

### **Unit 1: Statistical Methods I**

Descriptive statistics. Elements of probability theory, conditional probability, Bayes' theorem. Random variable-discrete and continuous. Mathematical expectation. Moment generating and characteristic functions. Laws of large numbers. Central limit theorem. Discrete probability distributions: binomial, Poisson, negative binomial, geometric, multinomial and hypergeometric. Continuous probability distributions: normal, rectangular, Cauchy, exponential, gamma and beta. Sampling distributions: chi-square, t, and F. Bivariate normal distribution: conditional and marginal.

Point estimation: unbiasedness, consistency, efficiency, sufficiency. Completeness. Minimum variance unbiased estimator. Cramer-Rao Inequality. Rao-Blackwell theorem and Lehman-Scheffe theorem. Methods of point estimation like Maximum likelihood, Moments, Minimum chi-square. Confidence interval estimation. Testing of hypotheses - two types of errors, level of significance and power of a test. Neyman-Pearson Lemma. Uniformly most powerful tests and their construction. Unbiased test, Likelihood ratio test. Tests of significance based on Z, t, chi-square and F distributions.

### **Unit 2: Statistical Methods II**

Correlation, rank correlation, correlation ratio, intra-class correlation. Simple and multiple regression analysis, partial and multiple correlation. Examination of residuals. Model-adequacy, Selecting best regression. Compound and truncated distribution, Order statistics. Non-parametric tests: run, sign, rank, Wilcoxon, Kruskal-Wallis, Mann-Whitney, Cochran and Friedman's tests. Contingency tables. Log linear models. Sequential analysis, sequential probability ratio test. Components of time series. Multivariate normal distribution: estimation of mean vector and dispersion matrix. Wishart distribution, Hotelling  $T^2$ , multivariate analysis of variance, principal component analysis, factor analysis, discriminant analysis, cluster analysis. Linear Programming: formulation and graphical solution, simplex method, duality, transportation and assignment problems.

### **Unit 3: Statistical Genetics**

Statistical analysis of segregation, detection and estimation of linkage. Gene and genotypic frequencies. Random mating and equilibrium in large populations. Disequilibrium due to linkages for two pairs of genes and for sex linked genes. Selection, mutation and migration. Equilibrium between forces in large population. Polymorphism. Fisher's fundamental theorem of natural selection. Polygenic systems for quantitative characters, Concepts of breeding value, dominance, average effect of gene and epistatic interactions. Genetic variance and its partitioning. Correlation between relatives. Regular system of inbreeding, effects of inbreeding. Genotype and environment interaction, stability parameters. Estimation of heritability,

repeatability and genetic correlation. Path coefficient analysis. Heterosis, concepts of general and specific combining abilities. Diallel crosses and line  $\times$  tester analysis. Response due to selection. Prediction of response to individual, family and combined selections. Construction of selection index.

#### **Unit 4: Design of Experiments**

Linear models: Random, fixed and mixed effects. Nested and crossed classifications. Gauss-Markoff theorem. Analysis of variance. Principles of design of experiments. Uniformity trials. Completely randomized design. Randomized complete block design. Latin square design. Factorial experiments:  $2^n$  and  $3^n$  series and asymmetrical factorial experiments, confounding in  $2^n$  and  $3^n$  experiments, split and strip-plot designs, crossover designs. Multiple comparison procedures. Missing plot techniques. Analysis of covariance. Variance stabilizing transformations. Analysis of general block design. Balanced incomplete block designs: construction and analysis. Partially balanced incomplete block designs with two associate classes, lattice designs. Youden square design. Groups of experiments.

#### **Unit 5: Sample Surveys**

Sampling versus complete enumeration. Concept of probability sampling. Simple random sampling. Stratified sampling, allocation in stratified sampling, choice of strata, construction of strata boundaries and collapsing of strata. Use of auxiliary information in sample surveys, ratio and regression methods of estimation. Systematic sampling. Cluster and multi-stage sampling with equal probability. Sampling with unequal probabilities with and without replacement, sampling schemes with inclusion probabilities proportional to size. Double sampling, sampling on successive occasions. Non-sampling errors: sources and classification. Randomized response techniques, imputation methods. Design and organization of pilot and large scale surveys. National sample surveys. Agricultural statistics system in the country-land use statistics, crop estimation surveys, livestock and fishery statistics.