III B.Sc. Statistics

Subject name: Design of experiment

Subject code : CST62

Unit :1

Design of Experiments

Definition

Design of experiments may be defined as the logical construction of the experiment in which the degrees of uncertainity with which the inference is drawn may be well defined

The experimental design is called a randomized group design the essential characteristic of this design is that subject are randomly assigned to the experimental treatment

Three important phase of every project

i) Experimental (or) Planning phase

1) Statement of problem

2) choice of response (or) dependent variable

3) Selection of factor to be varied

4) choice of level of these factors

a) Quantitative (or) Qualitative

b) Fixed (or) random

5) How factor level are to be combined

ii) Design phase

1) No of observation to be taken

2) Order of experimentation

3) Method of randomization to be used

4) Mathematical model to describe the experiment

5) Hypothesis to be tested

iii) Analysis phase

1) Data collection & processing

2) Computation of test statistic

3) Interpretation of result for the experiment

Terminology in Experimental Design

Experiment

An experiment is a device (or) a means of getting answer to the problem under consideration

Experiment can be classified into 2 categories

i) Absolute Experiment

ii) Comparative Experiment

i) Absolute Experiment

It consist in determining the absolute value of some characteristics.

1) obtaining the average intelligence Quotients (IQ) of a group of people

2) Finding the correlation co-efficient between 2 variables in a bi-variate distribution etc...

iii) Comparative Experiment

Comparative experiment designed to compare the effect of two or more object on some population characteristic

Example: Comparison of different manner fertilizer different kinds of varies of a different cultivation processes, different pieces of land in a field experiment (or) different diets (or) medicine in a dietary (or) medical experiments respectively.

Same paddi b/s diff fertilizer to compare

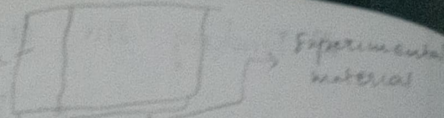
Treatment

Various object of comparison in a comparative experiment are termed as treatments.

various object

Eg: In field experimentation different fertilizers (or) different variety of crop (or) different method of cultivation are the treatment.

Experimental unit



The smallest division of the experimental material to which we apply the treatments & on which we make observation on the variable under study is termed as experimental unit.

Eg: In field experiment the plot of land is the experimental unit.

Blocks

In agricultural experiments most of the time we divide the whole experimental unit into relatively homogeneous subgroup (or) strata. These strata which are more uniform amongest themselves than field has a whole are known as blocks.

Yield

The measurement of the variable under study on different experimental units are termed as yield.

Experimental error

Variation from plot to plot which is due to random factors beyond human control is spoken are as experimental error.

Replication

Repeat treatment

Replication means the ~~reepetiation~~ repetation of the treatments under investigation.

The execution of an experiment more than once is called replication.

Precision

The reciparocal of the variance of the mean is termed as the precision (or) the amount of information of a design.

Thus for an experiment replicated r times the precision is given by

$V(\bar{x}) = \frac{\sigma^2}{n}$ $n \to r$

$$\frac{1}{V(\bar{x})} = \frac{r}{\sigma^2}$$

Where, $\sigma^2 \to$ Error variates per unit.

Efficiency of a design

Consider the design D_1 & D_2 with error variances per unit σ_1^2 and σ_2^2 & replications r_1 and r_2 respectively.

Then the variance of the difference between 2 treatment mean is given by

$$\frac{2\sigma_1^2}{r_1} \text{ and } \frac{2\sigma_2^2}{r_2}$$

for D_1 and D_2 respectively.

Then the ratio

$$E = \frac{2\sigma_2^2}{r_2} : \frac{2\sigma_1^2}{r_1}$$

$$= \frac{\sigma_2^2}{r_2} : \frac{\sigma_1^2}{r_1}$$

$$= \frac{r_1}{r_2} : \frac{\sigma_1^2}{\sigma_2^2}$$

is termed as efficiency of design D_1 with respect to D_2 (or) Efficiency of D_1 with respect to D_2 may be defined as the ratio of the precision of D_1 and D_2

Principles of Experimental Design

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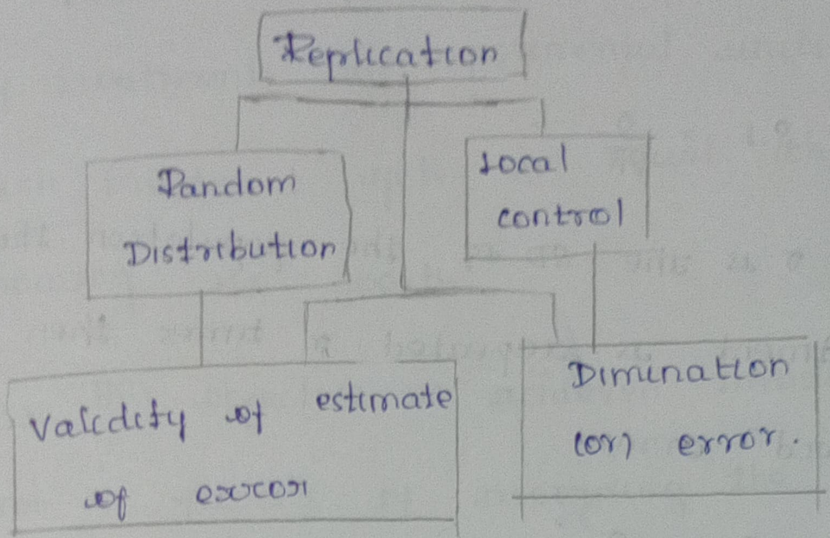
The basic principles of experimental design are classified into 3 types

1) Replication
2) Randomization
3) Local control.

Replication



Replication means the repetiation of the treatments under investigation. An experimental resorts to replication in order to average out influence of the chance factors on different experimental units.

Thus the repetiation of the treatment results is more reliable estimate than is possible with a single observation.

Advantage.

At the first instance replication serves to reduce experimental error and thus enables us to obtain more precise estimates of the treatment effects.

Standard Error for single mean of sample size n.

$$S.E = \frac{\sigma}{\sqrt{n}}$$

Here σ is the SD of the population thus, if treatment is repeated r times then the standard error

$$S.E = \frac{\sigma}{\sqrt{r}}$$

Here σ^2 is the variance of the individual plot is estimated from the "error variance"

Thus the precision of the experiment is inversly proportional to the square root of the replication.

NOTE

Replication has an important but limited role in increasing a efficiency of the design.

Randomization

By Replication the experimenter tries to average out as far as possible the effect due to uncontrolled factors.

This [illegible] to the question of allocation of treatments to experimental units so that each treatment gets an equal chance of showing its worth.

This objective is achieved through randomization a process of assigning the treatment to various experimental unit in a purely chance manner.

Objective

1) Randomization provides a logical basis for that and makes it possible to draw rigorous inductive inferences by the use of statistical theories.

2) The purpose of randomness is to assure that the sources of variation not controlled in the experiment operate randomly so that average effect on any group of units are zero.

⇒ Randomization insures that different treatment by the repetition of the experiment on average are subject to = environmental effec

⇒ Randomization eliminates biyers in a form it equalizes even factors of variation over which we have no control.

NOTE
It should be noted that randomization without replication is not sufficient.

Local control

⇒ If the experimental material say field for agriculture experimentation is heterogeneous & different treatment are allocated to various units (plots) at random over the entire field the soil heterogenity will also enter the uncontrolled factors & thus increase the experimental error

⇒ It is desire to reduce the experimental error as for as practicable without unduly increasing the no. of replication

⇒ In addition to the principles of replication & randomization the experimental error can further be reduced by making use of the fact that neighbouring area in a field relatively more homogeneous than those widely spread.

In order to separate the soil fertility effect from the experimental error the whole experimental area is divided into homogeneous group row wise (or) column wise (or) both

According to fertility gradiant of the soil such that the variation within each block is minimum and between the blocks is maximum the process of reducing experimental error by dividing the relatively heterogeneous experimental area (field) into homogeneous blocks is known as local control.

Size of the plots experimental unit (or) plots

The size of the plot depends on a no. of factors such as the total experimental area available. The no. of treatments the no. of replication of each treatments the crop and so on.

If the total experimental area remains fixed then an increase in the size of the plot will result in decrease in the no. of plot & consecuantly result in increase in the ~~no. of plots~~ size of the block & decrease in the no. of plots

Fairfield smith, after conducting uniformity trials experiments with the same crop on then harvesting the crop in small units obtained an important empirical relation between the plot size and the plot variance. These relationship known as fairfield smith Variance law and it expressed by the equation.

$$V_x = \frac{V_1}{x^b} \longrightarrow (1)$$

$$\log x = \log V - b \log x \longrightarrow (2)$$

Where,

V_x = Variance of the yield per unit area from plots of size x unit

V_1 = Regression coefficient soil characters indecating the relationship b/w un

The limiting values fare the being one and zero the we get for

When $b = 1$

$$V_x = \frac{V_1}{x}$$

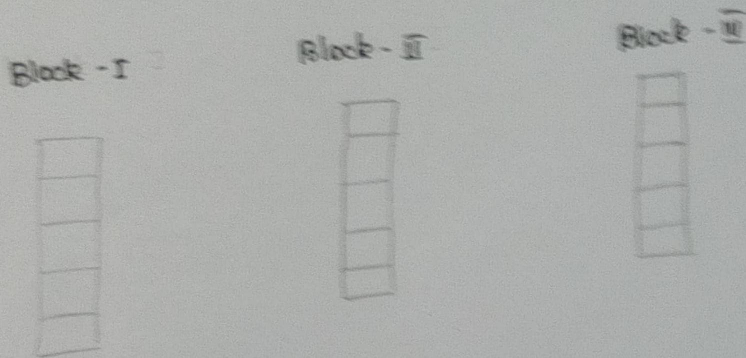
When $b = 0$

$$V_x = V_1$$

Therefore the increase in the plot size does not result in any again in efficiency result

Name of the crop	plot size in areas
Cereals	1/10
Maize	1/20
Sugar cane	1/40 to 1/80
Vegitables	1/80

Shape of Blocks and Plots Fertility Gradient



These will depend upon the shape and size of the plots. In order to control the experimental error it is desirable to divide the whole experimental area into different sub-group (plots) such that within each block there is much homogeneity as possible but b/w blocks there is maximum variation

Further each block is to be divided into as many plots as the no. of treatment

For maximum precison the plots should be rectangular in shape with their long sides parallel to the direction of the fertility gradient and the plots should be arranged one after the other al[ong] the fertility gradient