

9. Verma, M. M.; Arora, N. and Mirakhur, R. K. 1990. *Seed Analyst Manual*. Lad Computer Services Pvt. Ltd, New Delhi.

FB 702C: FOREST BIOMETRY

Credits: 2+0+1=3

UNIT I

Measurement of tree parameters. Determination of tree age and dendrochronology for growth history and climate change studies.

Estimation of volume, growth and yield of individual tree and forest stands. Volume tables, yield and stand tables.

UNIT II

Forest inventory, sampling methods adopted in forestry, Use of GIS in forest inventory. Quantification of regeneration and stand establishment. Measurement of crown density and crown ratios. Simulation techniques. Growth and yield prediction models – their preparation and applications.

Practical:

1. Application of different sampling methods.
2. Calculations of volume of felled as well as standing trees.
3. Volume table preparation.
4. Preparation of yield and stand table.
5. Quantification of regeneration and stand establishment.
6. Measurement of crown density and crown ratios.
7. Crown profiling of trees and stand.
8. Dendrochronological studies.

Suggested Readings

1. Avery, T. E. and Burkhardt, H. E. 2002. *Forest Measurements*. 5th Edition. McGraw Hill, New York.
2. Beers, T. W. and Miller, C. I. 1973. *Manual of Forest Mensuration*. T & C Enterprises, West Lafayette, IN
3. Chapman, H. H. and Meyer, W. H. 1949. *Forest Mensuration*. McGraw-Hill, New York.
4. Chaturvedi ANand Khanna LS. 1994. *Forest Mensuration*. International Book Distributor.
5. Hamilton, G. D. 1975. *Forest Mensuration Hand Book*. Her Majesty's Stationary office, London.
6. Husch, B.; Beers, T. W. and Kershaw, J. A. 2003. *Forest Mensuration*. 4th edition. John Wiley and Sons, INC, Hobokon, New Jersey.
7. Simmons CE. 1980. *A Manual of Forest Mensuration*. Bishen Singh Mahender Pal Singh, Dehradun.

FB 703C: BIODIVERSITY AND CONSERVATION

Credit: 3+0+1=4

Unit I

Basic concepts of biodiversity, Biodiversity- definition, levels and types; Factors promote high diversity, latitudinal and altitudinal gradients of biodiversity; biodiversity extinctions; biodiversity values-evolutionary, economic, social, cultural and intrinsic values, threats to biodiversity-Indian context, important threatened/endemic plant and animal taxa of India, biodiversity and ecosystem services; Climate change and biodiversity; Biodiversity of Indian subcontinent: biodiversity hotspots, their characteristic flora and fauna, Biodiversity resources of north-east India, threatened vascular plant species in India, specially emphasize on North east India; Threatened categories, biological invasions and Biodiversity, Biodiversity and Biotechnology, Biopiracy.

History of biodiversity conservation; Biodiversity conservation strategies: *in situ* conservation: Biosphere reserve, sanctuaries, national parks, *ex situ* conservation: botanical garden, zoological garden, *in vitro* conservation: germplasm or gene bank, tissue culture; Global approaches to biodiversity conservation, Indigenous approaches to biodiversity conservation, biodiversity & ethnomedicinal resources, Indian initiatives in biodiversity conservation-biodiversity act 2002, Biodiversity Rules 2004, national biodiversity strategy and action plan (NBSAP), Plant Varieties Protection and Farmer's Rights Act, 2001, National biodiversity authority (NBA) etc; protected area network (PAN)-biosphere reserves, national park, sanctuary, community conservation area, important bird areas in India, ecological sensitive zone; important protected areas of North East India; biodiversity conservation in North East India/Tripura- problems and prospects ethnobotany in the conservation of plant genetic resources; traditional knowledge digital library (TKDL).

Unit II

International programmes for biodiversity conservation, convention on biological diversity (CBD), CITES, ITTA, UNFCCC, Kyoto Protocol, TRIPS, Ramsar Convention on Wet Lands, Cartagena Protocol on Bio-Safety 2000 (CPB); The Basel Convention on the Control of Trans-boundary Movement of Hazardous Wastes and their Disposal, The Montreal Protocol, IPR.

Phytogeography and zoogeographical regions, Introduction of species, Theories of distribution, Endemism, Community concept; Community composition, qualitative and quantitative characters of community; methods of studying vegetation; Techniques for survey and assessment of endangered and threatened plant species, species diversity and stability relationship; Diversity indices, Plant and animal communities in forest, grassland, desert and mangrove ecosystems; high altitude communities; zonation and stratification of plant and animal communities.

Suggested Readings:

1. Gaston, K.J and Spicer, J.I. 2004. *Biodiversity: An Introduction*. Blackwell Publishing Company, USA.

2. Richard. B. Primack. 1998. *Essentials of conservation biology*. Sinauer Associates, Inc. USA.
3. Maiti P.K. and Maiti P. 2011. Biodiversity Perception, Peril and Preservation. PHI Learning Private Limited, New Delhi.
4. Ray S. and Ray A.K. 2010. Biodiversity and biotechnology. New central book Agency (P) Ltd. Kolkata.
5. Agarwal, S.K. 2002. *Biodiversity conservation*. Rohini Publishers, Jaipur.
6. Nautiyal, S and Kaul, A.K. 1999. *Forest Biodiversity and its conservation Practices in India*. Oriental Enterprises, Dehradun.
7. Ian. F. Spellberg. 1992. *Evaluation and Assessment for Conservation*. Chapman Hall, London, UK.
8. David, E.B. and Joel, T.C., 2003. *Monitoring Ecosystems*. Island Press, Washington, DC
9. Stanley, A.H., 2002. *Managing our wildlife resource*. Prentice-Hall, USA.
10. Benson, E.E., 1999. *Plant conservation Biotechnology*. Taylor and Francis Ltd. London.
11. Agrawal, K.C., 2000. *Wildlife of India: Conservation and Management*. Nidhi Publishers, India
12. Sinha, P.C., 1998. *Wildlife and forest conservation*. Anmol Publication Pvt. Ltd, New Delhi.
13. Edward, O.G., 2004. *Ex situ plant conservation*. Island Press, Washington, DC

Practical:

1. Determination of minimal quadrat size by the species area curve methods.
2. Study of vegetation by Line transect/belt transect/quadrat methods.
3. Determination of frequency/Density/Abundance/IVI of vegetation.
4. Determination of minimum number of quadrat to be laid down in the field under study.
5. Measurement of Different Biodiversity Indices (Simpson's Biodiversity Index, Shannon's index, Brillouin index)
6. Study of vegetation of the given area by physiognomic method – Biological spectrum method.
7. Estimation of plankton frequency in the aquatic system.
8. Ecological census techniques- wild animal census.

FB 704C: FOREST ECOLOGY

Credit: 2+0+1=3

UNIT:I

Concept of forest ecosystem, Significance of forest, forest ecosystem structural and functioning, forest diversity indices (alpha diversity, beta diversity, gamma), Forest productivity (primary and secondary productivity), Measurement of forest productivity, Methods of developing allometric equations relating girth and biomass of trees, concept of succession

Nutrient cycling in forest: nutrient uptake, retention and return, source of nutrients. Nutrient input (wet, dry and weathering), accumulation and return through litter fall, acid precipitation, organic

matter decomposition, nutrient release and output through runoff and leaching, nutrient conservation strategies in forest. Examples of forest Carbon and N cycles.

UNIT:II

Concept of global change ecology, major global change issues (increasing atmospheric CO₂ concentration, alterations in biogeochemistry of nitrogen, land use change and biodiversity), impact of human activities on global change

Global cycles of carbon and nitrogen with emphasis on major pools, fluxes and transformations, perturbations in global carbon and nitrogen cycles, human influences on global carbon and nitrogen cycles, major impacts of global ecological changes on forests.

Suggested readings:

1. Barnes, B V; Zak, D R; Denton, S R and Spurr, S R (1998). Forest ecology (4th edition). John Wiley and Sons
2. Burton V. Barnes, Donald R. Zak, Shirley R. Denton, Stephen H. Spurr. 1998. Forest Ecology. John Wiley & Sons
3. Champion, H.G. and Seth, S.K. (1968). A revised survey of the forest types of India (Reprinted 2004). Natraj Publication, Dehradun.
4. Kimmins, J.P. (2004). Forest ecology (2nd edition). Pearson Education.
5. Perry, DA, Oren, R and Hart, S.C. (2008). Forest Ecosystems (2nd edition) The John Hopkins University press , Baltimore

Practical:

1. Monitoring of micro-meteorological parameters
2. Determine the community structure of a forest stand.
3. Calculate the turnover rate of different plant components
4. Determine the litter accumulation/decomposition in a forest stand.
5. Determine the biomass of tree species by allometric method
6. Study the community structure of wetland ecosystem
7. Determine the net ecosystem productivity in forest ecosystem.
8. Estimation the carbon stock in forest ecosystem.

FB 705C: FOREST PROTECTION

Credits: 2+0+1=3

UNIT: I

General Concept and Forest Fire; Factors affecting forest health; grazing & browsing, adverse climatic factors, acids rains & air pollutants, weeds and other invasive species. Forest fire (History, types, main causes, prevention and control), Evaluation of losses due to forest fire.

Forests and climate change; Status of forests in global climate change. Harnessing Forests for Climate Change Mitigation, National action plan on Climate Change of India: aim and objectives. International climate negotiation, UNFCCC, IPCC, CoP :LULUCF, REDD++ and CDM.

Silviculture and sustainability-criteria and indicators for sustainable plantation forestry in India-CIFOR guidelines. Silvicultural and stand management strategies for carbon sink maximization and source minimization. Adaptive silviculture for climate change.

UNIT II

Deforestation and degradation trends at global, national and regional levels. Mega development projects, conservation of native and threatened species, management and rehabilitation plans.

Restoration forestry-silvicultural treatments for habitat restoration, catchment area treatments, Role of canopy in regulating functional inputs to stand: canopy and forest continuum, Continuous Cover Forestry. Carbon sequestration potential of Trees Outside forests (TOFs), homegardens and urban forests.

Suggested Readings:

1. Anderson P and Palik B. 2011. Silviculture for Climate Change. U.S. Department of Agriculture, Forest Service, Climate Change Resource Center.
2. *Climate Change: Challenges To Sustainable Development in India*. 2008. Research UNIT (Larrdis) Rajya Sabha Secretariat, New Delhi.
3. *Greenhouse Gas Emission from Agricultural System*, Published by IPCC- USEPA *Climate change and global crop productivity* Ed. by K R Reddy and HF Hodges CABI Publishing.
4. IPCC Assessment Report. 2007. *Climate Change Journal Climate Change: Source, Impact and Policy*, Proceeding of 2nd World Climate Conference. Ed. by J Jager and HL. Ferguson, Cambridge University Press.
5. John Houghton. *Global Warming* (4th), Cambridge Press.
6. Robert M, Clausen and Henry L Gholz. *Carbon and Forest Management*. School of Forest Resources and Conservation. University of Florida, Gainesville, FL 32611, USA.

FB 806C:FOREST BIOTECHNOLOGY

Credit: 2+0+1=3

UNIT-I

Principles and requirements of plant tissue culture; cellular totipotency, callus and multiple shoot induction, micro-propagation, protoplast isolation and fusion, cybrids, somaclonal variation, single and suspension cell cultures, somatic embryogenesis; meristem culture and virus free plants, haploid production, embryo rescue, acid and salt tolerant plants, artificial seed production and cryopreservation.

Introduction to nucleic acids-DNA and RNA as molecules of life, discovery, structural and functions of DNA, nucleotides and nucleosides; genetic code, replication, transcription and translation of DNA; molecular basis of mutation; chloroplast, mitochondrial and plasmid DNA-structure and functions; PCR, gel electrophoresis, SDS PAGE.

UNIT-II

Principles, tools & techniques in plant genetic engineering/ recombined DNA technology-vector and enzyme mediated transfer of plant genes, structure and function of Ti and Ri plasmids, reporter genes; direct gene transfer-electroporation, particle bombardment, biolistic gun; GMO; genetically modified forest crops-application in improving yield and quality, *Nif* gene in legume and non-legumes, stress tolerance, herbicide & disease resistance in forest crops.

Genetic diversity- concept, analysis of karyotype variation, genetic erosion, Techniques to assess genetic diversity- Molecular approaches to assessing genetic diversity, molecular maps and markers- RAPD, RFLP, AFLP, STS, microsatellites, etc.; Sampling strategies for genetic diversity assessment, sufficiency of sampling procedures, Effects of sampling on genetic diversity, Factor influencing levels of genetic diversity in woody plant species. Conservation of genetic diversity. Introduction to bioinformatics, biological databases-characteristics and categories.

Suggested Readings

An Introduction to Plant Tissue Culture, 1st Edition (1992). K.K. De, New Central Book Agency, Kolkata.

Introduction to Plant Tissue Culture (2007) M.K. Razdan, India Book House Pvt. Ltd., New D

DNA Fingerprinting in Plants-Principles, Methods and Applications, 2nd Edition (2009), K. Weising, H. Nybom, K. Wolf and G. Kahl, CRC Press (Taylor and Francis Group, Boca Raton (First Indian Reprint, Saurabhi Printers Pvt. Ltd.).

Gaston, K.G. (2004). *Biodiversity: an introduction* (2nd edition). Blackwell Science Ltd.

Geethabali, R.R. (2002). *Biodiversity: monitoring, management, conservation and enhancement*. APH Publishing, New Delhi.

B.G. Glick and J.J.(2001). *Molecular Biotechnology: Principles and applications of Recombinant DNA* (2nd Edition). Pasternak, ASM Press, Washington D.C. (First Indian Reprint, Replika Press Pvt. Ltd., New Delhi).

S. Mahesh, (2008). *Plant Molecular Biotechnology*. New Age International Publishers, New Delhi

Practical:

1. Demonstration of plant tissue culture methods

i) Preparation of Reagent/stock solutions

ii) Demonstration of various sterilization technique.

iii) Preparation of Medium

iv) Explant preparation

UNIT I

Definition and concepts of Agroforestry; Agroforestry research and development; Goals, objectives and strategies of National Agroforestry Policy 2014; Classification of agroforestry systems; Benefits and constraints of agroforestry; Agroforestry practices and systems in different agro-ecological zones of India; Shifting cultivation, Taungya, Homegarden, Alley cropping, Plantation crop combinations, Homegarden, Traditional agroforestry systems of northeast India.

Characteristics of agro forestry trees; General principles of plant productivity; Component interactions; Concept of allelopathy and its impact on agroforestry; Tree Domestication in Agroforestry; Plant management practices in agroforestry; Forage and fodder production through agroforestry; Resource use-efficiency in agroforestry.

UNIT II

Nutrient cycling in agroforestry; Land capability classification and land evaluation; Biomass production; Carbon sequestration potential in agroforestry. Phyto-remedial potential of agroforestry.

Criteria of an ideal agroforestry design, productivity, sustainability and adoptability; The Diagnosis and Design (D & D) methodology, Field experiments in agroforestry, Ecological basis of Agroforestry, Economic analysis of agroforestry system, Sociocultural considerations, Pest and disease management, Evaluation of agroforestry systems.

Suggested Readings

- Dwivedi A.P. (1992) Agroforestry: Principles and Practices. Oxford & IBH.
Jha, L. K. (2009) Advances in Agroforestry, APH Publishing Corporation, New Delhi.
Nair P.K.R., Rai M.R. & Buck LE. (2004) New Vistas in Agroforestry. Kluwer.
Nair P.K.R. (1993) An Introduction to Agroforestry. Kluwer.
Ong C.K. & Huxley P.K. (1996) Tree Crop Interactions – A Physiological Approach, ICRAF.
Young A. (1997) Agroforestry for Soil Management, CABI.

Practical:

1. Visit to agroforestry sites to study different crop combinations
2. Structural analysis and plant composition in different agroforestry systems
3. Economic evaluation of agroforestry systems
4. Sociocultural evaluation of agroforestry systems
5. Field exercise on plot demonstration showing root distribution of different plants.
6. Identification and characterization of manures and fertilizers.
7. Effect of different cropping systems on soil erosion and water quality.

Pandey. *Angiosperms : Taxonomy, Anatomy, Economic Botany & Embryology*.
 T. Cooke. *Flora of Bombay Presidency*.
Flora of Maharashtra. Botanical Survey of India.
 Talbot. *Flora of Bombat Presidency and Sind*.
 Sing, Jain. *Taxonomy of Angiosperms*.
 Dr. S. G. Date. *Key to family of Angiosperms*.
 M. A.. Smith., *The fauna of British India (Reptilia and Amphibia- Vol. -III, Serpentes*
 Salim Ali., S. D. Ripley., *Handbook of birds of India and Pakistan (Vol. I, II, III)*
The MacDonald encyclopedia of Butterflies and Moths
 Salim Ali, S.D.Ripley, *A pictorial guide to the birds of Indian subcontinent*.
 S.H Prater, *The book of Indian animals*
 Preston et al., *Primates of the world*
 Kotpal, *Arthropoda*
 Kotpal., *Khetrapal., Invertebrata*
 Ashlock., *Principles of Animal Taxonomy*
Burgey's manual of determinative bacteriology- 8th edition
Burgey's manual of systematic bacteriology
 J. T. Bonner., *Researches on cellular slime moulds: selected papers*
 Dr. M. G. Watve., *Microbiology: A practical approach*
 Stanier et. al., *General Microbiology*
 Prescott et. al., *Microbiology*
 Pelczar., *Introduction to Microbiology*

FRBD 802C Forest Genetics and Tree Improvement

Credit: 03

Unit I

Introduction, history and development of tree improvement, its relation to other disciplines for forest management. General concept of forest tree breeding, tree improvement and forest genetics. Reproduction in forest trees – anthesis and pollination – their importance in tree breeding. Quantitative inheritance, heritability, genetic advance, genetic gain, combining ability and their application. Genetic, environmental and phenotypic expression of trees. Variation in trees importance and its causes. Natural variation as a basis for tree improvement. Geographic variations – Ecotypes, clines, races and land races. Species and provenance trials in forest trees.

Unit II

Genetic basis of tree breeding; Selective breeding methods- mass, family, within family, family plus within family. Plus tree selection. Selection strategies and choice of breeding methods and progress in selective breeding in forest trees. Indirect selection for biotic and abiotic stresses. Progeny and clone testing. Seed orchards – type, functions and importance. Pollen handling; forced flowering for seed orchard manipulation. Vegetative propagation and tree improvement. Seed, seed formation, dispersal, storage, stratification and seed dormancy.

Unit III

Genetic consequences of hybridization. Back cross breeding, heterosis breeding, breeding for resistance to insect pest, diseases, air pollution and for wood properties. Manifestation and

fixation of heterosis. Species and racial hybridization. Examples. Polyploidy, aneuploidy and haploidy in soft and hard wood species. Induction of polyploidy. Hardy-Weinberg law, null hypothesis, Wohlund's Principle. Mutation breeding. Conservation of forest tree germplasm.

Unit IV

Biotechnology in tree improvement. Biotechnology: principles and techniques; Isolation, purification and quantification of DNA/RNA from plant materials. Application of molecular biotechnology in forest tree improvement: *In vitro* selection, transgenic Plants, Disease and Insect resistance etc., *In Vitro* and Micro-propagation techniques of forest trees: Somaclonal variation, Protoplast fusion, Embryo rescue, Artificial seeds, Haploid culture, Cryopreservation and *In Vitro* storage of plant materials. Recent techniques in tree improvement. Vegetative propagation and tree improvement. Economics of tree breeding. Transgenic plants; molecular markers and its application in forestry; modification of plant species to practically desired products; biodegradation of forestry wastes through genetically engineered microbes.

Suggested Readings

Mandal AK & Gibson GL. (Eds). 1997. *Forest Genetics and Tree Breeding*. CBS.
Surendran C, Sehgal RN & Paramathma M. 2003. *Text Book of Forest Tree Breeding*. ICAR Publ.
White JW. 1976. *Introduction to Forest Genetics*. Academic Press.
Zobel BJ & Talbert J. 1984. *Applied Forest Tree Improvement*. John Wiley & Sons.

FRBD 803C Forest Resource Management

Credit: 03

Unit I

Introduction: definition and scope. Peculiarities of forest management. Principles of forest management and their applications. Objects of management, purpose and policy. Sustained and progressive yield concept and meaning. General definitions – management and administrative units, felling cycle, cutting section. Rotations: definition, kinds of rotations, choice of rotations, length of rotations and conversion period. Concept of Economic rotation- rotation of max. NPV Land Expectation Value (Faustman's formula). Normal forest: definition and concept.

Unit II

Evenaged and unevenaged models. Estimation of growing stock, density, quantity and increment. Yield regulation – general principles of even aged and unevenaged forest crop. Yield regulation based on area, volume, area and volume, increment and number of trees. Working Plan – definition, objects and necessity. Economics of nature of crop: Economics of monoculture, mosaic and mixed culture, species choice Protection, harvesting etc. Role of economics in forestry and its limitations in decision-making.

Unit III

Demand: Theory of demand; essential elements of demand; demand for forest products; demand schedule; elasticity of demand. Supply: Concepts; law of supply; essential elements of supply; supply of forest products; supply schedule; elasticity of supply. Equilibrium point. Utility: Basic concepts and definition; concepts of total and marginal utility; law of diminishing marginal utility: The indifference curve and indifference map. Consumption possibility line. Cost: Cost of production; i.e. concept of real, opportunity and money cost; total, average, and marginal cost.

Unit IV

Production Theory: Concepts of total, average and marginal products. Production function and laws of return i.e. increasing, constant and diminishing returns. Utility theory of production and marginal products in forestry. Market: Main features of market; Forms of market-Perfect, imperfect, monopoly market. Types of competition in the market. Market of various forest products. Valuation techniques. Project Planning, Evaluation and Analysis.

Suggested Readings

- Davis, L.S. and K.N. Johnson. 1987. *Forest management*. Third Edition. McGraw Hill Book Company, New York. 790 p.
- Desai, V. 1994. *Forest management in India - Issues and problems*. Himalayan Publi. House. Bombay. 358 p.
- Jerram, M.R.K. 1982. *A textbook of forest management*, International Book Distributor, Dehradun.
- Kerr JM, Marothia DK, Singh K, Ramaswamy C & Beritley WR. 1997. *Natural Resource Economics : Theory and Applications in India*. Oxford & IBH.
- Osmaston, F.C. 1984. *Management of forests*, International Book Distributor, Dehradun.
- Nautiyal JC. 1988. *Forest Economics – Principles and Applications*. Natraj Publications, Dehradun.
- Ram Prakash. 1986. *Forest management*, International Book Distributor, Dehradun.
- Sharma LC. 1980. *Forest Economics, Planning and Management*. International Book Distributors, Dehradun.
- Sharpe GW, Hendee CW & Sharpe WE. 1986. *Introduction to Forestry*. McGraw-Hill.

FRBD 804C Forest and people

Credit: 02

Unit I

Forests in rural development, forest societies, interactions between forests and people, importance of forests in traditional farming systems, livestock economy and forests, social and cultural factors of forest management, man in ecosystem in relation to ecophilosophy, Forest and employment generation.

Unit II

Afforestation programmes and forest conflicts, wildlife and human conflicts, People's movement in forest conservation, Gender dimension of forest management, Pastoralists and their dependence on forests, Forest laws/policies and their effect on people, Forestry extension.

Unit III

Management of Commons and Common Property Resources (CPRs) and open access resources, forest management and sustainable livelihood strategies, forests and food security, participation of local people in ecotourism, land use change and forestry.

Unit IV

Forest rights, customary rights of people, community participation, biodiversity and ethnobotany, Joint Forest Management, Social forestry programme, micro-level planning and participatory rural appraisal. Global environmental change and land use; poverty alleviation and forests, role of NGOs and other community based organizations in forest management.

Suggested readings

Annamalai R. 1999. *Participatory Learning Action and Microplanning for JFM*. Dean SFRC, Coimbatore.

FAO 1978. *Forestry for Local Community Development*. FAO Publ.

Shah SA. 1988. *Forestry for People*. ICAR.

Tiwari KM. 1988. *Social Forestry and Rural Development*. International Book Distr.

Vyas GPD. 1999. *Community Forestry*. Agrobios.

FRBD 805C

Practical approaches in Forestry & Biodiversity- II

Credit: 04

Taxonomy - Field Methods -Morphology of major groups (Bryophytes, Pteridophytes, Gymnosperms and Angiosperms), Study of leaf and flower morphology, Study of fruits, Expected abilities: field identification of at least 100 species and identification up to family level for all common plants in the study area), Surveys, collection and preservation of different plant groups.

Identification using reference material, Visits to herbaria, gardens, culture collections, Photography and illustration in field and laboratory conditions Use of computers in analysis, documentation and dissemination of information. Morphology of Insects, Classification of insects (all major orders using key), Use of taxonomic literature and visit to local fish market for identification, morphometry, Methods of dry and wet preservation of animals, Dry preservation of insects for taxonomic studies, Study of traps

Taxonomy - Lab Methods- Cultivation and isolation of microorganisms, Nutritional requirements, Growth media and cultivation, Pure culture isolation, Enrichment, Maintenance and culture collection, Species databases, Methods of cultivation and characterization of Protozoa, Molecular methods of taxonomy and numerical taxonomy, Visit to culture collection centers

Tree Improvement: Floral biology & phenological observations in some important species. Manipulation of flowering through hormones. Estimation of pollen sterility and viability. Controlled pollination and pollen handling. Emasculation & hybridization in self pollinated species. Emasculation & hybridization in cross pollinated species. Recording observation in provenance trial of some important species-recording variation & working out coefficient of variation. Selection of superior phenotypes. Visit to species, provenance and progeny trials. Vegetative propagation techniques and tree improvement. Estimation of phenotypic and genotypic coefficient of variation. Estimation of genetic advance, heritability and GCA. Exercise in plus-tree selection. Seed orchard designs. Recording the design and observations in teak, Eucalyptus seed orchards. Induction of polyploidy through colchicine treatment.

Exercises on estimation of demand and supply functions; biodiversity valuation, valuation of non-marketed forest products. Exercises on financial and economic appraisal of forest projects. Exercises on marketing of forest products and international trade competitiveness. Visits to different Forest areas including rural and Urban Forests and carry out exercises for planning and management.

Syllabus of Third Semester

FRBD 901C: FOREST SOIL AND WATERSHED MANAGEMENT

4 CREDITS

UNIT I

Forest soils – distinguishing features - soils and vegetation development, physical and chemical properties- Types and properties of soils under different forest ecosystems. Forest floor - Organic horizons- litter dynamics- humus – types- organic matter decomposition- mineralization and immobilization of organic matter- nutrient cycling significance of C:N ratio, soil pH.

UNIT II

Forest soil biology - soil fauna - nitrogen fixation – legume & non-legume symbiosis, nitrification and denitrification in forest ecosystems. Mycorrhizal associations in forest soils. Nursery soils, problem soils, mineral nutrition, acidic deposition effects, and management interventions of forest soils.

UNIT III

History of watershed management, Definition, Concept, Types, Characteristics, Priority Watershed Concept and their Identification, Objectives and Principles of Watershed Management, Attributes of water yield, rate regime, quality. Physiographic features of watersheds, soil water storage– pore space, available water, infiltration, run-off (run-off hydrographs) total and peak, soil moisture, hydrograph, ground water recharge, evapo-transpiration and stream flow. Hydrological cycle and characteristics of small and medium watersheds precipitation. Resources inventory soil, land, water and Biota. Soil survey and land use planning –soil types, fertility, productivity, erosion and conservation practices. Water resource development, water availability, pressurized irrigation, crop water requirements and water use efficiency. Forest features of hydrologic significance. Hydrological processes affected

by forest lands – storage and drainage, overland flow, erosion and sedimentation. Hydrological evaluation of land treatment.

UNIT IV

Forest Management and water yields. Stream zone management– temperature– buffer strips. Soil conservation in India – problem, programmes and achievements. Land management problems in India. Soil survey and capability maps – agronomical practices and land management, rotational grazing, dry land farming. Soil and water conservation and water harvesting - principles and important techniques, structures – types & design. Sedimentation- sources, estimation, sediment bank treatment techniques.

Suggested Readings

- Baumer 1989. Agroforestry for watershed management. ICRAF, Kenya
- Brady N.C., and Weil R.R. 2007. *The Nature and Properties of Soils*. 14th Ed., Prentice Hall, New Jersey, 980p.
- Dhruva Narayana VV 1993. Soil and water conservation research in India, ICAR, New Delhi
- Dutta SK. 1986. *Soil Conservation and Land Management*. International Book Distributors, Dehra Dun.
- Fisher R.F. and Binkley D. 2000. *Ecology and Management of Forest Soils*. John Wiley & Sons, Inc. New York, 489p.
- Hamilton IS. 1987. *Forest and Watershed Development and Conservation in Asia and the Pacific*. International Book Distributors, Dehra Dun.
- Hamilton IS. 1988. *Tropical Forest Watersheds. Hydrologic and Soil Response to Major Uses of Conservation*. International Book Distributors, Dehra Dun.
- Hewlett, JD and Nutter, WL 1969. An outline of forest hydrology. University of Georgia Press, Athens.
- Moorthy VVN. 1990. *Land and Water Management*. Kalyani Publishers.
- Morgan 1984. Soil Conservation. Nataraj Pub, Dehra Dun.
- Murty JVS 1995. Watershed Management in India. Wiley Eastern, New Delhi.
- Oswal MC. 1999. *Watershed Management (For Dryland Agriculture)*, Associated Publishing Co., New Delhi.
- Rajora R. 1998. *Integrated Watershed Management*. Ravat Publ., New Delhi.
- Rama Rao. 1980. *Soil Conservation*. Standard Book Depot, Bangalore.
- Satterlund, DR. 1972. Wildland watershed management. The Ronald Press Company, New York.
- Tisdale, L.S., Nelson, L.W. and Beaton, J.D. 1985. *Soil Fertility and Fertilizers*. Macmillan Publishing Company, New York

FRBD 902C: FOREST GENETIC RESOURCE CONSERVATION 2 CREDITS

UNIT I

Overview: Basic Concepts: Definitions, Characteristics of forest genetic resources, Species diversity; Value and Importance of Forest Genetic Resources: Economic value, Environmental value, ecosystem services and resilience, Social, cultural, medicinal and scientific value, Preserving options for future development and adaptation; Conservation of Forest Genetic Resources: Management systems in the field (*in situ* and *circa situm* conservation), *Ex situ* conservation, Targeted species-based approach; Knowledge and Information on Forest Genetic

Resources; Drivers of Change: Drivers of change and trends affecting forest genetic resources; Global forest trends affecting forest genetic diversity

UNIT II

Current and emerging technologies: Trait-Based Knowledge of Tree Genetic Resources- Indigenous and traditional knowledge Classical tree improvement, Participatory tree domestication; Modern Advances- Population genetics based on molecular markers, Genomic advances, Combining molecular tools with tree improvement: marker-assisted selection, Genetic modification; Application of Genetic Knowledge in Forest Conservation: Combining spatial analysis with genetic markers to prioritize, conservation, Research on climate change and forest genetic resources, Genetic technologies for reducing illegal logging Characterization of Genetic Variability and Monitoring of Change.

UNIT III

State of forest genetic resources conservation and Management: Status of Forest Genetic Resources in India; Major Threats to Forest Genetic Resources; National Programmes for the Conservation and Management of Forest Genetic Resources: *Role of the organizations/Institutes in the Conservation of Forest Genetic Resources*; present level of production and use of genetically superior propagules; Management of Forest Genetic Resources; future requirements for superior propagules; Research and Development of Forest Genetic Resources: *National policies and legislations*- access to genetic resources; *National FGR conservation strategies*; *International collaboration and future initiatives*; Status of Medicinal Plants in India: Conservation and cultivation strategies for medicinal plants, Bamboo Diversity in India.

UNIT IV

Need for collection and conservation of germplasm, Strategies for conservation, *In situ* FGR conservation and management: Protected areas, *In situ* conservation outside protected areas, Formal *in situ* FGR conservation programmes, Forest restoration and FGR, Opportunities from climate change initiatives: restoration and connectivity for *in situ* FGR, *In situ* conservation through sustainable forest management; *Ex situ* conservation; genetic improvement and breeding programmes germplasm delivery and deployment: Uses of germplasm and plant materials, Demand for germplasm and planting materials, Actors involved in production, distribution and deployment, Production of germplasm and planting materials, Movement and transfer of genetic material, Information management in delivery and deployment of germplasm, International assistance; Institutional Framework for Conservation and Management of Forest Genetic Resources; Needs, challenges and required responses for the future: practices and technologies for improved management of forest genetic resources.

Suggested Readings

FAO, 2014 *The State of the World's Forest Genetic Resources*. Commission on Genetic Resources for Food and Agriculture, Food and Agriculture Organization of The United Nations. 276p.

Objective

To provide knowledge about bio-resources derived from the forests and equip the students regarding forest based industries and how it is affecting the economy of the country.

Theory**UNIT I**

Non-Timber Forest Products (NTFPs) definition and scope Importance and nomenclature of non-timber forest produce (NTFP) – importance in state, national and International economy. Role of NTFP in industrial economy, as a source of revenue- NTFP for sustainable forestry- Trade and development of NTFP in India- Characteristics of NTFP- Policy and legal issues- Management requirements – research needs.

Methods of survey of NTFP –classification, collection, processing and methods of utilization of fibres, flosses, grasses, bamboo, canes, reed, fibres, oil seeds, nuts, rubber, medicinal plants, charcoal, lac and shellac, Katha and Bidi leaves – collection of fatty oils and waxes – nature and chemistry of essential oils, oleoresins, gums, resins etc. and their collection; processing and disposal.

UNIT II

Environmentally sound forest harvesting practices; logging and extraction techniques and principles, transportation system, storage and sale. Need and importance of wood seasoning and preservation; general principles of seasoning, air and kiln seasoning, solar dehumidification, steam heated and electrical kilns. Anatomical structure of wood, defects and abnormalities of wood, timber identification – general principles.

Composite wood; adhesives-manufacture, properties, uses, plywood manufacture-properties, uses, fibre boards-manufacture properties, uses; particle boards manufacture; properties uses. Present status of composite wood industry in India in future expansion plans. Pulp-paper and rayon; present position of supply of raw material to industry, wood substitution, utilization of plantation wood; problems and possibilities.

UNIT III

Tannin and dye extraction – importance of medicinal plants – various types and classes – economic parts- extraction and isolation of active principles- edible plants – miscellaneous NTFP – animal products and mineral products. Use of wood of lesser known forest species for commercial purposes.

Importance of forest based industries in relation to Indian economy. Katha and catch. Description of different forest based industries.

UNIT IV

Cell wall constituents. Chemistry of cellulose, starch, hemicelluloses and lignin. Extraneous components of wood – water and organic soluble solvent. Chemical composition of oleoresin from major pine species. Structural difference among different gums (arabic, ghatti, tragacanth). Chemistry in relation to forest products. Chemical nature and uses of volatile oils, tannins, Chemical nature and uses of important forest based dyes and pigments.

Suggested Reading

Gupta T., Gularia A. 1992. *Non Wood Forest products in India: Economic Potentials*. Oxford and IBH publishing Co. New Delhi.
Mishra T.K, Banerjee, Pal, D.C. 2004. *An Omnibus of Non-Timber forest products of India, Prashant Gahlot at Valley*. Offset Printers and Publishers, Dehra Dun.
Nautiyal S and. Kaul A.K. 2003. *Non-Timber Forest Products of India*. Jyothi Publishers and Distributors, Dehra Dun.
Anonymous. 1981. *Wealth of India*. CSIR.
Anonymous. 2007. *Year Book of Forest Products*. FAO.
Dwivedi AP. 1993. *Forestry in India*. Surya Publ.
Mehta T. 1981. *A Handbook of Forest Utilization*. Periodical Expert Book Agency.
Krishnamurthy T. *Minor Forest Products of India*. Oxford & IBH.

FRBD 1002C Policy and legal issues in Forestry & Biodiversity Credit: 02

Objective

To develop understanding of students about forest and biodiversity-policy; laws and international conventions

Theory

UNIT I

Forest Law: legal definition. Objects of special forest law. National Forest policy – Relevance and scope; National Forest Policy – 1894, 1952 and 1988; National Environmental Policy 2006; National Eco tourism Policy

UNIT II

General principles of criminal law; Indian Penal Code, criminal procedure code; Indian evidence act applied to forestry matters. Forest laws; Indian Forest Act –1927 with recent amendments; Forest Conservation Act 1980 and Rules, Important Forest Rules and Guidelines.

UNIT III

Wildlife Protection Act 1972 with recent amendments, Biodiversity Act 2002, Plant Varieties Protection and Farmer's Rights Act 2001, The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act 2006; Case Law.

UNIT IV

Brief description about other major forest policies & laws of regional, national and international significance. Traditional land and forest management procedures and customary laws, Intellectual Property Right and bioresource patenting. Important case studies and landmark judgments. National Green Tribunal.

FRBD 1003C

Forest Protection

Credit: 02

Unit 1

Definition, Principles of forest protection; factors affecting forest health; kinds of forest protection measures; history of forest protection in India. Important diseases of forests and their management.

Unit II

Concept of disease, sign & symptoms & Koch's postulates. Bacteria as an agent of tree disease. Fungi as an agent of tree disease; Biodegradation of wood-microscopic and chemical effects of white rot, brown rot, soft rot and wood discoloration; Role of Mycorrhiza in tree health.

Unit III

Insect-plant relationship, population dynamics of forest insects, Insect feeding groups; Insect pests of important forest tree species. Theories of natural regulation of insect populations.

Unit IV

Protection against injuries by Man, Animal, Insects, Diseases, plants and adverse climatic factor; Timber salvage operations; Plant quarantine, Integrated Pest Management.

Suggested reading

Agrios, G.N., 2005. Plant Pathology. Elsevier Academic Press, USA.

Bakshi BK, 1976 Forest Pathology. Controller of Publication, GOI.

Jha LK and Sen Sarna PK, 1994. Forest Entomology. Ashish Publ. House

Manion PD. 1991. Tree Diseases Concept. Prentice Hall.

Khanna, L.S., 1982. Forest Protection. Khanna Bhandu, Dehradun.

Pedigo, L.P., 2002. Entomology and Pest Management, Prentice-Hall of India, New Delhi.

FRBD 1004C

Master's Research

Credit: 04

Student will select relevant or interested area of specialization available in the department during the 3rd Semester which will be continued in the 4th Semester. He/she will prepare a research project plan and it will be presented in-front of all the faculty members and students of the department at the end of the 3rd Semester. Also, for each student, one advisor will be provided, who will guide the student in completion of proposed research plan.

A total of 8 credits are allotted for project work and including (completed project work presentation) seminar (4 credits during 3rd Semester and 4 credits during 4th semester. The evaluation for the same will be conducted by the external examiner.

FRBD 1005E

Remote Sensing & GIS

Credit: 04

Unit 1

Definition, scope, history and development of remote sensing; Electromagnetic radiation (EMR) and electromagnetic spectrum; EMR interaction with atmosphere and earth surface; Types of remote sensing; Principles and applications of optical, thermal & microwave remote sensing.

Unit II

Aerial photographs – types, scale, & resolution; Photo interpretation, Satellite remote sensing - platforms and sensors; Satellite systems. Indian Remote Sensing Programme; Visual and digital image processing; Application of satellite based remote sensing techniques in forestry - vegetation mapping using satellite imagery; Forest cover monitoring and damage assessment; Microwave remote sensing.

Unit III

Introduction to GIS - Components of GIS, hardwares and softwares; Differences between GIS and conventional cartography; Spatial and non-spatial data, Integration of attribute data with spatial data. Spatial data - Raster and Vector data, Thematic over lays in GIS- topology building and calculation of area and length *etc.*

Unit IV

Application of GIS in forestry – using imageries and integration with GIS data. Maps-its projection, Toposheet and Map reading; Global Positioning System (GPS) applications in resource inventory, Global Navigation Satellite System, Galileo, IRNSS.

Suggested Reading:

Aber, J.S., Marzloff, I., and Ries, J. (2010): Small-Format Aerial Photography: Principles, Techniques and Geoscience Applications, Elsevier, Amsterdam, 268pp.

Campbell, J.B. (2002). Introduction to Remote Sensing (3rd edition). Taylor and Francis, London Environment System Research Institute, (1999). GIS for Everyone. Redlands, CA:ESRI

Campbell, J.B. and Wynne, R.H. (2011): Introduction to Remote Sensing (5th Ed.), Guilford Press, New York, 667pp.

Chang, Kang-tsung. 2002. Introduction to Geographic Information Systems. New Delhi: Tata McGraw-Hill Publishing Company Limited.

DeMers, Michael N. 2000. Fundamentals of Geographic Information Systems (2nd Ed.) (Wiley Student Edition). New York: John Wiley & Sons, Inc.

Jackson, M.J. (1992). Integrated Geographical Information Systems. International Journal of Remote Sensing, 13(6-7): 1343-1351

Jensen, J.R. (2006): Remote Sensing of the Environment: An Earth Resource Perspective (2nd Ed.), Prentice Hall, New Jersey, 608pp.

Konecny, G. (2003): Geoinformation: Remote sensing, Photogrammetry and Geographic Information Systems, Taylor & Francis, London, 266pp.

Lillesand, T.M. and Kiefer, W.R. (1994). Remote sensing and Image Interpretation, Fourth edition. John Wiley & Sons, Inc., USA

Lillesand, T.M., Kiefer, R.W., and Chipman, J.W. (2007): Remote Sensing and Image Interpretation (6th Ed.). Wiley, New Jersey, 804pp.

Morgan, D., and Falkner, E. (2001): Aerial Mapping: Methods and Applications (2nd Ed.), CRC Press, Boca Raton, Florida, 216pp.

FRBD 1006E

Wildlife management

Credit: 04

Unit 1

Principles and practices of wildlife management; Forest and wildlife management in India; History of Wildlife in India; Values of Wildlife : Ethical, cultural, scientific, economical, aesthetic & negative values; Basic requirements of wildlife – food, water, shelter, space, limiting factors; Food chain, Food web, Ecological pyramids;

Unit II

Wildlife Ecology: Biotic factors, Biological basis of wildlife, Productivity; Effect of light and temperature on animals; Zoogeographical regions (Animal Distribution) and biomes of the world; Wildlife Habitat: Niche, Territory, Home Range, Territoriality, Edge, Cruising Radius, Carrying Capacity; Animal behavior and adaptation; Wildlife census; Habitat Improvement: Food, Water, Shelter improvement; Captive wildlife: Zoos and safari parks, Captive breeding for conservation, Central zoo authority of India

Unit III

Population Management: Capture, handling, bio-telemetry, reintroduction, prey-predator relationship; Species conservation projects: lion, lion, elephant, rhino, crocodile, musk deer etc. Wildlife Management plan for Protected Areas; In-situ and Ex-situ management/ conservation

Unit IV

Man-animal conflict and its management; Red data book and IUCN; Wildlife Ecotourism: sustainable tourism and people's participation; Agencies in wildlife conservation: IUCN, CITES, WWF, IBWL; Community participation in wildlife management; Case studies; Wildlife policies and legislation, Wildlife (Protection) Act, 1972

Suggested reading

Berwick, S.H. and Saharia, V.B. 1995. Wildlife Research and Management. Oxford University Press, New Delhi.

Dasmann, R.F. 1982. Wildlife Biology. Wiley Eastern Ltd. New Delhi.

Davil, J.W. et al. 1981. Infectious diseases of wild mammals. Ed. II. Iowa State University Press, USA.

International Zoo Books, Published by New York Zoological Society, New York

Krebs C & Davis N. 1978. Introduction to behavioral ecology. Oxford University Press

Lever, C. 1985. Naturalised mammals of the world. John Wiley, London

Mathur R. 1985. Animal Behaviour. Oxford University Press

Mills, L. S. 2013. Conservation of Wildlife Populations Demography, Genetics and Management (Ed.2). Wiley-Blackwell.

Rajesh, G. 1995. Fundamentals of Wildlife Management, Justice Home, Allahabad.

Sawarkar B. Wildlife Management. Wildlife Institute of India. Dehra Dun

Sukumar, R. Asian Elephant. Ecology and Management. Oxford University Press Cambridge.

Wildlife Institute of India (2004) Compendium on the notes on the course Captive management of Endangered Species. Wildlife Institute of India. Dehra Dun

Wodroffe, G. 1981. Wildlife conservation and modern zoo. Saiga Publishing Co., England

Zoos Print and Zoo Zen, Published by Zoo Outreaches Organization, Coimbatore

FRBD 1007E

Forest Biology & Tree Physiology

Credit: 04

Unit I: Plant Nutrients

Mineral nutrients- absorption, translocation and utilization of mineral salts, Nitrogen metabolism, Water relation, Transport and translocation of water and solute, Salt and drought tolerance physiology in relation to production of biomass. Transpiration and osmo-regulation in relation to stress physiology.

Unit II: Plant biochemistry and metabolism

Photosynthesis: Carbon partitioning, light reactions. General concepts. Organization of light-absorbing Mechanisms of electron transport. The carbon reactions. The Calvin-Benson cycle. Inorganic carbon-concentrating mechanisms: the C3, C4 and CAM carbon cycle. The impact of environmental conditions on photosynthesis. Overview of plant respiration. Glycolysis. The

citric acid cycle. The oxidative pentose phosphate pathway, Mitochondrial electron transport and ATP synthesis. Respiration in intact plants and tissues. Photorespiration.

Unit III: Growth, development and differentiation

Study of tree structure, growth, development and function, how these are related to the environment and to cultural practices, Factors affecting growth of trees, Phytohormones- Auxins, Gibberellins, Cytokinins, Ethylene, Abscissic Acid, Phytochrome; their mechanism of action, Role of growth hormones in vegetative propagation. Signaling and integration: auxin and GA, Biosynthesis and elicitors: ethylene and ABA

Unit IV: Reproductive Physiology

Physiology of flowering, Pollen Biology, Regulation of sexuality, photoperiodism in trees relating to the growth and regeneration, Vernalisation, Physiology of Embryo growth, Fruit Development and Ripening, Seed physiology – Germination and seed dormancy, The mechanism and regulation of seed dormancy and germination, molecular dissection of seed quality, The biophysical basis of seed longevity Bud dormancy, Abscission and senescence.

Suggested reading:

The Embryology of Angiosperm- S. P Bhatnagar, P K Dantu S. S Bhojwani,
The Plant Physiology – Ross and Salisbury
Textbook of Plant Physiology – C.P. Mallik and A.K. Srivastava, Kalyani Publisher, New Delhi
Physiology of Woody Plants – *Dr. Stephen G. Pallardy*, Science Direct
Tree Physiology - **Meinzer**, Frederick C., **Niinemets**, Ülo; Springer
Forest tree Physiology – E. Dreyer, Elsevier