$$\sum_{i=1}^{p}\sum_{j=1}^{q}(y_{ij}-\bar{y}_{oo})^2 = \sum_i\sum_j(\bar{y}_{io}-\bar{y}_{oo})^2 + \sum\sum(\bar{y}_{oj}-\bar{y}_{oo})^2$$

$$+\sum\sum(y_{ij}+\bar{y}_{oo}-\bar{y}_{io}-\bar{y}_{oj})^2 + 2(\text{Cross product Term which vanish})$$

$\Rightarrow TSS = S.S.A + S.S.B + E.S.S.$

$\Rightarrow S^2 = S_A^2 + S_B^2 + S_E^2$

Where $S^2 = TSS = \sum_i\sum_j(y_{ij}-\bar{y}_{oo})^2$

$$S_A^2 = S.S.A = q\sum_i(\bar{y}_{io}-\bar{y}_{oo})^2$$

$$S_B^2 = S.S.B = p\sum_{j=1}^{n}(\bar{y}_{oj}-\bar{y}_{oo})^2$$

$$S_E^2 = S.S.E = \sum_i\sum_j(y_{ij}-\bar{y}_{oo}-\bar{y}_{io}-\bar{y}_{oj})^2$$

TSS is ~~obtained by~~ by squaring and summing over pq quantities of the form $\sum_i\sum_j(y_{ij}-\bar{y}_{oo})^2$ and its d.f. is $(pq-1)$.

SS A is obtained by squaring and summing over p quantities and its d.f. is $(p-1)$ Similarly d.f. due to SS B is $(q-1)$

$\therefore$ d.f. due to ESS $= (pq-1)-(p-1)-(q-1)$

$$= pq-1-p+1-q+1$$

$$= pq-p-q+1$$

$$= p(q-1)-1(q-1)$$

$$= (p-1)(q-1)$$

Let us set up the null hypothesis H_0:

H_0: The treatment as well as the variates are homogeneous i.e. $H_t: \alpha_1 = \alpha_2 = \cdots = \alpha_p = 0$.

and $H_v: \beta_1 = \beta_2 = \cdots = \beta_q = 0$.

Dividing the SS by the respective d.f. we get the mean Sum of Square (MSS)

Thus

$$MSA = \frac{SSA}{(p-1)} \; ; \quad MSB = \frac{SSB}{(q-1)}$$

$$EMS = \frac{ESS}{(p-1)(q-1)}$$

It can be shown that

$E(EMS) = E(MSA)$ when H_t is true.

Also $E(EMS) = E(MSB)$ when H_v is true.

Hence $\frac{MSA}{EMS}$ which follows the F-distribution with $\{(p-1); (p-1)(q-1)\}$ d.f.

and $F_B = \frac{MSB}{EMS}$ which follows the F-distn with $\{(q-1); (p-1)(q-1)\}$ d.f.

The above statistical analysis may be represented in the following ANOVA Table.

ANOVA Table

Source	d.f.	SS	MS	F
Factor A (Treatment)	$(p-1)$	SSA	$\frac{SSA}{(p-1)}$	$\frac{MSA}{EMS}$
Factor B (variates)	$(q-1)$	SSB	$\frac{SSB}{(q-1)}$	$\frac{MSB}{EMS}$
Error	$(p-1)(q-1)$	ESS	$\frac{ESS}{(p-1)(q-1)}$	
Total	$(pq-1)$	S^2		

Conclusion :- If the calculated value of F_A is less than the tabulated value of F for $\{(p-1); (p-1)(q-1)\}$ d.f at a certain level of significance (Generally at 5%) we may accept our null hypothesis.

DESIGNS OF EXPRIMENT:-

INTRODUCTION:-

Any person performing an exprimment of comparing the effects of various treatments should perform the exprimment in such a way that the treatments are completely free to show their effects on the subject, keeping of all other treatment or factor under control.

Thus the plan under which the exprimment is conducted in such a way that all the factors are kept under the control as much as possible is known as 'exprimental Design'.

Exprimental unit:- A subject or group of subject to which a treatment is applied in a trial in case of a single replication is known as exprimental unit.

For example, a plot in case of field trial, a rat in case of biological exprimment are examples of exprimental unit.

Treatment:- A treatment is a substance or a known factor which is administered or allocated to one or more exprimental units or estimate its effect pertaining to certain character. The treatments are generally compared with each other. Application of fertilizer to field plots, testing feed on cows.

applying medicine to several patients are a few examples of treatments which are applied to the experimental units. An experimental unit may receive a single treatment or a combination of treatment.

—x—

Experimental Error :-

An experimenter always try to control the effect of several factors which can influence the independent performance of ~~treatm~~ treatments. The choice of the design to be made in such a way that this objective is ~~fulfi~~ fulfilled. But inspite of all efforts there are always certain external factors that effect the experiment. Such factors are beyond the control of the experimenter. Thus the error caused by some external factors which are beyond the control of human approach is known as Experimental Error.

The reduction in experimental Error provides smaller standard error for treatment means or difference between treatment means.

—x—