		Tukey-Kramer	0.0024
IRRIGATE*STAND	Irrigate	3		No Irrig	2		Tukey-Kramer	0.0107
IRRIGATE*STAND	Irrigate	3		No Irrig	3		Tukey-Kramer	0.0007
IRRIGATE*STAND	No Irrig	1		No Irrig	2		Tukey-Kramer	0.9288
IRRIGATE*STAND	No Irrig	1		No Irrig	3		Tukey-Kramer	0.9665
IRRIGATE*STAND	No Irrig	2		No Irrig	3		Tukey-Kramer	0.5481
IRRIGATE*FERT	Irrigate		1	Irrigate		2	Tukey-Kramer	0.0066
IRRIGATE*FERT	Irrigate		1	Irrigate		3	Tukey-Kramer	<.0001
IRRIGATE*FERT	Irrigate		1	No Irrig		1	Tukey-Kramer	0.2240
IRRIGATE*FERT	Irrigate		1	No Irrig		2	Tukey-Kramer	0.3072
IRRIGATE*FERT	Irrigate		1	No Irrig		3	Tukey-Kramer	0.7178
IRRIGATE*FERT	Irrigate		2	Irrigate		3	Tukey-Kramer	0.4912
IRRIGATE*FERT	Irrigate		2	No Irrig		1	Tukey-Kramer	0.0001
IRRIGATE*FERT	Irrigate		2	No Irrig		2	Tukey-Kramer	0.0002
IRRIGATE*FERT	Irrigate		2	No Irrig		3	Tukey-Kramer	0.0015
IRRIGATE*FERT	Irrigate		3	No Irrig		1	Tukey-Kramer	<.0001
IRRIGATE*FERT	Irrigate		3	No Irrig		2	Tukey-Kramer	<.0001
IRRIGATE*FERT	Irrigate		3	No Irrig		3	Tukey-Kramer	<.0001
IRRIGATE*FERT	No Irrig		1	No Irrig		2	Tukey-Kramer	0.9999
IRRIGATE*FERT	No Irrig		1	No Irrig		3	Tukey-Kramer	0.8603
IRRIGATE*FERT	No Irrig		2	No Irrig		3	Tukey-Kramer	0.9438

```
125        OPTIONS PS=25 LS=80;
126        PROC SORT DATA=SPLIT; BY STAND IRRIGATE;
NOTE: There were 72 observations read from the data set WORK.SPLIT.
NOTE: The data set WORK.SPLIT has 72 observations and 5 variables.
NOTE: PROCEDURE SORT used:
      real time           0.04 seconds
      cpu time            0.04 seconds
127           PROC MEANS NOPRINT; BY STAND IRRIGATE; VAR YIELD; OUTPUT OUT=X1
127       ! MEAN=Y;
NOTE: There were 72 observations read from the data set WORK.SPLIT.
NOTE: The data set WORK.X1 has 6 observations and 5 variables.
NOTE: PROCEDURE MEANS used:
      real time           0.04 seconds
      cpu time            0.04 seconds
128           PROC PLOT DATA=X1;PLOT Y*STAND=IRRIGATE;
129              TITLE2 'Plot of stand by irrigation interaction';
130        RUN;
NOTE: There were 6 observations read from the data set WORK.X1.
NOTE: The PROCEDURE PLOT printed page 8.
NOTE: PROCEDURE PLOT used:
      real time           0.01 seconds
      cpu time            0.01 seconds

EXST7015: Yield of Corn in a Split-split plot design. Main plot is RBD
Plot of stand by irrigation interaction

                Plot of Y*STAND.  Symbol is value of IRRIGATE.
  Y |
140 +
    |
    |
    |
120 +                                                                   I
    |                                   I
    |
    |
100 +
    |I                                  N
    |N
    |                                                                  N
 80 +
    -+----------------------------------+----------------------------------+
     1                                   2                                  3
                                      STAND

131        PROC SORT DATA=SPLIT; BY FERT IRRIGATE;
NOTE: There were 72 observations read from the data set WORK.SPLIT.
NOTE: The data set WORK.SPLIT has 72 observations and 5 variables.
NOTE: PROCEDURE SORT used:
      real time           0.03 seconds
      cpu time            0.03 seconds
132           PROC MEANS NOPRINT; BY FERT IRRIGATE; VAR YIELD; OUTPUT OUT=X2
132       ! MEAN=Y;
NOTE: There were 72 observations read from the data set WORK.SPLIT.
NOTE: The data set WORK.X2 has 6 observations and 5 variables.
NOTE: PROCEDURE MEANS used:
real time           0.03 seconds
      cpu time            0.03 seconds
133           PROC PLOT DATA=X2;  PLOT Y*FERT=IRRIGATE;
134              TITLE2 'Plot of fertilizer by irrigation interaction';
135        RUN;
```

```
136        OPTIONS PS=50 LS=80;
137
NOTE: There were 6 observations read from the data set WORK.X2.
NOTE: The PROCEDURE PLOT printed page 9.
NOTE: PROCEDURE PLOT used:
      real time           0.01 seconds
      cpu time            0.01 seconds

EXST7015: Yield of Corn in a Split-split plot design. Main plot is RBD
Plot of fertilizer by irrigation interaction

                Plot of Y*FERT.  Symbol is value of IRRIGATE.

  Y |
120 +
I
    |
    |                                     I
    |
    |
    |
100 +I
    |
    |
    |
N
    |N                                    N
    |
 80 +
    -+-----------------------------------+---------------------------------
--+
     1                                    2
3
                                        FERT



138        PROC GLM DATA=SPLIT; CLASSES BLOCK IRRIGATE STAND FERT;
139          TITLE2 'Split/Split plot Analysis of Variance with PROC GLM';
140          TITLE3 'The correct analysis probably has all fixed effects';
141          MODEL YIELD = BLOCK IRRIGATE BLOCK*IRRIGATE STAND IRRIGATE*STAND
142                BLOCK*IRRIGATE*STAND FERT FERT*IRRIGATE FERT*STAND
142      ! FERT*IRRIGATE*STAND;
143          TEST H=BLOCK IRRIGATE E=BLOCK*IRRIGATE;
144          TEST H=BLOCK*IRRIGATE STAND STAND*IRRIGATE
E=BLOCK*IRRIGATE*STAND;
145          RANDOM BLOCK BLOCK*IRRIGATE BLOCK*IRRIGATE*STAND / TEST; RUN;
NOTE: TYPE I EMS not available without the E1 option.
146          TITLE3 'Model to show EMS with random subplot effects';
147          RANDOM BLOCK BLOCK*IRRIGATE STAND IRRIGATE*STAND
147      ! BLOCK*IRRIGATE*STAND
148                FERT FERT*IRRIGATE FERT*STAND FERT*IRRIGATE*STAND / TEST;
149        RUN;
NOTE: TYPE I EMS not available without the E1 option.
149      !      QUIT;
NOTE: The PROCEDURE GLM printed pages 10-17.
NOTE: PROCEDURE GLM used:
      real time           0.12 seconds
      cpu time            0.12 seconds
```

EXST7015: Yield of Corn in a Split-split plot design. Main plot is RBD
Split/Split plot Analysis of Variance with PROC GLM
The correct analysis probably has all fixed effects

The GLM Procedure

Class Level Information

Class	Levels	Values
BLOCK	4	1 2 3 4
IRRIGATE	2	Irrigate No Irrig
STAND	3	1 2 3
FERT	3	1 2 3

Number of observations 72

Dependent Variable: YIELD

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	35	20647.61111	589.93175	6.83	<.0001
Error	36	3108.83333	86.35648		
Corrected Total	71	23756.44444			

R-Square	Coeff Var	Root MSE	YIELD Mean
0.869137	9.318704	9.292819	99.72222

Source	DF	Type I SS	Mean Square	F Value	Pr > F
BLOCK	3	194.444444	64.814815	0.75	0.5292
IRRIGATE	1	8277.555556	8277.555556	95.85	<.0001
BLOCK*IRRIGATE	3	1411.777778	470.592593	5.45	0.0034
STAND	2	1758.361111	879.180556	10.18	0.0003
IRRIGATE*STAND	2	2747.027778	1373.513889	15.91	<.0001
BLOCK*IRRIGATE*STAND	12	2787.944444	232.328704	2.69	0.0108
FERT	2	1977.444444	988.722222	11.45	0.0001
IRRIGATE*FERT	2	953.444444	476.722222	5.52	0.0081
STAND*FERT	4	304.888889	76.222222	0.88	0.4841
IRRIGATE*STAND*FERT	4	234.722222	58.680556	0.68	0.6107

Source	DF	Type III SS	Mean Square	F Value	Pr > F
BLOCK	3	194.444444	64.814815	0.75	0.5292
IRRIGATE	1	8277.555556	8277.555556	95.85	<.0001
BLOCK*IRRIGATE	3	1411.777778	470.592593	5.45	0.0034
STAND	2	1758.361111	879.180556	10.18	0.0003
IRRIGATE*STAND	2	2747.027778	1373.513889	15.91	<.0001
BLOCK*IRRIGATE*STAND	12	2787.944444	232.328704	2.69	0.0108
FERT	2	1977.444444	988.722222	11.45	0.0001
IRRIGATE*FERT	2	953.444444	476.722222	5.52	0.0081
STAND*FERT	4	304.888889	76.222222	0.88	0.4841
IRRIGATE*STAND*FERT	4	234.722222	58.680556	0.68	0.6107

Dependent Variable: YIELD
Tests of Hypotheses Using the Type III MS for BLOCK*IRRIGATE as an Error Term

Source	DF	Type III SS	Mean Square	F Value	Pr > F
BLOCK	3	194.444444	64.814815	0.14	0.9312
IRRIGATE	1	8277.555556	8277.555556	17.59	0.0247

Tests of Hypotheses Using the Type III MS for BLOCK*IRRIGATE*STAND as an Error Term

Source	DF	Type III SS	Mean Square	F Value	Pr > F
BLOCK*IRRIGATE	3	1411.777778	470.592593	2.03	0.1641
STAND	2	1758.361111	879.180556	3.78	0.0532
IRRIGATE*STAND	2	2747.027778	1373.513889	5.91	0.0163

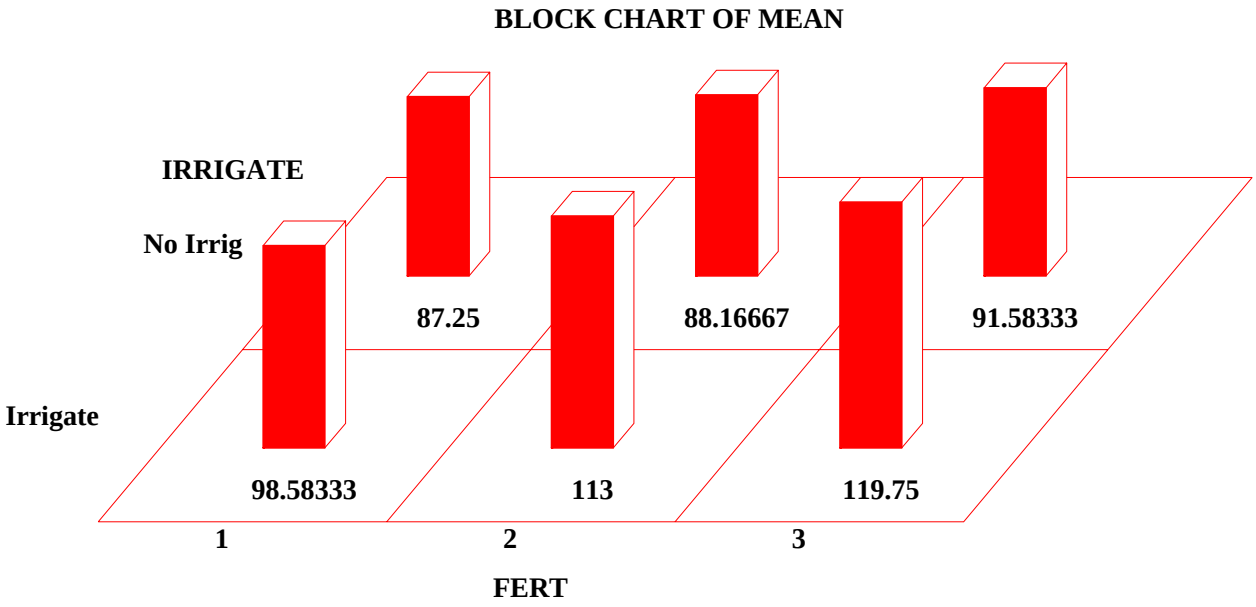
```
Source                Type III Expected Mean Square
BLOCK                 Var(Error) + 3 Var(BLOCK*IRRIGATE*STAND) + 9 Var(BLOCK*IRRIGATE) + 18
Var(BLOCK)
IRRIGATE              Var(Error) + 3 Var(BLOCK*IRRIGATE*STAND) + 9 Var(BLOCK*IRRIGATE) +
                      Q(IRRIGATE,IRRIGATE*STAND,IRRIGATE*FERT,IRRIGATE*STAND*FERT)
BLOCK*IRRIGATE        Var(Error) + 3 Var(BLOCK*IRRIGATE*STAND) + 9 Var(BLOCK*IRRIGATE)
STAND                 Var(Error) + 3 Var(BLOCK*IRRIGATE*STAND) +
                      Q(STAND,IRRIGATE*STAND,STAND*FERT,IRRIGATE*STAND*FERT)
IRRIGATE*STAND        Var(Error) + 3 Var(BLOCK*IRRIGATE*STAND) +
Q(IRRIGATE*STAND,IRRIGATE*STAND*FERT)
BLOCK*IRRIGATE*STAND  Var(Error) + 3 Var(BLOCK*IRRIGATE*STAND)
FERT                  Var(Error) + Q(FERT,IRRIGATE*FERT,STAND*FERT,IRRIGATE*STAND*FERT)
IRRIGATE*FERT         Var(Error) + Q(IRRIGATE*FERT,IRRIGATE*STAND*FERT)
STAND*FERT            Var(Error) + Q(STAND*FERT,IRRIGATE*STAND*FERT)
IRRIGATE*STAND*FERT   Var(Error) + Q(IRRIGATE*STAND*FERT)

Tests of Hypotheses for Mixed Model Analysis of Variance
Dependent Variable: YIELD
   Source                    DF   Type III SS   Mean Square  F Value  Pr > F
   BLOCK                      3    194.444444     64.814815     0.14  0.9312
*  IRRIGATE                   1   8277.555556   8277.555556    17.59  0.0247
   Error                      3   1411.777778    470.592593
Error: MS(BLOCK*IRRIGATE)
* This test assumes one or more other fixed effects are zero.

   Source                    DF   Type III SS   Mean Square  F Value  Pr > F
   BLOCK*IRRIGATE             3   1411.777778    470.592593     2.03  0.1641
*  STAND                      2   1758.361111    879.180556     3.78  0.0532
*  IRRIGATE*STAND             2   2747.027778   1373.513889     5.91  0.0163
   Error                     12   2787.944444    232.328704
Error: MS(BLOCK*IRRIGATE*STAND)
* This test assumes one or more other fixed effects are zero.
   Source                    DF   Type III SS   Mean Square  F Value  Pr > F
   BLOCK*IRRIGATE*STAND      12   2787.944444    232.328704     2.69  0.0108
*  FERT                       2   1977.444444    988.722222    11.45  0.0001
*  IRRIGATE*FERT              2    953.444444    476.722222     5.52  0.0081
*  STAND*FERT                 4    304.888889     76.222222     0.88  0.4841
   IRRIGATE*STAND*FERT        4    234.722222     58.680556     0.68  0.6107
   Error: MS(Error)          36   3108.833333     86.356481
* This test assumes one or more other fixed effects are zero.


Source                Type III Expected Mean Square
BLOCK                 Var(Error) + 3 Var(BLOCK*IRRIGATE*STAND) + 9
                      Var(BLOCK*IRRIGATE) + 18 Var(BLOCK)
IRRIGATE              Var(Error) + 4 Var(IRRIGATE*STAND*FERT) + 12
                      Var(IRRIGATE*FERT) + 3 Var(BLOCK*IRRIGATE*STAND) + 12
                      Var(IRRIGATE*STAND) +9 Var(BLOCK*IRRIGATE) +Q(IRRIGATE)
BLOCK*IRRIGATE        Var(Error) + 3 Var(BLOCK*IRRIGATE*STAND) + 9
                      Var(BLOCK*IRRIGATE)
STAND                 Var(Error) + 4 Var(IRRIGATE*STAND*FERT) + 8
                      Var(STAND*FERT) + 3 Var(BLOCK*IRRIGATE*STAND) + 12
                      Var(IRRIGATE*STAND) + 24 Var(STAND)
IRRIGATE*STAND        Var(Error) + 4 Var(IRRIGATE*STAND*FERT) + 3
                      Var(BLOCK*IRRIGATE*STAND) + 12 Var(IRRIGATE*STAND)
BLOCK*IRRIGATE*STAND  Var(Error) + 3 Var(BLOCK*IRRIGATE*STAND)
FERT                  Var(Error) + 4 Var(IRRIGATE*STAND*FERT) + 8
                      Var(STAND*FERT) + 12 Var(IRRIGATE*FERT) + 24 Var(FERT)
IRRIGATE*FERT         Var(Error) + 4 Var(IRRIGATE*STAND*FERT) + 12
                      Var(IRRIGATE*FERT)
STAND*FERT            Var(Error) + 4 Var(IRRIGATE*STAND*FERT) + 8
                      Var(STAND*FERT)
IRRIGATE*STAND*FERT   Var(Error) + 4 Var(IRRIGATE*STAND*FERT)
```

```
Tests of Hypotheses for Mixed Model Analysis of Variance
Dependent Variable: YIELD
Source                      DF    Type III SS    Mean Square   F Value   Pr > F
BLOCK                        3     194.444444      64.814815      0.14   0.9312
Error                        3    1411.777778     470.592593
Error: MS(BLOCK*IRRIGATE)

Source                      DF    Type III SS    Mean Square   F Value   Pr > F
IRRIGATE                     1    8277.555556    8277.555556      4.08   0.1208
Error                   3.6267    7361.447284    2029.819444
Error: MS(BLOCK*IRRIGATE) + MS(IRRIGATE*STAND) - MS(BLOCK*IRRIGATE*STAND)
+ MS(IRRIGATE*FERT) - MS(IRRIGATE*STAND*FERT) - 36E-16*MS(Error)

Source                      DF    Type III SS    Mean Square   F Value   Pr > F
BLOCK*IRRIGATE               3    1411.777778     470.592593      2.03   0.1641
Error                       12    2787.944444     232.328704
Error: MS(BLOCK*IRRIGATE*STAND)

Source                      DF    Type III SS    Mean Square   F Value   Pr > F
STAND                        2    1758.361111     879.180556      0.63   0.6113
Error                   2.0464    2846.646473    1391.055556
Error: MS(IRRIGATE*STAND) + MS(STAND*FERT) -
MS(IRRIGATE*STAND*FERT) + 19E-16*MS(Error)

Source                      DF    Type III SS    Mean Square   F Value   Pr > F
IRRIGATE*STAND               2    2747.027778    1373.513889      6.71   0.0212
Error                   7.5247    1539.945731     204.652778
Error: MS(BLOCK*IRRIGATE*STAND) + MS(IRRIGATE*STAND*FERT) - MS(Error)

Source                      DF    Type III SS    Mean Square   F Value   Pr > F
BLOCK*IRRIGATE*STAND        12    2787.944444     232.328704      2.69   0.0108
IRRIGATE*STAND*FERT          4     234.722222      58.680556      0.68   0.6107
Error: MS(Error)            36    3108.833333      86.356481

Source                      DF    Type III SS    Mean Square   F Value   Pr > F
FERT                         2    1977.444444     988.722222      2.00   0.3259
Error                    2.107    1041.413780     494.263889
Error: MS(IRRIGATE*FERT) + MS(STAND*FERT) -
MS(IRRIGATE*STAND*FERT) + 24E-16*MS(Error)

Source                      DF    Type III SS    Mean Square   F Value   Pr > F
IRRIGATE*FERT                2     953.444444     476.722222      8.12   0.0390
STAND*FERT                   4     304.888889      76.222222      1.30   0.4030
Error                        4     234.722222      58.680556
Error: MS(IRRIGATE*STAND*FERT)
```

```
134        GOPTIONS GSFNAME=OUT4;  FILENAME OUT4
134      ! 'C:\Geaghan\EXST\EXST7015New\SAS\split1.CGM';
135        PROC GCHART DATA=SPLIT;
136             BLOCK FERT / GROUP=IRRIGATE SUMVAR=YIELD DISCRETE TYPE=MEAN;
137             PATTERN C=RED V=S; RUN;
NOTE:  31 RECORDS WRITTEN TO C:\Geaghan\EXST\EXST7015New\SAS\split1.CGM
138        GOPTIONS GSFNAME=OUT5;  FILENAME OUT5
138      ! 'C:\Geaghan\EXST\EXST7015New\SAS\split2.CGM';
NOTE: There were 72 observations read from the data set WORK.SPLIT.
NOTE: PROCEDURE GCHART used:
      real time           0.11 seconds
      cpu time            0.05 seconds
139        PROC GCHART DATA=SPLIT;
140             BLOCK STAND / GROUP=IRRIGATE SUMVAR=YIELD DISCRETE TYPE=MEAN;
141             PATTERN C=RED V=S; RUN;
NOTE:  31 RECORDS WRITTEN TO C:\Geaghan\EXST\EXST7015New\SAS\split2.CGM
```

```
142        QUIT;
NOTE: There were 72 observations read from the data set WORK.SPLIT.
NOTE: PROCEDURE GCHART used:
      real time           0.09 seconds
      cpu time            0.05 seconds



151        GOPTIONS GSFNAME=OUT4;  FILENAME OUT4
151      ! 'C:\Geaghan\EXST\EXST7015New\Fall2002\SAS\24s-Anova-SplitPlot-Corn1.C
151      ! GM';
 The SAS System
152        PROC GCHART DATA=SPLIT;
153             BLOCK FERT / GROUP=IRRIGATE SUMVAR=YIELD DISCRETE TYPE=MEAN;
154             PATTERN C=RED V=S; RUN;
NOTE: Foreground color BLACK same as background. Part of your graph may not be
      visible.
NOTE:  9 RECORDS WRITTEN TO
      C:\Geaghan\EXST\EXST7015New\Fall2002\SAS\24s-Anova-SplitPlot-Corn1.CGM
155        GOPTIONS GSFNAME=OUT5;  FILENAME OUT5
           'C:\Geaghan\EXST\EXST7015New\Fall2002\SAS\24s-Anova-SplitPlot-Corn2.CGM';
NOTE: There were 72 observations read from the data set WORK.SPLIT.
NOTE: PROCEDURE GCHART used:
      real time           0.08 seconds
      cpu time            0.04 seconds
156        PROC GCHART DATA=SPLIT;
157             BLOCK STAND / GROUP=IRRIGATE SUMVAR=YIELD DISCRETE TYPE=MEAN;
158             PATTERN C=RED V=S; RUN;
NOTE: Foreground color BLACK same as background. Part of your graph may not be
      visible.
NOTE:  9 RECORDS WRITTEN TO
      C:\Geaghan\EXST\EXST7015New\Fall2002\SAS\24s-Anova-SplitPlot-Corn2.CGM
159        QUIT;
NOTE: There were 72 observations read from the data set WORK.SPLIT.
NOTE: PROCEDURE GCHART used:
      real time           0.06 seconds
      cpu time            0.03 seconds
56         GOPTIONS DEVICE=cgm GSFMODE=REPLACE GSFNAME=OUT1 NOPROMPT noROTATE;
57         GOPTIONS GSFNAME=OUT3;  FILENAME OUT3
                  'C:\Geaghan\EXST\EXST7015New\SAS\harvest.CGM';
58         ***GOPTIONS VPOS=48 HPOS=90;
59         PROC GCHART DATA=HARVEST;
60            BLOCK YEAR / GROUP=CUTTING SUMVAR=HARVEST DISCRETE TYPE=MEAN; RUN;
NOTE:  51 RECORDS WRITTEN TO C:\Geaghan\EXST\EXST7015New\SAS\harvest.CGM
61         quit;
NOTE: There were 64 observations read from the data set WORK.HARVEST.
NOTE: PROCEDURE GCHART used:
      real time           1.13 seconds
      cpu time            0.20 seconds
```

EXST7015: Yield of Corn in a Split-split plot design. Main plot is RBD
Split/Split plot Analysis of Variance with PROC GLM
Model to show EMS with random subplot effects



EXST7015: Yield of Corn in a Split-split plot design. Main plot is RBD
Split/Split plot Analysis of Variance with PROC GLM
Model to show EMS with random subplot effects