3 PLANT GENETIC RESOURCES

Unit 1: Biodiversity and Plant Genetic Resources

Biodiversity- an overview, genetic, species and ecosystem diversity; determinants of biodiversity ,species richness and endemism, agriculture as friend and foe of biodiversity, harmonizing biodiversity, conservation and agricultural development, origin and history of agriculture; dynamics of domestication; centers of crop plant origin and diversity; geographical distribution of crops of Indian origin, plant genetic resources management (importance and usefulness of germplasm, germplasm conservation, threat of genetic vulnerability, global concerns) *in situ* conservation of genetic resources, collecting genetic resources and managing genetic resources, biotechnology and germplasm conservation.

Unit 2: Exploration and Germplasm Collecting

History and importance of germplasm exploration; distribution and extent of prevalent genetic diversity; phyto-geographical regions/ecological zones and associated diversity; mapping eco-geographic distribution of diversity, threatened habitats, use of flora. Concept of population and gene pool, variations in population and their classification, gene frequencies in populations, rare and common alleles, gene pool sampling in self- and cross-pollinated and vegetatively propagated species, non-selective, random and selective sampling strategies. Strategies and logistics of plant exploration and collection, coarse and fine grid surveys, practical problems in plant exploration, use of *in vitro* methods in germplasm collection. Ethnobotanical aspects of PGR, crop botany, farming systems, collecting wild relatives of crop plants. Post-exploration handling of germplasm collections, collection and preservation of specimens, importance and use of herbaria and preparation of herbarium specimens. Present status and future strategies in collecting of major crops of Indian origin such as rice, maize, sorghum, sesame, brassica, okra, eggplant, cotton, mango, etc.

Unit 3: Germplasm Exchange and Plant Quarantine

History, principles, objectives and importance of plant introduction; Prerequisites, conventions, national and international legislations and policies on germplasm collection and exchange.

Plant quarantine- introduction, history, principles, objectives and relevance; Regulations and plant quarantine set up in India; Pest risk analysis, pest and pathogen information database; Quarantine in relation to integrated pest management; Economic significance of seed-borne pests (insects, mites, non-insect pests, nematodes, fungi, bacteria, viruses, phytoplasma etc.). Detection and identification of pests including use of recent techniques like ELISA, PCR etc., Symptoms of pest damage, salvaging techniques for infested/infected germplasm, post-entry quarantine operation, seed treatment and other prophylactic treatments and facilities. Domestic quarantine; seed certification; International linkages in plant quarantine; weaknesses and future thrust. Genetically modified organisms (GMOs) or genetically engineered plants (GEPs), Concepts of biosafety, risk analysis and consequences of spread of GE crops on the environment; Treaties and multilateral agreements governing trans-boundary movement of GEPs

or GMOs, Indian regulatory system for biosafety.

Unit 4: Principles and Methods of Germplasm Conservation

In situ and *ex situ* conservation: concept of biosphere reserves, gene sanctuaries, on-farm conservation, field genebanks, botanical gardens, herbal gardens, *in vitro* repositories cryo-banks and DNA banks, Short-, medium- and long-term conservation, concept of base, active and working collections, seed structure and function, physiological and genetic changes during storage, theories of aging, viability equations, predicting storage life of seeds, dormancy and germination. Genebank management: acquisition, accessioning and processing of germplasm samples for storage, genebank standards for various crops, ISTA, AOSA, IPGRI guidelines, monitoring and regeneration of plant germplasm. Design of storage facilities, maintenance and operation of storage modules. Information management in genebanks, strategies for revival and rescue of rare genetic material.

Unit 5: Principles and Practices of Germplasm Regeneration and Evaluation

Principles and practices of germplasm regeneration and maintenance, breeding systems and mode of reproduction; maintaining sufficiently large populations for effective conservation of farmer landraces. Germplasm characterization/evaluation procedures; evaluation of germplasm for specific traits; key issues for the improvement of characterization, evaluation and use of plant genetic resources; concept of core collection. Measuring diversity using agro-morphological data; gene markers and their use in PGR management. Evaluation and maintenance of wild relatives of crop plants; genetic enhancement/pre-breeding and use of alien/unadapted genetic resources in crop improvement.

Unit 6: Biotechnology in Plant Genetic Resource Management

History and importance of Tissue culture, Tissue culture media, Sterilization techniques, *In vitro* clonal multiplication, Somatic embryogenesis, Meristem culture and virus elimination, *In vitro* conservation –Introduction and principle, Strategies for *in vitro* short- and medium-term conservation, *In vitro* collection, *in vitro* exchange of germplasm.

Plant Cryopreservation-Introduction, Principle of cryotolerance, Techniques of cryopreservation: slow cooling, desiccation, pre-growth, encapsulation-dehydration, vitrification, droplet freezing, Cryoprotectants, Cryopreservation of seeds and pollen, Cryopreservation of *in vitro* cultures, Application of *in vitro* cryopreservation techniques, Management of *in vitro* and cryobanks, Genetic stability of *in vitro* conserved and cryopreserved germplasm, Importance of database for *in vitro* and cryopreserved germplasm.

Unit 7: Economic Botany

Origin, evolution, botany, cultivation, genetic resource activities and utilization of genetic diversity of important crops of cereals, millets, legumes, forage and fodder crops, medicinal and aromatic plants, beverages, oil yielding plants, spices and condiments, wood and timber yielding taxa, fumigatory and masticatory plants, vegetable crops, sugar, starch and cellulose yielding

plants, rubber yielding plants, insecticidal and herbicidal plants, fruits and nuts, flowering agents, gums and resins, fiber yielding plants, under-utilized and under-exploited plants, new crops, pseudo-cereals, important taxa in agro-forestry, horticulture and floriculture, processing and use of crop residues.

Unit 8: Information Management in Plant Genetic Resources

Statistical techniques in management of germplasm, developing core collection, estimation of sample size during plant explorations, impact of sampling on population structure, Sequential sampling for viability estimation, introduction of binomial, normal and negative cumulative normal, use of Probit scales, viability equations and nomograms, estimation of sample size for storage and viability testing,

Germplasm documentation; basics of computer and operating systems, database management system, use of statistical softwares, pictorial and graphical representation of data; Introduction to communication network.

Unit 9: Plant Taxonomy

Classical and modern species concepts, differentiation and evolution of species and biosystematics -variation within species, population genetics, phenotypic plasticity, environmental effects on populations, Modern evidences for Morphology and Anatomy, Embryology and Palynology; Biogeography and Cytotaxonomy; Modern evidences for Comparative studies on phytochemistry, Chemotaxonomy; Molecular taxonomy methods; Numerical methods in taxonomy; Biosystematic approaches in plant taxonomy- some Indian case studies, Taxonomy of cultivated plants: Taxonomy of cultivated plants with particular emphasis on Indian groups: Hybrids, domesticated species, wild-cultivated continuum; Tools of taxonomy for identification of plant species and variation patterns therein; Field and herbarium methods; Floristic and monographic works; Systematic and evolutionary studies, Taxonomic databases: Taxonomic databases and documentation methods.

Unit 10: Plant Biosecurity

History and Concept of biosecurity, Components of biosecurity, Quarantine, Invasive Alien Species, Biowarfare, Emerging/ resurgence of pests and diseases, National Regulatory Mechanism and International Agreements/Conventions viz. Agreement on Application of Sanitary and Phytosanitary (SPS), Measures/ World Trade Organization (WTO), Convention on Biological Diversity (CBD), International Standards for Phytosanitary Measures, pest risk analysis, risk assessment models, pest information system, early warning and forecasting system, use of Global Positioning System (GPS) and Geographic Information System (GIS) for plant biosecurity, pest/ disease and epidemic management, strategies for combating risks and costs associated with agro-terrorism event, mitigation planning, integrated approach for biosecurity, Biosafety, policies and regulatory mechanism, Cartagena Protocol on Biosafety and its implications, Issues related to release of genetically modified crops.

Unit 11: Fundamentals of Molecular Biology for PGR Management

Structure and function of DNA, genome organization, Tools for genetic manipulation, Introduction to molecular markers, classification and comparison of markers, basis for DNA polymorphism and principles of generating molecular markers, - RFLP, PCR, sequencing; Principles, merits and demerits of RAPD, ISSR, SSR, SCAR, SCOT, SRAP, AFLP, SNPs markers; data handling and statistical analysis, Overview of molecular marker applications, Introduction to transgenics, monitoring strategies and methods for detecting transgenics.