

## **SCHOOL OF AGRICULTURE**

### **Paper-I: Research Methodology**

Research and Types of research: Meaning of Research- Objectives of Research- Motivation in Research. Research methods vs Methodology. Types of research – Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical. Research Process. Criteria of good Research. Research Formulation – Defining and formulating the research problem - Selecting the problem - Necessity of defining the problem - Importance of literature review in defining a problem – Literature review – Primary and secondary sources – reviews, treatise, monographs-patents – web as a source – searching the web - Critical literature review – Identifying gap areas from literature review - Development of working hypothesis. Data Collection and analysis: Execution of the research - Observation and Collection of data - Methods of data collection – Modeling, Mathematical Models for research, Sampling Methods- Data processing and Analysis strategies. Data Analysis with Statistical Packages – Hypothesis-testing, Generalization-and Interpretation

### **Paper – II: GENERAL GENETICS AND PLANT BREEDING**

#### **General Genetics and Plant Breeding**

Mendelian inheritance. Cell structure and division, Linkage. Epistasis. Gene concept, allelism and structure of gene. Extra chromosomal inheritance. DNA – structure, function, replication and repair. Genetic code. Gene-enzyme relationship. Replication, Transcription and Translation. Gene regulation in prokaryotes and eukaryotes. Nuclear and cytoplasmic genome organization. Mutations and their molecular mechanisms. Crop domestication, evolution of crops and centres of diversity. Plant breeding, Objectives and accomplishments in plant breeding and the role of National and International institutes. Modes of reproduction and its relation to plant breeding methodology. Apomixes, incompatibility and male sterility systems and their use in plant breeding. Epigenetics.

#### **Economics Botany and Plant Breeding Methods**

Origin, distribution, classification, description and botany of cereals (wheat, rice, maize, sorghum, pearl millet, small millets); pulses (pigeonpea, chickpea, black gram, green gram,

cowpea, soybean, pea, lentil, horse gram, lab-lab, rice bean, lathyrus, lima bean; oilseeds (groundnut, sesamum, castor, rapeseed mustard, sunflower, safflower, niger, linseed); fibre and sugar crops, fodder and green manures; Breeding methods for self-pollinated, cross-pollinated and asexually propagated crops. Combination, recombination and transgressive breeding. Populations, their improvement methods and maintenance, Hybrid breeding and genetic basis of heterosis. Ideotype breeding. Mutation breeding, Concept of tree breeding. Speed breeding methods, Pre-breeding, Reverse Breeding.

### **Genome Organization and Cytogenetics of Crop Plants**

Chromosomes, types, function and replication. Structural and numerical changes in chromosomes. Sex determination & sex linkage. Recombination and crossing over. Cell cycle and its regulation. In situ hybridization. Polyploids, aneuploids, their utility and their meiotic behaviour. Wide hybridization and chromosomal manipulations for alien gene transfer. Pre-and post- fertilization barriers in wide hybridization. Genome organization and Cytogenetics of important crop species- wheat, maize, rice, sorghum, Brassica, groundnut, cotton, Vigna, potato and sugarcane. Cytogenetic techniques for gene location and gene transfer, Construction and use of molecular marker based chromosome map

### **Quantitative and Biometrical Genetics Quantitative characters.**

Multiple factors inheritance. Genetic control of polygenic characters. Genetic advance and types of selection. Metric characters under natural selection. Repeatability and asymmetry of response. Breeding value. Dominance and interaction deviations. Hardy Weinberg law and changes in gene frequency. Linkage disequilibrium. Genetic load. Polymorphism. Breeding value, heritability. Response to selection, correlated response. Estimates of variance components and covariance among relatives. Mating designs with random and inbred parents. Gene effects and combining ability. Effects of linkage and epistasis on estimation of genetic parameters. Maternal effects. Genotype-environment interactions, stability analysis. Heterosis Mating system and mating design- diallel, line X tester, NC-I NC-II and NC-III designs and GGE biplot analysis, Principal component analysis, AMMI and GGI analysis.

### **Genetic Engineering and Biotechnological Tools in Plant Breeding**

Somatic hybridization, micropropagation, somaclonal variation, in vitro mutagenesis. Anther culture. Cryopreservation. Genetic and molecular markers and their application in genetic diversity analysis and breeding for complex characters. Gene tagging, QTL mapping, MAS, MARS and MABB. Vectors. DNA libraries, DNA fingerprinting, DNA sequencing. Nucleic acid hybridization and immunochemical detection. Chromosome walking, Recombinant DNA technology, Gene cloning strategies. Gene transfer methods. Artificial synthesis of gene. Genetic transformation, transgenics and cisgenics. Antisense RNA, RNAi and micro RNA techniques in crop improvement. Genome editing using CRISPER/cas, Genomic selection, RNA Seq analysis.

## **Plant Breeding for Stress Resistance and Nutritional Quality**

Genetic and molecular basis and breeding for resistance to diseases and insect-pests. Vertical and horizontal resistance to diseases. Genetic and physiological basis of abiotic stress tolerance. Breeding for resistance to heat, frost, flood, drought and soil stresses. Important quality parameters in various crops, their genetic basis and breeding for these traits. Role of molecular markers in stress resistance breeding using biotechnological tools (MAS, MARS and MABB and transgenics). Biofortification.

## **Plant Genetic Resources and their Regulatory System**

Varietal Release and Seed Production Plant exploration, germplasm introduction, exchange, conservation, evaluation and utilization of plant genetic resources. Types of genetic resources. Centres of diversity of cultivated plants. Genetic erosion and genetic vulnerability. Convention on Biological Diversity and International Treaty on Plant Genetic Resources for Food and Agriculture. Intellectual Property Rights and its different forms for protection of plant genetic resources. Biodiversity Act. PPVFRA. System of variety release and notification. Types of seeds and seed chain. Maintenance breeding- nucleus and breeder seed production and certification.

## **Statistical Methods and Field Plot Techniques**

Frequency distribution. Measures of central tendency, probability theory and its applications in genetics. Probability distribution and tests of significance. Correlation, linear, partial and multiple regression. Genetic divergence. Multivariate analysis. Designs of experiments - basic principles, CRD, RBD and split plot design. Complete and incomplete block designs. Augmented design, Grid and honeycomb design. Hill plots, unreplicated evaluation. Data collection and interpretation.