

Restructured and Revised Syllabus of PG Programme
M.Sc. FORESTRY IN SILVICULTURE AND AGROFORESTRY
Course Contents

Semester 1					
Code	Title	Theory	Internal	Practical/ Term Paper	Total
Major Courses					
SOA/FCMC/501	Silviculture	60 (2)	20	20 (2+1)	100 (3)
SOA/FCMC/502	Forest Biometry	60 (1)	20	20 (1+1)	100 (2)
SOA/FCMC/503	Silvicultural Practices	60 (1)	20	20 (1+1)	100 (2)
SOA/FCMC/504	Agroforestry System	60 (2)	20	20 (2+1)	100 (3)
Supporting Course					
SOA/FESC/511A	General Statistical Methods and Computer Application	60 (2)	20	20 (2+1)	100 (3)
Common Course					
SOA/FECC/01	Library and Information Services	-	40	60 (0+1)	100 (1)
SOA/FECC/02	Technical Writing & Communication Skills	-	40	60 (0+1)	100 (1)
SOA/FECC/03	Intellectual Property & Its Management in Agriculture	60 (1)	40	- (1+0)	100 (1)
SOA/FECC/04	Basic Concepts in Laboratory Techniques	-	40	60 (0+1)	100 (1)
SOA/FECC/05	Agricultural Research, Research Ethics & Rural Development Programmes	60 (1)	40	- (1+0)	100 (1)
		Total Marks and Credits			1000 (18)
Semester II					
Major Courses					
SOA/FCMC/505	Interactions in Agroforestry Systems	60 (1)	20	20 (1+1)	100 (2)
SOA/FCMC/506	Modern Nursery & Plantation Technology	60 (2)	20	20 (2+1)	100 (3)
SOA/FCMC/508	Industrial Agroforestry	60 (1)	20	20 (1+1)	100 (2)
Minor Courses					
SOA/FEMC/01	Forest Ecology & Biodiversity Management	60 (2)	20	20 (2+0)	100 (3)
SOA/FEMC/02	Applied Forest Tree Improvement	60 (2)	20	20 (2+1)	100 (3)
SOA/FEMC/03	Clonal Forestry	60 (1)	40	- (2+0)	100 (2)
Supporting Courses					
SOA/FCSC/511B	Experimental Designs	60	20	20 (2+1)	100 (3)
		Total Marks and Credits			700 (18)
Semester III					
SOA/FCMC/509	Climate Change and Conservation Silviculture	60 (1)	20	20 (2+0)	100 (2)
SOA/FCMC/510	Tree and Shrubs for Agroforestry	60 (1)	20	20 (1+1)	100 (2)
SOA/FCMC/511	Economics of Agroforestry System	60 (2)	20	20 (2+1)	100 (3)
SOA/FCMC/512	Tree Seed Technology	60 (2)	20	20 (2+1)	100 (3)
SOA/FCMC/591	Master's Seminar	-	-	100 (1)	100 (1)
SOA/FCMC/599A	Research Review (Master Thesis)	-	-	100 (7)	100 (7)
		Total Marks and Credits			600 (18)
Semester IV					
SOA/FEMC/513	Nutrient and Weed Management in Production Forestry	60 (1)	20	20 (1+1)	100 (2)
SOA/FEMC/514	Crops and Live Stock Management in Agroforestry	60 (1)	40	- (2+0)	100 (2)
SOA/FE/599B	Master's Research (Thesis)	-	-	100 (23)	100 (23)
		Total Marks and Credits			300 (27)

SEMESTER I

MAJOR COURSES

SOA/FCMC/501 - SILVICULTURE

I – Title	II - Code	III - Credit Hours	Theory	Internal	Practical	Total
Silviculture	SOA/FCMC/501	2+1	60	20	20	100 (3)

IV – Aim of the Course

To understand stand growth, development and provide knowledge regarding the application of silvicultural principles for the production and protection benefits from the forests.

V – Theory

Unit I

Forest ecosystems- Introduction to tropical/ temperate silviculture. Role of silviculture in forest and wild land management, major forest formations classification, distribution, composition and structure. Vegetation dynamics- species richness-diversity indices. Vegetation forms of India and their productivity. Forest ecosystem-structure and functioning, community development, competitive interactions in forest communities, forest succession, concepts and models of succession-Connell-Slatyer models, climax theories, tolerance.

Unit II

Ecophysiology of tree growth- effect of radiation and water relationship, mineral nutrients and temperature. Forest stand development – stand development, even aged and uneven-aged stands, age and site quality. Tree architecture and its role in stand management.

Unit III

Stand density determination-stand density indices-stand density management density management diagram, silvicultural treatments involved- thinning as a stand management tool, objectives of thinning, effects on growth and yield, thinning effect on economic yield of stands. Forest site quality evaluation-direct and indirect methods.

Unit IV

Treatment analysis-silvicultural regimes- factors influencing choice of regimes, use of system analysis to determine regimes, models for evaluating silvicultural alternatives, development of silvicultural regimes to suit management objectives, optimum management strategies, silvicultural prescriptions for maximum production regime.

VI – Practical

Visit to forest areas to study forest composition, classification, factors of locality, site quality, form and growth of forest trees- study plant succession- study stand density, changes on productivity- thinning effects

VII – Suggested Reading

- Daniel TW, Helms JA and Baker FS. 1979. Principles of Silviculture. McGraw-Hill Book Company.
- Julius E. 1992. Plantation Forestry in the Tropics. Oxford University Press.
- Khanna LS. 1996. Principle and Practice of Silviculture. International Book Distributors.
- Khanna LS. 2015. Theory and Practice of Indian Silviculture Systems. Bio-Green Publisher.
- Lamprecht. 1986. Silviculture in the Tropics. Verlag Paul Parey, Hamburg und Berlin.
- Nyland RD, Laura S, Kenefic, Kimberly K, Bohn and Susan LS. 2016 Silviculture: Concepts and Applications (III edition), Kindle Edition, USA.
- Pascal. 1988. Wet Evergreen Forests of the Western Ghats.
- Shepherd KR. 1986. Plantation Silviculture. Springer.
- Smith DM, Larson BC, Ketty MJ and Ashton PMS. 1997. The Practices of Silviculture- Applied Forest Ecology. John Wiley & Sons.

SOA/FCMC/502 - FOREST BIOMETRY

I – Title	II – Code	III - Credit Hours	Theory	Internal	Practical	Total
Forest Biometry	SOA/FCMC/502	2+1	60	20	20	100 (2)

IV – Aim of the Course

To develop understanding of students about tree and stand measurements, forest inventory and yield concepts.

V – Theory**Unit I**

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

Unit II

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

Unit III

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.

VI – Practical

- Calculations of volume of felled as well as standing trees;
- Volume table preparation;
- Application of different sampling methods;
- Preparation of yield and stand table;
- Quantification of regeneration and stand establishment;
- Measurement of crown density and crown ratios;
- Crown profiling of trees and stand;
- Dendrochronological studies.

VII - Suggested Reading

- Chaturvedi AN and Khanna LS. 1994. Forest Mensuration. International Book Distributor.
- Ram Parkash 1983. Forest Surveying. International Book Distributor.
- Sharpe GW, Hende CW and Sharpe WE. 1986. Introduction to Forestry. McGraw-Hill.
- Simmons CE. 1980. A Manual of Forest Mensuration. Bishen Singh Mahender Pal Singh, Dehradun.

SOA/FCMC/503 – SILVICULTURAL PRACTICES

I – Title	II – Code	III - Credit Hours	Theory	Internal	Practical	Total
Silvicultural Practices	SOA/FCMC/503	1+1	60	20	20	100 (2)

IV – Aim of the Course

To acquaint the students with the advanced silvicultural practices in forestry with particular reference to commercial and short rotation forestry.

V – Theory**Unit I**

Silviculture under changing context of forestry- silviculture and ecosystem management, stand dynamics, silvicultural practices for pure and mixed stand, even aged and uneven aged stand – silvicultural practices for changing climatic conditions.

Unit II

Silvicultural practices for natural and artificial regeneration – Ecology of regeneration, forest site management-enrichment of site – quality classes and site index models – stand density – spacing and tree growth – forest vegetation management – techniques for early stand growth- tending operations. Biomass allocation: belowground and aboveground. Changing trends in adoption of silvicultural systems.

Unit III

Stand development – stages- crown dynamics, Crown Competition factor, Maximum crown area, thinning – pruning – response of trees and impact on wood quality, salvage cutting – improvement felling and enrichment planting – management of weeds, Invasive weeds in forests, Silvicultural practices for short rotation forestry coppice forestry, Continuous cover forestry.

Unit IV

Site specific selection of tree species. Precision silviculture –silvicultural practices for important fast growing trees and bamboos of India- *Populus* spp., *Neolamarkia cadamba*, *Eucalyptus* sp., *Casuarina* spp., *Tectona grandis*, *Melia dubia*, *Dalbergia sissoo*, *Gmelina arborea*, *Leucaena leucocephala*, *Ailanthus excelsa*, *Azadirachta indica*, *Swietenia macrophylla*, *Dendrocalamus* spp., *Bambusa* spp., – Mechanization of silvicultural practices.

VI – Practical

- Visit to different forest sites to study the influence of site factors on composition;
- Determination of site quality;
- Studies on stand structure and composition of different forest types;
- Practicing pruning and its impact on wood quality;
- Characterizing methods of thinning;
- Working out intensity of thinning;
- Study of stand densities in natural forest stand and plantation stand;
- Afforestation techniques, Wood management techniques for forest tree crops;
- Planning and designing a tree planting programme;
- Exercise on precision silviculture practices;
- Exercise on mechanized silvicultural practices.

VII – Suggested Reading

- Daniel TW, Helms JA and Baker FS. 1979. Principles of Silviculture. McGraw-Hill Book Company.
- Julius E. 1992. Plantation Forestry in the Tropics. Oxford University Press.
- Khanna LS. 1996. Principle and Practice of Silviculture. International Book Distributors.
- Khanna LS. 2015. Theory and Practice of Indian Silviculture Systems. Bio-Green Publisher.
- Lamprecht. 1986. Silviculture in the Tropics-Verlag Paul Parey, Hamburg und Berlin.
- Nyland RD, Laura S, Kenefic, Kimberly K, Bohn and Susan LS. 2016 Silviculture: Concepts and Applications (III edition), Kindle Edition, USA.
- Shepherd KR. 1986. Plantation Silviculture. Springer.
- Smith DM, Larson BC, Ketty MJ and Ashton PMS. 1997. The Practices of Silviculture- Applied Forest Ecology. John Wiley & Sons.

SOA/FCMC/504 – AGROFORESTRY SYSTEMS

I – Title	II - Code	III - Credit Hours	Theory	Internal	Practical	Total
Agroforestry Systems	SOA/FCMC/504	2+1	60	20	20	100 (3)

IV – Aim of the Course

To impart knowledge on the concept of agroforestry as a sustainable land use including diagnosis and design methodologies; overview of agroforestry and case studies.

V – Theory**Unit I**

Agroforestry: objectives, importance, potentials and limitations for implementations. Land capability classification and land evaluation. Basis of classification of agroforestry systems and principles, indigenous vs. exotic, intraspecific variations, crown architecture of tropical/ temperate trees. Ideotype concept for selection of multipurpose trees. Nitrogen fixing trees. Overview and case studies of different agroforestry systems.

Unit II

Structural and functional attributes of agroforestry systems, shifting cultivation, taungya system, multiple and mixed cropping, alley cropping, silvopastoral systems, shelter-belts and windbreaks, energy plantations and home gardens.

Unit III

Role of trees in soil productivity and conservation– micro-site enrichment- litter and fine root dynamics, Nitrogen fixation and nutrient pumping. Soil productivity and management in agroforestry.

Unit IV

Community forestry and social forestry, linear strip plantations.

Unit V

Trends in agroforestry systems research and development, Diagnosis and Design –PRA-RRA tools in agroforestry problem diagnosis.

Unit VI

Climate Change mitigation and adaptation through agroforestry- climate negotiations- LULUCF- agroforestry options.

VI – Practical

- Survey and analysis of land use systems in the adjoining areas;
- Study of tree crown architecture;
- Design and plan of suitable models for improvement;
- PRA-RRA tools in agroforestry problem diagnosis.

VII – Suggested Reading

- Buck LE, Lassoie, Fernandes ECM 1999. Agroforestry in Sustainable Agri. Systems. CRC Press.
- Kumar BM and Nair PKR. 2006. Tropical Homegardens: A Time-Tested Example of Sustainable Agroforestry. Springer publication.
- Kumar BM and Nair PKR. 2013. Carbon Sequestration Potential of Agroforestry Systems: Opportunities and Challenges (Advances in Agroforestry). Springer publication.
- Nair PKR and Latt 1998. Directions in Tropical Agroforestry Research. Kluwer.
- Nair PKR, Rai MR and Buck LE. 2004. New Vistas in Agroforestry. Kluwer
- Nair PKR. 1993. An Introduction to Agroforestry. Kluwer Academic Pub.
- Ong CK and Huxley PK. 1996. Tree Crop Interactions – A Physiological Approach. ICRAF.
- Peter Huxley. 1999. Multiple Cropping with Woody and Non-Woody Plants. John Wiley and Sons Ltd, Oxford, United Kingdom.
- Tejwani KG. 1994. Agroforestry in India. Oxford & IBH Publishing Co. Pvt Ltd.
- Thampan PK. 1993. Trees and Tree Farming. Peekay Tree Crops Development Foundation.
- Young A. 1997. Agroforestry for Soil Management. CABI.

SUPPORTING COURSES**SOA/FESC/511A – GENERAL STATISTICAL METHODS AND COMPUTER APPLICATIONS**

I – Title	II – Code	III - Credit Hours	Theory	Internal	Practical	Total
General Statistical Methods and Computer Applications	SOA/FESC/511A	2+1	60	20	20	100 (3)

IV – Aim of the Course

This course is meant for students who do not have sufficient background of statistical methods. The students would be exposed to concepts of general statistical methods and statistical inference that would help them in understanding the importance of statistical methodology. It would also help them in understanding the concepts involved in data presentation, analysis and interpretation of results.

V – Theory**Unit I**

Review of probability. Random variable and mathematical expectation. Discrete and continuous probability distributions, viz., Binomial, Poisson and Normal distributions.

Unit II

Correlation and regression, Rank correlation, Non-linear regression, Partial and multiple correlation coefficient,

Intra class correlation, Multiple linear regression.

Unit III

Introduction to theory of estimation, Testing of statistical hypothesis: chi-square, t and F distributions. Tests of significance based on chi-square, t and F tests. Large sample tests, Fisher Z transformation.

Unit IV

Analysis of variance: One way and two way classification. Design of Experiments: Basic Principles of design of experiments, Completely Randomised Design, Randomised Block Design, Latin Square Design. Elementary idea of factorial experiments. Estimation of genetic parameters from ANOVA table.

Unit V

Non-parametric tests: Sign test, Wilcoxon test, Mann-Whitney U-test, Wald Wolfowitz run test, Median test, Kruskal- Wallis test. MS Excel, Introduction to computer softwares.

VI – Practical

- Random variable and mathematical expectation;
- Fitting of distributions, viz., Binomial, Poisson, Normal;
- Correlation and regression;
- Non-linear regression
- Multiple linear regression;
- Testing of hypothesis based on chi square, t and F tests. Large sample tests. Completely Randomised Design, Randomised Block Design, Latin Square Design and Factorial experiments. Non-parametric tests. Exercises based on computer software.

VII – Suggested Reading

- Aggarwal BL. 1996. Basic Statistics. Wiley Eastern Limited, New Age International Ltd.
- Bansal ML, Singh S, Singh TP and Kumar R. 2004. Statistical Methods for Research Workers. Kalyani Publishers.
- Chandel SRS. 2014. A Handbook of Agricultural Statistics. Achal Prakashan.
- Goon AM, Gupta MK and Dasgupta B. 1968. Fundamentals of Statistics, vol I, II. The World Press, Calcutta.
- Snedecor GW and Cochran WG. 1980. Statistical Methods. East West Press.

COMMON COURSES

SOA/FECC/01 – LIBRARY AND INFORMATION SERVICES

I - Title	II – Code	III - Credit Hours	Theory	Internal	Practical/ Term Paper	Total
Library and Information Services	SOA/FECC/01	0+1	-	40	60	100 (1)

IV. Objective

To equip the library users with skills to trace information from libraries efficiently, to apprise them of information and knowledge resources, to carry out literature survey, to formulate information search strategies, and to use modern tools (Internet, OPAC, search engines, etc.) of information search.

Practical

Introduction to library and its services; Role of libraries in education, research and technology transfer; Classification systems and organization of library; Sources of information- Primary Sources, Secondary Sources and Tertiary Sources; Intricacies of abstracting and indexing services (Science Citation Index, Biological Abstracts, Chemical Abstracts, CABI Abstracts, etc.); Tracing information from reference sources; Literature survey; Citation techniques/ Preparation of bibliography; Use of CD-ROM Databases, Online Public Access Catalogue and other computerized library services; Use of Internet including search engines and its resources; eresources access methods.

SOA/FECC/02 -TECHNICAL WRITING AND COMMUNICATIONS SKILLS

I - Title	II – Code	III - Credit Hours	Theory	Internal	Practical/ Term Paper	Total
Technical Writing and Communications Skills	SOA/FECC/02	0+1	-	40	60	100 (1)

Objective

To equip the students/ scholars with skills to write dissertations, research papers, etc. To equip the students/ scholars with skills to communicate and articulate in English (verbal as well as writing).

Practical (Technical Writing)

- Various forms of scientific writings- theses, technical papers, reviews, manuals, etc.;
- Various parts of thesis and research communications (title page, authorship contents page, preface, introduction, review of literature, material and methods, experimental results and discussion);
- Writing of abstracts, summaries, précis, citations, etc.;
- Commonly used abbreviations in the theses and research communications;
- Illustrations, photographs and drawings with suitable captions; pagination, numbering of tables and illustrations;
- Writing of numbers and dates in scientific write-ups;
- Editing and proof-reading;
- Writing of a review article;
- Communication Skills - Grammar (Tenses, parts of speech, clauses, punctuation marks);
- Error analysis (Common errors), Concord, Collocation, Phonetic symbols and transcription;
- Accentual pattern: Weak forms in connected speech;
- Participation in group discussion;
- Facing an interview;
- Presentation of scientific papers.

Suggested Readings

1. Barnes and Noble. Robert C. (Ed.). 2005. Spoken English: Flourish Your Language.
2. Chicago Manual of Style. 14th Ed. 1996. Prentice Hall of India.
3. Collins' Cobuild English Dictionary. 1995.
4. Harper Collins. Gordon HM and Walter JA. 1970. Technical Writing. 3rd Ed.
5. Holt, Rinehart and Winston. Hornby AS. 2000. Comp. Oxford Advanced Learner's Dictionary of Current English. 6th Ed. Oxford University Press.
6. James HS. 1994. Handbook for Technical Writing. NTC Business Books.
7. Joseph G. 2000. MLA Handbook for Writers of Research Papers. 5th Ed. Affiliated East-West Press.
8. Mohan K. 2005. Speaking English Effectively. MacMillan India.
9. Richard WS. 1969. Technical Writing.
10. Sethi J and Dhamija PV. 2004. Course in Phonetics and Spoken English. 2nd Ed. Prentice Hall of India.
11. Wren PC and Martin H. 2006. High School English Grammar and Composition. S. Chand & Co.

SOA/FECC/03 -INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE

I - Title	II - Code	III - Credit Hours	Theory	Internal	Practical/ Term Paper	Total
Intellectual Property and its Management in Agriculture	SOA/FECC/03	1+0	60	40	No Practical	100 (1)

Objective

The main objective of this course is to equip students and stakeholders with knowledge of Intellectual Property Rights (IPR) related protection systems, their significance and use of IPR as a tool for wealth and value creation in a knowledge based economy.

Theory

Historical perspectives and need for the introduction of Intellectual Property Right regime; TRIPs and various provisions in TRIPs Agreement; Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs; Indian Legislations for the protection of various types of Intellectual Properties; Fundamentals of patents, copyrights, geographical indications, designs and layout, trade secrets and traditional knowledge, trademarks, protection of plant varieties and farmers' rights and biodiversity protection; Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection; National Biodiversity protection initiatives; Convention on Biological Diversity; International Treaty on Plant Genetic Resources for Food and Agriculture; Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement.

Suggested Readings

1. Erbisch FH and Maredia K.1998. Intellectual Property Rights in Agricultural Biotechnology. CABI.
2. Ganguli P. 2001. Intellectual Property Rights: Unleashing Knowledge Economy. McGraw-Hill.
3. Intellectual Property Rights: Key to New Wealth Generation. 2001. NRDC and Aesthetic Technologies.
4. Ministry of Agriculture, Government of India. 2004. State of Indian Farmer. Vol. V. Technology Generation and IPR Issues. Academic Foundation.
5. Rothschild M and Scott N. (Ed.). 2003. Intellectual Property Rights in Animal Breeding and Genetics. CABI.
6. Saha R. (Ed.). 2006. Intellectual Property Rights in NAM and Other Developing Countries: A Compendium on Law and Policies. Daya Publ. House. The Indian Acts - Patents Act, 1970 and amendments; Design Act, 2000; Trademarks Act, 1999; The Copyright Act, 1957 and amendments; Layout Design Act, 2000; PPV and FR Act 2001, and Rules 2003; The Biological Diversity Act, 2002.

SOA/FECC/04 - BASIC CONCEPTS IN LABORATORY TECHNIQUES

I - Title	II - Code	III - Credit Hours	Theory	Internal	Practical/ Term Paper	Total
Basic Concepts in Laboratory Techniques	SOA/FECC/04	0+1	-	40	60	100 (1)

Objective

To acquaint the students about the basics of commonly used techniques in laboratory.

Practical

- Safety measures while in Lab;
- Handling of chemical substances;
- Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micropipettes and vaccumets;
- Washing, drying and sterilization of glassware;
- Drying of solvents/ chemicals;
- Weighing and preparation of solutions of different strengths and their dilution;
- Handling techniques of solutions;
- Preparation of different agro-chemical doses in field and pot applications;
- Preparation of solutions of acids;
- Neutralisation of acid and bases;
- Preparation of buffers of different strengths and pH values;
- Use and handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sandbath, waterbath, oilbath;
- Electric wiring and earthing;
- Preparation of media and methods of sterilization;
- Seed viability testing, testing of pollen viability;
- Tissue culture of crop plants;
- Description of flowering plants in botanical terms in relation to taxonomy.

Suggested Readings

1. Furr AK. 2000. CRC Hand Book of Laboratory Safety. CRC Press.
2. Gabb MH and Latchem WE. 1968. A Handbook of Laboratory Solutions. Chemical Publ. Co.

SOA/FECC/05 - AGRICULTURAL RESEARCH, RESEARCH ETHICS & RURAL DEVELOPMENT PROGRAM.

I - Title	II – Code	III - Credit Hours	Theory	Internal	Practical/ Term Paper	Total
Agricultural Research, Research Ethics & Rural Development Program.	SOA/FECC/05	1+0	60	40	No Practical	100 (1)

Objective

To enlighten the students about the organization and functioning of agricultural research systems at national and international levels, research ethics, and rural development programmes and policies of Government.

Theory

UNIT I

History of agriculture in brief; Global agricultural research system: need, scope, opportunities; Role in promoting food security, reducing poverty and protecting the environment; National Agricultural Research Systems (NARS) and Regional Agricultural Research Institutions; Consultative Group on International Agricultural Research (CGIAR): International Agricultural Research Centres (IARC), partnership with NARS, role as a partner in the global agricultural research system, strengthening capacities at national and regional levels; International fellowships for scientific mobility.

UNIT II

Research ethics: research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards and problems in research ethics.

UNIT III

Concept and connotations of rural development, rural development policies and strategies. Rural development programmes: Community Development Programme, Intensive Agricultural District Programme, Special group – Area Specific Programme, Integrated Rural Development Programme (IRDP) Panchayati Raj Institutions, Co-operatives, Voluntary Agencies/ Non-Governmental Organisations. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes.

Suggested Readings

1. Bhalla GS and Singh G. 2001. Indian Agriculture - Four Decades of Development. Sage Publ.
2. Punia MS. Manual on International Research and Research Ethics. CCS Haryana Agricultural University, Hisar.
3. Rao BSV. 2007. Rural Development Strategies and Role of Institutions - Issues, Innovations and Initiatives. Mittal Publ.
4. Singh K. 1998. Rural Development - Principles, Policies and Management. Sage Publ.

2.4 Mandatory requirement of seminars

- It has been agreed to have mandatory seminars one in Masters (One Credit) and two in Doctoral programmes (two Credits).
- The students should be encouraged to make presentations on the latest developments and literature in the area of research topic. This will provide training to the students on preparation for seminar, organizing the work, critical analysis of data and presentation skills.

3. Residential requirements

- The minimum and maximum duration of residential requirement for Masters'

SEMESTER II

MAJOR COURSES

SOA/FCMC/505 – INTERACTIONS IN AGROFORESTRY SYSTEMS

I – Title	II - Code	III - Credit Hours	Theory	Internal	Practical	Total
Interactions in Agroforestry Systems	SOA/FCMC/505	1+1	60	20	20	100 (2)

IV – Aim of the Course

To impart knowledge to the students regarding tree-crop interaction, their quantification and techniques to neutralize the negative tree- crop interactions.

V – Theory

Unit I

Tree-crop interphase- biological factors affecting form and function in woody and non-woody plant mixtures. Nature and types of interactions- positive and negative, aboveground and belowground interactions- competition, complementarity in resource sharing.

Unit II

Method for quantifying interactions, principles of resource capture and utilization of light and water, nutrition and space. Tree-soil-crop interactions- nitrogen fixing trees interactions in agroforestry. Allelopathy. Use of radioisotopes in tree-crop interaction studies. Root distribution of trees and crops-competition and/or complementarity. Animal-tree-crop interaction.

Unit III

Management options to neutralize negative (competitive) interactions, tree husbandry practices for alleviating competition- tree density manipulation, pruning, mixture of trees and herbaceous crops.

VI – Practical

- Different methods for quantifying interactions;
- Studies on allelopathy;
- Effect, microclimate modifications, different plant mixtures, tree-soil-crop interactions;
- Estimation of Land Equivalent Ratio, Estimation of competition indices;
- Measurement and interpretation of light interception in agroforestry systems;
- Interpretation of yield responses to shelter, soil water and drainage measurement, transpiration measurement, quantifying root distribution.

VII – Suggested Reading

- Avery MA, Cannel MGR and Ong CK. 2005. Biophysical Research for Asian Agroforestry. Oxford and IBH Publishing Co. Pvt. Ltd.
- Mac Dicken, KG and Vergara NT. 1989. Agroforestry-classification and Management. Nair PKR. 1993. An Introduction to Agroforestry. Kluwer Academic Pub.
- Ong CK and P Huxley. 2002. Tree-Crop Interactions- A Physiological approach, CAB International.
- Patra AK. 2013. Agroforestry-Principles and Practices. New India Publishing AGENCY, New Delhi (India).

SOA/FCMC/506 – MODERN NURSERY & PLANTATION TECHNOLOGY

I – Title	II - Code	III - Credit Hours	Theory	Internal	Practical	Total
Modern Nursery & Plantation Technology	SOA/FCMC/506	2+1	60	20	20	100 (3)

IV – Aim of the Course

To impart knowledge and develop understanding about modern nursery techniques for mass production along with various aspects of productivity, integrated nutrient and irrigation management as well as ecological factors in raising forest plantation.

V – Theory

Unit I

Introduction and importance of nursery. Types of nurseries-temporary and permanent, bare root, containerized and clonal nursery. Bare root nursery- nursery soil and water management, bed preparation, pre-sowing seed treatments, seed sowing and intermediate operations, viz., pricking, watering, fertilization, weeding and hoeing.

Unit II

Root culturing techniques. Types of green house and mist chamber for propagation.

Unit III Vegetative propagation – importance, selection of superior genotypes. Advanced methods of propagation, growing media, fertilizers, sanitation and management in vegetative propagation. Special requirement for clonal propagation. Propagation structure and management.

Unit III

Clonal propagation: miniclinal and micro cuttings technology. Vegetative propagation of bamboos and canes. Factors affecting rooting of cuttings. Lifting windows. Important forest nursery pests and diseases and their management. Seedling quality assessment, grading, packaging, storing and transportation.

Unit IV

Role of plantation forestry in meeting the wood demand. Purpose of plantation. Factors determining scale and rate of plantation. Land suitability and choice of species.

Unit V

Preliminary site preparation for establishing plantation. Plantation planning. Project formulation and appraisal. Planting programme. Time of planting. Spacing, pattern and planting methods.

Unit VI

Nutritional dynamics and irrigation of plantation. Mechanization in plantation. Protection and after care of plantation. Pruning and thinning in plantations. Rotation in plantation. Failures of plantations.

Unit VII

Sustainable yield from plantations. Case studies in plantations of *Eucalyptus*, *Poplars*, *Acacias*, *Pine*, *Gmelina*, *Bamboo*, etc. Production technology of energy plantations. Industrial plantations.

VI – Practical

- Introduction and identification of modern equipments and tools used in nursery;
- Pre-sowing seed treatments;
- Preparation of nursery beds and growing media for containerized nursery;
- Sowing of seed and other intermediate operations;
- Preparation and planting of cuttings;
- Assessment of seedling quality;
- Visit to forest nurseries;
- Nursery practices of commercially important tree species;
- Preparation of plantation calendar;
- Preliminary arrangement for a plantations programme;
- Planting geometry and calculation of planting stock;
- Studies on wood based industries – problems and prospects;
- Management of *Eucalyptus*, *Casuarina*, *Teak*, *Sal*, *Poplar*, *Acacias* and *Bamboo* plantations;
- Production technology for energy plantations. INM in plantations.

VII – Suggested Reading

- Bhardwaj RL and Sarolia DK. 2011. Modern Nursery Management. Published by Agrobios Publishing. New Delhi (India).
- Kumar GA and Gopikumar. 2003. Forest Nursery and Tree Husbandry.
- Kumar V. 2012. Nursery and Plantation Practices in Forestry. Scientific Publishers (India).
- Saini RS, Kaushik N, Kaushik RA and Godara NR. 2012. Practical Nursery Production. Agrobios, New Delhi (India).
- Dwivedi AP 1993. Forestry in India. Surya Publ.
- Julius E. 1982. Planation Forestry in the Topics. Clarendon Press Oxford.
- Kumar, V. 1999. Nursery and Plantation Practices in Forestry. Scientific Publ.
- Luna R.K. 1989. Plantation Forestry in India. International Book Distributors.
- Prakash R. Chaudhary DC and Negi SS. 1998. Plantation and Nursery Techniques of Forest Trees. International Book Distributors.

SOA/FCMC/508 – INDUSTRIAL AGROFORESTRY

I – Title	II - Code	III - Credit Hours	Theory	Internal	Practical	Total
Industrial Agroforestry	SOA/FCMC/508	1+1	60	20	20	100 (2)

IV – Aim of the Course

To develop skill and expertise on industrial wood production and processing technology.

V – Theory**Unit I**

Role of forests in industrial sector, industrial raw material, demand and supply, indigenous and exotic industrial resources, extent of area, policy and legal issues towards industrial wood plantation. Major wood based industries in India; timber, pulp wood, plywood, matches, etc. Raw material requirements and their procurements.

Unit II

Industrial wood plantations – status in India and different states, preferred species – current plantation management and establishment, propagation and plantation technique, economics of industrial agroforestry, pest and disease management for major industrial wood species, harvesting, reduced impact logging, mechanization.

Unit III

Supply chain; definition, concept, supply chain network, logistic activities, Marketing system; marketing type and channel, price patterns of various industrial wood agroforestry plantations. Contract farming: concept and methods, contract tree farming system in India. Industrial experiences– price support system – constraints. Corporates in industrial agroforestry: International and National corporate, success stories. Corporate social responsibilities. Tree insurance.

Unit IV

Impacts of industrial agroforestry – ecological impacts; climatic, edaphic and biotic– carbon sequestration. Carbon storage potential of industrial agroforestry and carbon trading mechanism of industrial agroforestry, socio-economic impacts–clean development mechanism. Certification of industrial plantations.

VI – Practical

- Study of various wood based industries;
- Study on raw material requirement and sourcing of plywood, pulp and paper, matchwood, timber processing;
- Biomass power generation industries;
- Value addition technology of various wood products;
- Industrial wood plantations – economics and impact assessment.

VII – Suggested Reading

- Cosalter C and C Pye-Smith. 2003. Fast Wood Forestry – Myths and Realities. CIFOR. Bogor, Indonesia. 50p.
- Mehta T. 1981. A Hand Book of Forest Utilization. International Book Distributors, Dehradun.
- Nair PKR. 1993. An Introduction to Agroforestry. Kluwer Academic publishers.
- Parthiban KT, Umarani R, UmeshKanna S, Sekar I, Rajendran P and Durairasu P. 2014. Industrial Agroforestry: Perspectives and Prospectives. Scientific Publishers.
- Tejwani KG. 1994. Agroforestry in India. Oxford and IBH publishing Co., New Delhi.

MINOR COURSES**SOA/FEMC/01 – FOREST ECOLOGY & BIODIVERSITY MANAGEMENT**

I – Title	II – Code	III - Credit Hours	Theory	Internal	Practical	Total
Forest Ecology & Biodiversity Management	SOA/FEMC/01	2+1	60	20	20	100 (3)

IV – Aim of the Course

To develop understanding among students about ecological aspects of forest, conservation of forest resources and biodiversity, consequences of depleting biodiversity and concept of sustainability.

V – Theory

Unit I

Hierarchy issues in ecology and ecosystem. Advanced topics in forest ecology including forest population, forest community dynamics, forest community structure and analysis, forest productivity, ecology of forest landscapes spatial heterogeneity and ecological succession.

Unit II

Conservation of natural resources (hotspot areas, wildlife sanctuaries, national parks, biosphere reserve). Climate change, Global warming and forests. Green house effect and its consequences. Ozone depletion. Conservation laws and acts. Forest genetics resources of India: timber and non timber species. Survey exploration and sampling strategies Phytogeography and vegetation types of India.

Unit III

Documentation and evaluation of forest genetical resources (FGR), in situ and ex situ conservation of gene resources. Phytodiversity and its significance to sustainable use. Handling and storage of FGR. Intellectual property rights. Quarantine laws and FGR exchange.

VI – Practical

- Study of forest community structure and its successional status;
- Estimation of productivity of forest ecosystem;
- Study tours to different regions of the state to study forest vegetation;
- Collection and preservation of specimen, Methods of vegetation analysis;
- Measurement of biomass and productivity;
- Quantification of litter production and decomposition;
- Visit to national parks, wildlife sanctuaries. Botanical gardens and arboreta.

VII – Suggested Reading

- Avery TE and Burkharts H. 2001. Forest Measurements. McGraw-Hill Education.
- Barnes BV, Zak DR, Denton SR and Spurr SH. 1998. Forest Ecology. Wiley.
- Jha BC, Pandey BN, Jaiswal K, Katiha PK, Pandey PN and Sharma AP. 2012. Biodiversity: Issues Threats and Conservation. Narendra Publishing House, Delhi.
- Kumar Biju. 2013. Biodiversity and Taxonomy. Narendra Publishing House, Delhi.
- Larocque GR. 2016. Ecological Forest Management Handbook (Applied Ecology and Environmental Management).
- Taylor & Francis. Mahato B, Pandey BN, Singh LB, Pandey PN and Singh RK. 2010. Text Book of Environmental Pollution. Narendra Publishing House, Delhi.
- Mikusiński G, Roberge JM and Fuller R. 2018. Ecology and Conservation of Forest Birds (Ecology, Biodiversity and Conservation). Cambridge University Press.
- Pandey PN. 2009. Biodiversity and Environment Ecology. Narendra Publishing House, Delhi.
- Perry DA, Oren R and Hart SC. 2008. Forest Ecosystems. 2nd ed. Baltimore: Johns Hopkins University Press.
- Young RA and Giese RL. 2003. Introduction to Forest Ecosystem Science and Management. Wiley.

SOA/FEMC/02 –APPLIED FOREST TREE IMPROVEMENT

I – Title	II – Code	III - Credit Hours	Theory	Internal	Practical	Total
Applied Forest Tree Improvement	SOA/FEMC/02	2+1	60	20	20	100 (3)

IV – Aim of the Course

To acquaint the students about general principles of tree breeding with examples of important trees.

V – Theory

Unit I

General concept of forest tree breeding, tree improvement and forest genetics.

Unit II

Reproduction in forest trees, dimorphism, pollination mechanism. Pollen dispersal, pollinators. Attractants for pollinators.

Unit III

Variation in trees, importance and its causes. Natural variations as a basis for tree improvement. Geographic variations – Ecotypes, clines, races and land races.

Unit IV

Selective breeding methods- mass, family, within family, family plus within family. Plus tree selection for wood quality, disease resistance and agroforestry objectives. Selection strategies and choice of breeding methods and progress in selective breeding in forest trees.

Unit V

Seed orchards – type, functions and importance, Genetic testing- mating designs and field designs. Progeny and clone testing estimating genetic parameters and genetic gain, clonal and breeding values. Average performance of half sibs and fullsibs. GxE interaction in trees.

Unit VI

Heterosis breeding: inbreeding and hybrid vigour. Manifestation and fixation of heterosis. Species and racial hybridization. Indian examples – *Teak, shisham, eucalypts, acacias, poplar*, etc.

Unit VII

Polyploidy, aneuploidy and haploidy in soft and hard wood species. Induction of polyploidy. Unit VIII Elements of biotechnology in tree improvement.

VI – Practical

- Floral biology, modes of reproduction and modes of pollination in forest trees;
- Estimating pollen viability. Controlled pollination and pollen handling;
- Manipulation of flowering through hormones;
- Identification of ecotypes, races and land-races in natural forest;
- Visit to species, provenance and progeny trials;
- Selection of superior phenotypes;
- Marking of candidate trees, plus trees and elite trees;
- Visit to seed orchards;
- Comparison of parents and their putative hybrids;
- Induction of polyploidy through colchicine treatment;
- In-vitro propagation, study of molecular markers.

VII – Suggested Reading

- Dutta M and Saini GC. 2009. Advances in Forestry Research in India, Vol. XXX. Forest Tree Improvement and Seed Technology. International Book Distributors.
- Finkeldey R and Hattermer HH. 2006. Tropical Forest Genetics. Springer.
- Mandal AK and Gibson GL. (Eds). 1997. Forest Genetics and Tree Breeding. CBS.
- Sedgley M and Griffin AR. 1989. Sexual Reproduction of Tree Crops. Academic Press.
- Surendran C, Sehgal RN and Paramathma M. 2003. Text Book of Forest Tree Breeding. ICAR.
- White TL, Adams WT and Neale DB. 2007. Forest Genetics. CABI, UK.
- Wright JW. 1976. Introduction to Forest Genetics. Academic Press.
- Zobel BJ and Talbert J. 1984. Applied Forest Tree Improvement. John Wiley and Sons.

SOA/FEMC/03 – CLONAL FORESTRY

I – Title	II – Code	III - Credit Hours	Theory	Internal	Practical/ Term Paper	Total
Clonal Forestry	SOA/FEMC/03	2+0	60	40	No Practical	100 (2)

IV – Aim of the Course

To provide information about genetics, conservation, biotechnological approaches for trees in clonal forestry system for higher biomass/ yield productivity

V – Theory
<p>Unit I Introduction to Clonal Forestry. History of clonal forestry. Clonal propagation. Clonal planting. Strategies for clonal forestry for higher productive potential.</p> <p>Unit II Juvenility and maturation, rejuvenation and maintainance, regulation of phase changes, markers of phase changes. Breeding strategies using vegetative propagation- selection and breeding for extreme genotypes. Physiological research for higher productivity of clonal forest. Field design, testing and evaluation of clones. Genetic gains from breeding with clonal option. Clonal conservation approaches- management of populations for genetic diversity and gain.</p> <p>Unit III Biotechnological approaches for clonal forestry, Plant tissue culture, micropropagation, Rejuvenation of tissues from mature trees, Testing of Clonal fidelity using molecular markers.</p>
VI – Suggested Reading
<ul style="list-style-type: none"> • Ahuja MR and Libby WJ. 1993. Clonal Forestry I Conservation and Application. Springer • Ahuja MR. 1992. Micropropagation of Woody Plants: Volume 41 (Forestry Sciences). Springer • Ahuja MR and Libby WJ. 1993. Clonal Forestry II Genetics and Biotechnology. Springer • Mandal AK and Gibson GL. 2002. Forest Genetics and Tree Breeding. CBS Publishers, New Delhi

SUPPORTING COURSES

SOA/FCSC/511B – EXPERIMENTAL DESIGNS

I – Title	II – Code	III - Credit Hours	Theory	Internal	Practical	Total
Experimental Designs	SOA/FCSC/511B	2+1	60	20	20	100 (3)

IV – Aim of the Courses
This course is meant for students who do not have sufficient background of statistical methods. The students would be exposed to concepts of general statistical methods and statistical inference that would help them in understanding the importance of statistical methodology. It would also help them in understanding the concepts involved in data presentation, analysis and interpretation of results.

V – Theory
Design of Experiments: Basic Principles of design of experiments, Completely Randomised Design, Randomised Block Design, Latin Square Design. Elementary idea of factorial experiments. Estimation of genetic parameters from ANOVA table. Unit V Non-parametric tests: Sign test, Wilcoxon test, Mann-Whitney U-test, Wald Wolfowitz run test, Median test, Kruskal- Wallis test. MS Excel, Introduction to computer softwares.
VI – Practical
<ul style="list-style-type: none"> • Random variable and mathematical expectation; • Fitting of distributions, viz., Binomial, Poisson, Normal; • Correlation and regression; • Non-linear regression • Multiple linear regression; • Testing of hypothesis based on chi square, t and F tests. Large sample tests. Completely Randomised Design, Randomised Block Design, Latin Square Design and Factorial experiments. Non-parametric tests. Exercises based on computer software.
VII – Suggested Reading
<ul style="list-style-type: none"> • Aggarwal BL. 1996. Basic Statistics. Wiley Eastern Limited, New Age International Ltd. • Bansal ML, Singh S, Singh TP and Kumar R. 2004. Statistical Methods for Research Workers. Kalyani Publishers. Chandel SRS. 2014. A Handbook of Agricultural Statistics. AchalPrakashan. • Goon AM, Gupta MK and Dasgupta B. 1968. Fundamentals of Statistics, vol I, II. The World Press, Calcutta. Snedecor GW and Cochran WG. 1980. Statistical Methods. East West Press.

SEMESTER III

SOA/FEMC/509 - CLIMATE CHANGE AND CONSERVATION SILVICULTURE

I – Title	II – Code	III - Credit Hours	Theory	Internal	Practical	Total
Climate Change and Conservation Silviculture	SOA/FCMC/509	2+0	60	40	No Practical	100 (2)

IV – Aim of the Course

To understand the scenario of climate change and international treaties on climate change, adaptive silviculture for climate change mitigation, silviculture for conservation of ecosystems.

V – Theory

Unit I

Global climate change-factors involved, green house gases, potential threats, global carbon cycle and C-budget, carbon sequestration. Forests and climate change: Forest responses and vulnerabilities to climate change mitigation. Status of forests in global climate change. Harnessing Forests for Climate Change Mitigation, International climate negotiation, UNFCCC, IPCC, CoP:LULUCF, REDD++ and CDM.

Unit II

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 III

Disturbance- natural and anthropogenic, short and long term impacts and their implications. Fire loss estimation in forests. Deforestation and degradation trends at global, national and regional levels. Mega development projects, Road widening projects and conservation of native and threatened species, management and rehabilitation plans.

Unit IV

Impacts of 'No Green Felling' on stand productivity and health. Restoration forestry silvicultural treatments for habitat restoration, catchment area treatments, enrichment planting, Analog forestry for site productivity and carbon value. Expanding forest and tree cover area- TOF sector in India.

Unit V

Role of canopy in regulating functional inputs to stand: canopy and forest continuum, Continuous Cover Forestry. Silviculture of old growth stands and sacred grooves their ecological significance and biodiversity values. Carbon sequestration potential of Trees Outside forests (TOFs), homegardens and urban forests.

VII – Suggested Reading

- Anderson P and Palik B. 2011. Silviculture for Climate Change. U.S. Department of Agriculture, Forest Service, Climate Change Resource Center.

SOA/FCMC/510 – TREE AND SHRUBS FOR AGROFORESTRY

I – Title	II – Code	III - Credit Hours	Theory	Internal	Practical	Total
Tree and Shrubs for Agroforestry	SOA/FCMC/510	1+1	60	20	20	100 (2)

IV – Aim of the Course

To make students familiar with trees and shrubs (fruit, fodder and small timber) suitable for agroforestry.

V – Theory

Unit I

Introduction, importance of woody elements in agroforestry systems, their role in biomass production. Suitability

of species for different purposes. Multipurpose trees in agroforestry systems. Fodder from trees/ shrubs and their nutritive value, propagation techniques.

Unit II

Role of nitrogen fixing trees/ shrubs. Choice of species for various agro-climatic zones for the production of timber, fodder, fuel wood, fibre, fruits, medicinal and aromatic plants. Generic and specific characters of trees and shrubs for agroforestry.

Unit III

Fruit crop and small timber trees and their need and relevance in agroforestry, trees suitable for various assemblage and their planting plan in different agroclimatic zones and agroforestry system. Intercropping in fruit orchards like *Apple, Walnut, Jack fruit, Mango, Sapota, Pomegranate, Orange, Citrus, Guava*, etc. Modification in tending and pruning operations and canopy management. Fertility management, yield and quality improvement.

VI – Practical

- Field survey and acquaintance with specialized features of trees, shrubs and fruit species and varieties for Agroforestry;
- Planting plans including wind breaks;
- Training and pruning of forest trees, shrubs and fruit trees for enhancing production in agroforestry system.

VII – Suggested Reading

- Dwivedi AP. 1992. Agroforestry: Principles and Practices. Oxford & IBH.
- Nair PKR, Rai MR and Buck LE. 2004. New Vistas in Agroforestry. Kluwer.
- Nair PKR. 1993. An Introduction to Agroforestry. Kluwer.
- Ong CK and Huxley PK. 1996. Tree Crop Interactions – A Physiological Approach. ICRAF.
- Srivastava KK. 2007. Canopy Management of Fruit Crops, IBD.
- Thampan PK. 1993. Trees and Tree Farming. Peekay Tree Crops Development Foundation.

SOA/FCMC/511 – ECONOMICS OF AGROFORESTRY SYSTEMS

I – Title	II – Code	III - Credit Hours	Theory	Internal	Practical	Total
Economics of Agroforestry Systems	SOA/FCMC/511	2+1	60	20	20	100 (3)

IV – Aim of the Course

To acquaint the students with principles of economics and use of economic tools in appraisal of the agroforestry systems. Evaluation of ecosystem services from agroforestry- economic and ecological aspects of agroforestry.

V – Theory

Unit I

Basic principles of economics applied to agroforestry. Financial measures. Quantification and valuation of inputs and outputs- direct and indirect methods.

Unit II

Optimization techniques-Planning, budgeting and functional analysis. Role of time, risk and uncertainty in decision making. Agroforestry budgeting. Risk analysis, reassessment.

Unit III

Financial and socio-economic analysis of agroforestry projects. Principles of financial management and harvesting, post harvest handling, value addition, marketing of agroforestry products including benefit sharing.

Unit IV

Valuation of ecosystem services in agroforestry and payment for ecosystem systems. Bankable agroforestry projects, incentives, tree insurance, etc. Certification process in agroforestry based carbon projects, carbon finance, etc.

VI – Practical

- Exercises on agroforestry production relationships;
- Preparation of agroforestry based enterprise, partial and complete budgets;
- Application of various methods in formulation and appraisal of agro-forestry projects;
- Case studies on harvesting, post harvest management and marketing of agroforestry products;

- Valuation of ecosystem services in agroforestry and payment for ecosystem services.

VII – Suggested Reading

- Alavalapati JRR and Mercer D Evan. 2004 Valuing Agroforestry Systems: Methods and Applications. Kluwer Academic Publishers.
- Kant S and Janaki A. 2014. Handbook of Forest Resource Economics. Publisher: Routledge
- Nair PKR, Rai MR and Buck LE. 2004. New Vistas in Agroforestry. Kluwer Academic Publishers.
- Nair PKR. 1993. An Introduction to Agroforestry. Kluwer Academic Publishers.
- Ong CK and Huxley PK. 1996. Tree Crop Interactions – A Physiological Approach. ICRAF. Sullivan
- Gregory M, Susan Hoke M and Jefferson M. Fox (editors). 1992. Financial and Economic Analyses of Agroforestry Systems.
- Proceedings of a workshop held in Honolulu. Hawaii. USA. July 1991. Paia, Ill: Nitrogen Fixing Tree Association.
- Thampan PK. 1993. Trees and Tree Farming. Peekay Tree Crops Development Foundation.

SOA/FCMC/512 – TREE SEED TECHNOLOGY

I – Title	II – Code	III - Credit Hours	Theory	Internal	Practical	Total
Tree Seed Technology	SOA/FCMC/512	2+1	60	20	20	100 (3)

IV – Aim of the Course

To impart knowledge and to develop understanding about tree seed development, harvesting, processing, storage, dormancy, germination of tropical, sub-tropical and temperate species, their testing and certification.

V – Theory

Unit I

Introduction, trends and development in tropical, sub-tropical and temperate forestry and their influence on seed demand. Seed problems, limiting factors in tree propagation and afforestation.

Unit II

Reproductive biology of seed plants – development and maturation of seed bearing organs and seeds – morphology of fruit and seed – seed dispersal – ecological fruit and seed types- seasonality and periodicity of flowering and fruiting – reproductive age – influence of external factors on seed production. Seed structure and chemical composition – development and maturation – germination – breakdown of storage products – endogenous hormonal regulation – effect of stimulators and inhibitors– dormancy – its causes and breakage specific problems of seeds of woody plants.

Unit III

Determining maturity indices. Factors influencing choice of collection methods. Methods of seed collection and processing. Storage methods – loss of viability during storage. Dormancy and pre-treatment. Germination and seedling establishment and seed testing techniques. Unit IV Quality seed production technologies – seed certification.

Unit V

Eco-physiological role of seed storage. Classification of seed storage potential. Factors affecting seed longevity. Pre-storage treatment. Physiological change during ageing. Storage of orthodox, recalcitrant and intermediate seeds, Fumigation and seed treatment.

VI – Practical

- Identification of forest seeds;
- Seed sampling, different storage methods, Seed quality testing-purity, viability and germination, collection and processing of seeds/ fruit;
- Tests of viability, viz., cutting, hydrogen peroxide, excised embryo, tetrazolium, seed health testing primarily to the presence or absence of disease-causing organisms such as fungi, bacteria, virus and animal pests, recording, calculation and use of results of seed treatment.

VII – Suggested Reading

- Baldwin HI. 1942. Forest Tree Seed of the North Temperate Regions. Periodical Experts Book Agency, Delhi.
- Bedell PE. 1998. Seed Science and Technology: Indian Forestry Species. Allied Publisher Limited.
- Chin HF and Roberts EH. 1980. Recalcitrant crop seeds. Tropical Press Sdn. Bhd. Malaysia.
- Dutta M and Saini GC. 2010. Forest Tree Improvement and Seed Technology.

- Hong TD and Ellis RH. 1996. A protocol to determine seed storage behaviour. IPGRI Technical Bulletin No. 1. (J. M. M. Engels and J. Toll, vol. Eds.) International Plant Genetic Resources Institute, Rome, Italy.
- ISTA. 1993. International Rules for Seed Testing. International Seed Testing Association, Zurich, Switzerland.
- Khullar P. et al. 1992. Forest Seed. ICFRE, New Forest, Dehra Dun.
- Leadem CL. 1984. Quick Tests for Tree Seed Viability. B.C. Ministry of Forests and Lands, Canada.
- Schmidt L. 2000. Guide to handling of tropical and subtropical forest seed. DANIDA Forest Seed Centre, Denmark. Umarani R and Vanangamudi K. 2004. An Introduction to Tree Seed Technology. IBD, Dehradun.
- Vanangamudi K. 2007. Advances in Seed Science and Technology: (Vol. 1. to 5).
- Willan RL. 1985. A guide to forest seed handling. FAO Forestry Paper 20/2, DANIDA Forest Seed Centre, Denmark and FAO, Rome.

SOA/FCMC/591 – MASTER’S SEMINAR

I – Title	II – Code	III - Credit Hours	Theory	Internal	Practical/ Term Paper	Total
Master’s Seminar	SOA/FCMC/591	0+1	--	--	100 (1)	100 (1)
<ul style="list-style-type: none"> • Concerned department will organize in house seminars about pre-discussion of the master thesis topics. • Departmental committee will discuss and finalize synopsis of master thesis through ppt. presentation. 						

SOA/FCMC/599A – RESEARCH REVIEW (MASTER THESIS)

I – Title	II – Code	III - Credit Hours	Theory	Internal	Practical/ Term Paper	Total
Research Review (Master Thesis)	SOA/FCMC/599A	0+7	--	--	100 (7)	100 (7)
<ul style="list-style-type: none"> • Mid-term progress will be presented by each student by ppt. presentation. • Mater thesis review work will be presented by each student. 						

SEMESTER IV

SOA/FEMC/513 – NUTRIENT AND WEED MANAGEMENT IN PRODUCTION FORESTRY

I – Title	II – Code	III - Credit Hours	Theory	Internal	Practical	Total
Nutrient and Weed Management in Production Forestry	SOA/FEMC/513	1+1	60	20	20	100 (2)

IV – Aim of the Course

To make students to understand the concepts of nutrients and their management, weeds and their management in nurseries and plantations.

V – Theory

Unit I

History of nutrient management in forest nurseries and plantations. Essential nutrient elements and their deficiency. Mechanism of nutrient uptake by plants, functions and translocation/ interactions. Concept of nutrient availability.

Unit II Climatic and soil conditions causing micronutrient deficiencies in plants. Occurrence and treatment of micronutrient disorders. Evaluation of soil for the supply of micronutrient. Rare and non-essential elements.

Unit III Technology and use of complex liquid and suspension fertilizers. Fertilizer use efficiency. Biological nitrogen fixation and bio-fertilizers. Farm yard manure and other organic fertilizers. Mycorrhizal associations and their significance. Economic implications of nutrient management. Importance of renewable wastes and their

recycling.

Unit IV Principles of weed control. Methods of weed control-cultural, biological, mechanical and chemical. Herbicide/ weedicide classification, properties and their application.

VI – Practical

- Methods of soil and plant analysis.
- Preparation of nutrient solutions.
- Practical application of fertilizers;
- Study of fertilizer response and diagnosis of deficiency symptoms.
- Fertilizer testing and pot experiments;
- Nursery inoculation techniques of bio-fertilizers;
- Methods of application of formulated products-seed treatment, root dip, suckers treatment, soil application, foliar application and combination of different methods;
- Important weeds in forest nurseries and plantations. Control of weeds.

VII – Suggested Reading

- Allen V and Barker. 2007. Handbook of Plant Nutrition. Pitman London.
- Gupta OP. 2011. Modern Weed Management. Agrobios, New Delhi (India).
- Kumar D, Chowdhary S and Sharma R. 2011. Weed Management: Principles and Practices. Narendra Publishing House.
- Rajaram C. 2012. Hand book of Plant Nutrition. Neha Publishers and Distributors.
- Rammoorthy and Subbian P. 2012. Weed Management. Agrotech Publishing Academy, Udaipur (India).

SOA/FEMC/514 – CROPS AND LIVE STOCK MANAGEMENT IN AGROFORESTRY

I – Title	II – Code	III - Credit Hours	Theory	Internal	Practical	Total
Crops and Live Stock Management in Agroforestry	SOA/FEMC/514	2+0	60	40	No Practical	100 (2)

IV – Aim of the Course

To impart knowledge on interactions between tree and live stock including their management, principles of crops and fodder production in agroforestry.

V – Theory

Unit I

Choice of inter-crops for different tree species, sowing and planting techniques. Planting patterns, crop geometry, nutrient requirements, and weed management. Management of fodder tree species, thinning, lopping, pruning. Ecological and socio-economic interactions.

Unit II

Role of tree architecture and its management on system's productivity. Production potentials of fodder based agroforestry systems in different agro-climatic conditions and crop combinations. Importance of cattle, sheep and goat vis-à-vis agro-forestry systems. Feed and fodder resources in agro-forestry systems and live stock management.

Unit III

Nutrient analysis of forages derived from fodder trees/ shrubs. Nutrient requirement for various livestock and their ration computation with agroforestry forages and tree leaves. Forage and tree leaves preservation.

Unit IV

Calendars for forage crop production in agro-forestry systems including lopping schedules. Optimization of animal production. Animal products technology and marketing.

Unit V

Integrated Agroforestry Farming System.

VII – Suggested Reading

- Bran Powell. 2017. Livestock Production and Management. L & K Education.
- Kundu SS, Dagar JC, Prakash O, Chaturvedi and Sirohi SK. 2008. Environment, Agroforestry and Livestock Management.

SOA/FE/599B – Master Research (Thesis)

I – Title	II – Code	III - Credit Hours	Theory	Internal	Practical/ Term Paper	Total
Master Research (Thesis)	SOA/FE/599B	0+23	--	--	100(23)	100 (23)
Evaluation of the master thesis shall be as follows:						
1. Periodical presentation					20 Marks	
2. Viva-Voce					20 Marks	
3. Thesis evaluation					60 Marks	
Evaluation of the thesis shall be done by one external and one internal examiner.						