# Assignment - 2

# Statistics and Numerical Methods (S&NM)

Name : Naveen Kumar.S
Class : CSE -B
Roll : 202201100

$\frac{15}{15}$

Design experiment is a systematic and statistical approach used to plan, conduct, analyze and interpret equipments in order to optimize processes, approve product quality and understand the relationship between variables.

lets say a company manufacture a product and wants to determine the optimal combination of factors (Temperature, Pressure) that result in highest yield. The company should investigate the experiments to find effect of this factors.

2). Efficient use of resources :-

Factorial experiments allows researchers to simultaneously allow researchers to investigate the effect of multiple factors and their interaction in simple single experiment.

Comprehensive understanding of factors and interactions :-

By systematically varying multiple factors in a factorial design, researchers gain a deeper understanding of how different factor interact with each other and influence the outcome of interest.

## Part - B

1). A variable trial was conducted on wheat with 4 varieties in a Latin Square design. The plan of the experiment and the per plot yield are given

|  | $x_1$ | $x_2$ | $x_3$ | $x_4$ |  |  | $x_1^2$ | $x_2^2$ | $x_3^2$ | $x_4^2$ |
|---|---|---|---|---|---|---|---|---|---|---|
| $y_1$ | 8 | 4 | 1 | 1 | 12 |  | 36 | 16 | 1 | 1 |
| $y_2$ | 0 | 0 | 2 | -1 | 1 |  | 0 | 0 | 4 | 1 |
| $y_3$ | -18 | -4 | -2 | 1 | -23 |  | 324 | 16 | 4 | 1 |
| $y_4$ | -2 | 1 | 2 | -4 | -3 |  | 4 | 1 | 4 | 16 |
|  | -14 | 1 | 3 | -3 |  |  | 364 | 33 | 13 | 19 |

$H_0$ :
  There is no significant difference between rows, columns and treatments

$H_1$ :
  There is significant difference between rows, columns and treatments.

$N = 16$

$T = -13$

$\# \ C.F = \dfrac{T^2}{N} = 10.56.$

$$SSC = \frac{(\sum x_1)^2}{n_1} + \frac{(\sum x_2)^2}{n_2} + \frac{(\sum x_3^2)}{n_3} + \frac{(\sum x_4)^2}{n_4} - C.F$$

$$= 53.75 - 10.56$$

$$= 43.10$$

$$TSS = \sum x_1^2 + \sum x_2^2 + \sum x_3^2 + \sum x_4^2 - C.F$$

$$= 364 + 33 + 13 + 19 - 10.56$$

$$= 418.44$$

$$SSR = \frac{(\sum Y_1)^2}{N_2} + \frac{(\sum Y_{b2})^2}{N_2} + \frac{(\sum Y_3)^2}{N_2} + \frac{(\sum Y_4)^2}{N_2} - C.F$$

$$= \frac{(12)^2}{4} + \frac{(1)^2}{4} + \frac{(-23)^2}{4} + \frac{(-3)^2}{4} - 10.56$$

$$= 170.75 - 10.56$$

$$= 160.19$$

**SSK.**

| Treatment | 1 | 2 | 3 | 4 | -7 |
|---|---|---|---|---|---|
| A | 0 | -4 | 1 | -4 | -13 |
| B | -15 | 4 | 2 | -1 | 10 |
| C | 6 | 1 | 2 | 1 | -7 |
| D | -2 | 0 | -2 | -3 | |

$$SSK = \frac{(-7)^2}{4} + \frac{(-13)^2}{4} + \frac{(10)^2}{4} + \frac{(7)^2}{4} - C.F$$

$$= 91.15 - 10.56$$

$$= 81.19$$

$$SSE = TSS - SSC - SSR - SSh$$

$$= 133.87$$

ANOVA TABLE:

| Source of variance | Sum of Squares | d.F | Mean Sum of Squares | Variance ratio | T V at 5% LOS |
|---|---|---|---|---|---|
| B/w rows | 160.19 | 3 | 53.39 | 2.39 | 4.76 |
| B/w columns | 43.14 | 3 | 14.39 | 1.55 | 4.76 |
| Treatment | 81.19 | 3 | 27.06 | 1.21 | 4.76 |
| Error | 133.87 | 6 | 22.311 | | |

Conclusion:

Calculate $F_r$ < & Table value

$F_c$ :- Calculated value < T.V

$F_k$ :- C.V < T.V

Accept $H_0$.

| Block | yield (1b per plot) | | | |
|---|---|---|---|---|
| I | (1) 23 | k 25 | P 22 | kP 38 |
| II | P 40 | (1) 26 | (k) 36 | kP 28 |
| III | (1) 29 | k 20 | kP 30 | P 20 |
| IV | kP 34 | k 31 | P 24 | (1) 28 |

| Treatment Combination | $x_1$ I | $x_2$ II | $x_3$ III | $x_4$ IV |
|---|---|---|---|---|
| (1) | 23 | 26 | 29 | 28 |
| P | 22 | 40 | 20 | 24 |
| k | 25 | 36 | 20 | 31 |
| kP | 38 | 38 | 30 | 34 |

Subtract 20 from each

Ho: There is no significant difference in mean effects

H₁: There is a significant difference in mean effects.

number of replications = 4

| Treatment Combination | Replication | | | | | Total | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | II | III | IV | | $x_1^2$ | $x_2^2$ | $x_3^2$ | $x_4^2$ |
| (1) $(y_1)$ | 3 | 6 | 9 | 8 | 26 | 9 | 36 | 81 | 64 |
| P $(y_2)$ | 2 | 20 | 0 | 4 | 26 | 4 | 400 | 0 | 16 |
| k $(y_3)$ | 5 | 16 | 0 | 11 | 32 | 25 | 256 | 0 | 121 |
| Pk $(y_4)$ | 18 | 18 | 10 | 14 | 60 | 324 | 324 | 100 | 196 |
| Totals | 28 | 60 | 19 | 31 | | 362 | 1016 | 181 | 377 |

$N = 16$

Step:

$T = 144$

$$C.F = \frac{T^2}{N} = \frac{(144)^2}{16} = 1296.$$

$$TSS = \Sigma x_1^2 + \Sigma x_2^2 + \Sigma x_3^2 + \Sigma x_4^2 - C.F$$

$$= 362 + 1016 + 181 + 397 - 1296$$

$$= 660$$

$$SSC = \frac{(\Sigma x_1)^2}{n_1} + \frac{(\Sigma x_2)^2}{n_1} + \frac{(\Sigma v_3)^2}{n_1} + \frac{(\Sigma x_4)^2}{n_1} - C.F$$

$$= 1528.5 - 1296$$

$$= 232.5$$

$$SSR = \frac{(\Sigma y_1)^2}{h_2} + \frac{(\Sigma y_2)^2}{h_2} + \frac{(\Sigma y_3)^2}{h_2} + \frac{(\Sigma y_4)^2}{h_2} - C.F$$

$$= 1494 - 1296$$

$$= 198$$

$$SSE = TSS - SSC - SSR$$

$$= 229.5$$

Contrast $A = \{a + ab - b - (1)\} = \{26 + 60 - 32 - 26\} = 28$

Contrast $B = \{b + ab - a - (1)\} \Rightarrow \{A + PA - 1 - (1)\} = \{32 + 60 - 26 - 26\} = 40$

Contrast $AB = \{a \, b + (1) - a - b\} \Rightarrow \{60 + 26 - 26 - 32\} = 28$

$$SSA = \frac{(con A)^2}{16} = \frac{(28)^2}{16} = 49$$

$$SSB = \frac{(con B)^2}{16} = \frac{(40)^2}{16} = 100$$

$$SS_{AB} = \frac{(con AB)^2}{16} = \frac{(28)^2}{16} = 49$$

main/effect $A = \frac{1}{2}(28) = 14$

$B = \frac{1}{2}(40) = 20$

$AB = \frac{1}{2}(28) = 14$