The plots to which the different treatments are to be given are found by the following randomisation principle. The plots are numbered from 1 to n serially. n identical cards are taken, numbered from 1 to n and shuffled thoroughly. The numbers on the first n_1 cards drawn randomly give the numbers of the plots to which the first treatment is to be given. The numbers on the next n_2 cards drawn at random give the numbers of the plots to which the second treatment is to be given and so on. This design is called a completely randomised design, which is used when the plots are homogeneous or the pattern of heterogeneity of the plots is unknown.

Analysis of Variance (ANOVA)

The analysis of variance is a widely used technique developed by R.A. Fisher. It enables us to divide the total variation (represented by variance) in a group into parts which are ascribable to different factors and a residual random variation which could not be accounted for by any of these factors. The variation due to any specific factor is compared with the residual variation for significance by applying the F-test, with which the reader is assumed to be familiar. The details of the procedure will be explained in the sequel.

Analysis of Variance for One Factor of Classification

Let a sample of N values of a given random variable X (representing the yield of paddy) be subdivided into 'h' classes according to some factor of classification (different manures).

We wish to test the null hypothesis that the factor of classification has no effect on the variable, viz., there is no difference between various classes, viz., the classes are homogeneous. Let x_{ij} be the value of the j^{th} member of the i^{th} class, which contains n_i members. Let the general mean of all the N values be $\bar{x}$ and the mean of n_i values in the i^{th} class be $\bar{x}_i$.

Basic Principles of Experimental Design

In order to achieve the objective mentioned above, the following three principles are adopted while designing the experiments– (1) randomisation, (2) replication and (3) local control.

1. Randomisation

As it is not possible to eliminate completely the contribution of extraneous variables to the value of the response variable (the amount of yield of paddy), we try to control it by randomisation. The group of experimental units (plots of the same size) in which the manure is used is called the *experimental group* and the other group of plots in which the manure is not used and which will provide a basis for comparison is called the *control group*. If any information regarding the extraneous variables and the nature and magnitude of their effect on the response variable in question is not available, we resort to randomisation. That is, we select the plots for *the* experimental and control groups in a random manner, which provides the most effective way of eliminating any unknown bias in the experiment.

2. Replication

In a comparative experiment, in which the effects of different manures on the yield are studied, each manure is used in more than one plot. In other words, we resort to replication which mean repetition. It is essential to carry out more than one test on each manure in order to estimate the amount of the experimental error and hence to get some idea of the precision of the estimates of the manure effects.

3. Local Control

To provide adequate control of extraneous variables, another essential principle used in the experimental design is the local control. This includes techniques such as grouping, blocking and balancing of the experimental units used in the experimental design. By *grouping*, we mean combining sets of homogeneous plots into groups, so that different manures may be used in different groups. The number of plots in different groups need not necessarily be the same. By *blocking*, we mean assigning the same number of plots in different blocks. The plots in the same block may be assumed to be relatively homogeneous. We use as many manures as the number of plots in a block in a random manner. By *balancing*, we mean adjusting the procedures of grouping, blocking and assigning the manures in such a manner that a balanced configuration is obtained.

SOME BASIC DESIGNS OF EXPERIMENT

1. Completely Randomised Design (C.R.D.)

Let us suppose that we wish to compare 'h' treatments (use of 'h' different manures) and there are n plots available for the experiment.

Let the ith treatment be replicated (repeated) n_i times, so that $n_1 + n_2 + \dots + n_h = n$.

Table 10.1 ANOVA table for one factor of classification

Source of variation (S.V.)	*Sum of squares (S.S.)*	*Degree of freedom (d.f.)*	*Mean square (M.S.)*	*Variance ratio (F)*
Between classes	Q_1	$h-1$	$Q_1/(h-1)$	$\dfrac{Q_1/(h-1)}{Q_2/(N-h)}$ (OR)
Within classes classes	Q_2	$N-h$	$Q_2/(N-h)$	$\dfrac{Q_2/(N-h)}{Q_1/(h-1)}$
Total	Q	$N-1$	–	–

Note *For calculating Q, Q_1, Q_2, the following computational formulas may be used:*

$$Q = N\left\{\frac{1}{N}\sum\sum x_{ij}^2 - \bar{x}^2\right\}$$

$$= N\left\{\frac{1}{N}\sum\sum x_{ij}^2 - \left(\frac{1}{N}\sum\sum x_{ij}\right)^2\right\}$$

$$= \sum\sum x_{ij}^2 - \frac{T^2}{N}, \text{ where } T = \sum\sum x_{ij}$$

Similarly, for the 1^{th} class,

$$\sum_j (x_{ij} - \bar{x}_i)^2 = \sum_j x_{ij}^2 - \frac{T_i^2}{n_i}, \text{ where } T_i = \sum_j x_{ij}.$$

$$\therefore \quad Q_2 = \sum_i\sum_j (x_{ij} - \bar{x}_i)^2 = \sum_i\sum_j x_{ij}^2 - \sum_i \frac{T_i^2}{n_i}$$

Hence

$$Q_1 = Q - Q_2$$

$$= \sum_i \frac{T_i^2}{n_i} - \frac{T^2}{N}$$