

13 NATURAL RESOURCE MANAGEMENT-II

(13.1 Agronomy, 13.2 Soil Sciences)

13.1 AGRONOMY

Unit 1 : Crop Ecology and Geography

Principles of crop ecology; Ecosystem concept and determinants of productivity of ecosystem; Physiological limits of crop yield and variability in relation to ecological optima; Crop adaptation; Climate shift and its ecological implication; Greenhouse effect; Agro-ecological and agro climatic regions of India; Geographical distribution of cereals, legumes, oilseeds, vegetables, fodders and forages, commercial crops, condiments and spices, medicinal and aromatic plants; Adverse climatic factors and crop productivity; Photosynthesis, respiration, net assimilation, solar energy conversion efficiency and relative water content, light intensity, water and CO₂ in relation to photosynthetic rates and efficiency; Physiological stress in crops; Remote sensing: Spectral indices and their application in agriculture, crop water stress indices and crop stress detection.

Unit 2 : Weed Management

Scope and principles of weed management; Weeds' classification, biology, ecology and allelopathy; Crop weed competition, weed threshold; Herbicides classification, formulations, mode of action, selectivity and resistance; Persistence of herbicides in soils and plants; Application methods and equipment; Cultural, physical, mechanical weed control, Biological weed control, bio-herbicides: Integrated weed management; Special weeds, parasitic and aquatic weeds and their management in cropped and non-cropped lands; weed control schedules in field crops, vegetables and plantation crops; Role of GM crops in weed management.

Unit 3 : Soil Fertility and Fertilizer Use

History of soil fertility and fertilizer use; Concept of essentiality of plant nutrients, their critical concentrations in plants, nutrient interactions, diagnostic techniques with special emphasis on emerging deficiencies of secondary and micro-nutrients; Soil fertility and productivity and their indicators; Fertilizer materials including liquid fertilizers, their composition, mineralization, availability and reaction products in soils; Water solubility of phosphate fertilizers; Slow release fertilizers, nitrification inhibitors and their use for crop production; Principles and methods of fertilizer application including fertigation; Integrated nutrient management and bio-fertilizers; Agronomic and physiological efficiency and recovery of applied plant nutrients; Criteria for determining fertilizer schedules for cropping systems direct, residual and cumulative effects; Fertilizer related environmental problems including ground water pollution; Site-specific nutrient management; Contamination of heavy metals in peri-urban soils and their remediation.

Unit 4 : Dryland Agronomy

Concept of dryland farming; dryland farming vs rainfed farming; History, development, significance and constraints of dryland agriculture in India; Climatic classification and delineation of dryland tracts; Characterization of agro-climatic environments of drylands; Rainfall analysis and length of growing season; Types of drought, drought syndrome, effect on plant growth, drought resistance, drought avoidance, drought management; Crop Planning including contingency, crop diversification, varieties, cropping systems, conservation cropping and mid-season corrections for aberrant weather conditions; Techniques of moisture conservation in-situ to reduce evapotranspiration, runoff and to increase infiltration; Rain water harvesting and recycling concept, techniques and practices; Timelines and precision key factors for timely sowing, precision in seeding, weed control; Fertilizer placement, top dressing and foliar application, aqua-fertigation; Concept and importance of watershed management in dryland areas.

Unit 5 : Crop Production in Problem Soils

Problem soils and their distribution in India, acid, saline, waterlogged and mined - soils; Response of crop to acidity, salinity, sodicity, excess water and nutrient imbalances; Reclamation of problem soils, role of amendments and drainage; Crop production techniques in problem soils - crops, varieties, cropping system and agronomic

practices; Effects of water table fluctuation on crop growth; Degraded lands and their rehabilitation.

Unit 6 : Crop Production

Crop production techniques for cereals, millets, legumes, oilseeds, fiber crops, sugarcane, tobacco, fodder and pasture crops including origin, history, distribution, adaptation, climate, soil, season, modern varieties, Seed rate, fertilizer requirements, crop geometry, intercultural operations, water requirement. weed control, harvest, quality components, industrial use, economics and post-harvest technology.

Unit 7 : Agricultural Statistics

Frequency distribution, standard error and deviation, correlation and regression analyses, co-efficient of variation; Tests of significance-t, F and chi-square (X²); Data transformation and missing plot techniques; Design of experiments and their basic principles, completely randomized, randomized block, split plot, strip-plot, factorial and simple confounding designs; Efficiency of designs; Methods of statistical analysis for cropping systems including intercropping; Pooled analysis.

Unit 8 : Sustainable Land Use Systems

Concept of sustainability; Sustainability parameters and indicators; Conservation agriculture; Alternate land use systems; Types, extent and causes of wasteland; Shifting cultivation; Agro forestry systems; Agricultural and agro-industrial residues and its recycling, safe disposal; Allelopathy and biomass production.

Unit 9 : Basics of Soil and Water

Soil and water as vital resources for agricultural production; Occurrence of groundwater, groundwater aquifers, exploration of groundwater; Hydrological cycle; Soil-plant water relationship; Fate of rain water received at the soil surface, runoff and infiltration reciprocity, factors affecting infiltration, means to enhance infiltrability of soil, mechanical and biological means to reduce runoff and soil loss; Water harvesting for crop lifesaving irrigations; watershed management; Soil and water conservation; Contingent crop plans and other strategies for aberrant weather conditions; Cropping patterns, alternate land use and crop diversification in rainfed areas; Analysis of hydrologic data and their use.

Unit 10 : Soil Water Relationship

Soil water relations, water retention by soil, soil moisture characteristics, field capacity, permanent wilting point, plant available water and extractable water; Soil irrigability, classifications, factors affecting profile water storage; Determination of soil water content, computation of soil water depletion, soil water potential and its components, hydraulic head; Movement of soil water saturated and unsaturated water flow; Field water budget, water gains and water losses from soil, deep percolation beyond root zone, capillary rise; Evapotranspiration (ET), scope for economizing water, measures for reducing direct evaporation from soil and crop canopies; Soil physical properties in relation to plant growth and development; Erodability of soils and their prevention.

Unit 11 : Plant Water Relationship

Plant water relations: Concept of plant water potential, cell water relations, plant water potential and its components; Significance of osmotic adjustment, leaf diffusive resistance, canopy temperature, canopy temperature depression (CTD); Water movement through soil - plant atmosphere systems, uptake and transport of water by roots; Development of crop water deficit, crop adaptation to water deficit, morpho-physiological effect of water deficit; Drought tolerance, mechanisms of drought tolerance, potential drought tolerance traits and their measurements. management and breeding strategies to improve crop productivity under different patterns of drought situations of limited water supplies; Effect of excess water on plant growth and production; Types of droughts, drought indices.

Unit 12 : Irrigation Water Management

Management of irrigation water; History of irrigation in India; Major irrigation projects in India; Water resources development; Crop water requirements; Concepts of irrigation scheduling, Different approaches of irrigation

scheduling; Soil water depletion plant indices and climatic parameters; Concept of critical stages of crop growth in relation to water supplies; Crop modeling, crop coefficients, water production functions; Methods of irrigation viz. surface methods, overhead methods, drip irrigation and air conditioning irrigation, merits and demerits of various methods, design and evaluation of irrigation methods; Measurement of irrigation water, application and distribution efficiencies; Management of water resources (rain, canal and ground water) for agricultural production; Agronomic considerations in tile-design and operation of irrigation projects, characteristics of irrigation and family systems affecting irrigation management; Irrigation legislation; Water quality, conjunctive use of water, irrigation strategies under different situation of water availability, optimum crop plans and cropping patterns in canal command areas; Socio-economic aspects of on-farm water management; Irrigation water distribution, Estimation of ET by direct and indirect methods, Irrigation efficiencies; Design of irrigation canals, design of irrigation structures; Interaction between irrigation and fertilizers.

Unit 13 : Management of Problematic Soils and Water

Problem soils and their distribution in India; Salt-affected, acidic, water logged soils; Ground water resources, water quality criteria and use of brackish waters in agriculture; Excess salt and salt tolerant crops; Hydrological imbalances and their corrective measures; Concept of critical water table depths for crop growth; Contribution of shallow water table to crop water requirements; Management strategies for flood prone areas crop and crop calendar for flood affected areas; Drainage for improving water logged soils for crop production; Crop production and alternate use of problematic soils and poor quality water for agricultural and fish production; Amelioration of salt affected soils.

13.2 SOIL SCIENCES

Unit 1: Pedology

Concept of land, soil and soil science. Composition of earth crust and its relationship with soils; Rocks, minerals and other soil forming materials; Weathering of rocks and minerals; Factors of soil formation; Pedogenic processes and their relationships with soil properties; Soil development; Pedon, polypedon, soil profile, horizons and their nomenclature. Soil Taxonomy - epipedons, diagnostic subsurface horizons and other diagnostic characteristics, soil moisture and temperature regimes, categories of the system and their criteria; Interpretation of soil survey data for land capability and crop suitability classifications, Macro-morphological study of soils, Application and use of global positioning system for soil survey. Soil survey- types, techniques. Soil series-characterization and procedure for establishing soil series, benchmark soils and soil correlations. Study of base maps: cadastral maps, toposheets, aerial photographs and satellite imageries. Use of geographical information system for preparing thematic maps. Application of Remote Sensing in soil survey and mapping.

Unit 2: Soil Physics

Soil physical constraints affecting crop production. Soil texture – textural classes. Soil structure – classification, soil aggregation and significance, soil consistency, soil crusting, bulk density and particle density of soils and porosity, their significance and manipulation. Soil water- retention and potentials. Soil moisture constants. Movement of soil water - infiltration, percolation, permeability, drainage and methods of determination of soil moisture. Darcy's law. Thermal properties of soils, soil temperature, Soil air- composition, gaseous exchange, influence of soil temperature and air on plant growth. Soil erosion by water- types, effects, mechanics. Rain erosivity and soil erodibility. Runoff - methods of measurement, factors and management, runoff farming. Soil conservation measures.

Characterization and evaluation of soil and land quality indicators; Causes of land degradation; Management of soil physical properties for prevention/restoration of land degradation; Identification, monitoring and management of waste lands; Land use-land cover mapping and land use planning using conventional and remote sensing techniques; Concept of watershed – its characterization and management.

Unit 3: Soil Chemistry

Chemical composition of soil; Soil colloids - structure, composition, constitution of clay minerals, amorphous clays and other non-crystalline silicate minerals, oxide and hydroxide minerals; Charge development on clays and organic matter; pH-charge relations; Buffer capacity of soils.

Elements of equilibrium thermodynamics, chemical equilibria , electrochemistry and chemical kinetics. Inorganic