

Course Unit	Genetics and Forest Improvement			Field of study	Forestry & Hunting	
Master in	Management of Forest Resources			School	School of Agriculture	
Academic Year	2023/2024	Year of study	1	Level	2-1	ECTS credits 6.0
Туре	Semestral	Semester	1	Code	6363-808-1102-00-23	
Workload (hours)	162	Contact hours	T - Lectures; TP - Lectures a	- PL - T	C - S -	Fieldwork; S - Seminar; E - Placement; OT - Tutorial; O - Other

Name(s) of lecturer(s)

Emilia Carolina Fernandes Caminha

Learning outcomes and competences

- At the end of the course unit the learner is expected to be able to: 1. Knowing the principles of Mendelian genetics, population genetics and quantitative genetics which will provide the student the tool box to manipulate the genetic variation of tree populations
- Understanding the need to preserve the genetic heritage to ensure the sustainability of the forests;
 Understanding the complexity, difficulties and specificities of tree improvement programs

Prerequisites

Before the course unit the learner is expected to be able to: Non-applicable

Course contents

Molecular basis of inheritance. Transmission genetics. Population genetics: inbreeding, forces of evolution. Quantitative genetics: genetic variances and heritabilities, specific and general combining ability, clonal and breeding values, genetic gain, genetic correlations. Genetic variation in natural populations. Tree improvement programs: structure, concepts. Breeding cycle: base populations; mass selection, genetic testing.

Course contents (extended version)

1. Introduction

- Concepts of forest genetics, forest tree breeding and forest tree improvement Historical perspective of forest tree improvement
- Phases of a tree improvement program Pros and cons of forest tree improvement
- Pros and cons of forest tree improvement
 Molecular basis of inheritance
 Molecular foundations of genetics. DNA structure and replication. Central dogma and the genetic code
 Transcription and translation. Regulation of gene expression
 DNA location in the cells. Genome organization. Mitochondrial, cloroplastic, and nuclear genomes
 Nuclear genome size. The C-vlaue enigma. Coding and non-coding DNA
 DNA packing in the chromosome. Gene organization in the chromosome
 Variation in the n^o of chromosomes and ploidy in gimnosperms and angiosperms. Poliploidy origin
 Transmission genetics. Mendelian genetics
 Mendelian genetics
 Extensions to Mendel's Laws
 Partial dominance. Codominance. Pleiotropy. Epistasy. Genetic linkage. Extranuclear beredity.
- - Partial dominance. Codominance. Pleiotropy. Epistasy. Genetic linkage. Extranuclear heredity
- 4. Population genetics
- Population genetics
 Quantifying the genetic composition of populations: allelic and genotypic frequencies
 Hardy-Weinberg Principle
 Evolutionary forces that change allelic frequencies: mutation, migration, selection, genetic drift
 Mating systems and endogamy. Influence of inbreeding on genotypic frequencies
 Inbreeding coefficient. Inbreeding depression
 Quantitative genetics
 The nature and study of polygenic traits
 Modeling phenotypes of parents and offspring
 Clonal value and breeding value
 Estimating the average performance of offspring
 Genotypic variances and heritabilities
 Pleiotropy and genetic correlations
 Genotype are environment interaction
 Estimating genetic parameters
 Mating design
 Field design. Data analysis
 Genetic variation in natural populations. Genetic variation within populations
- Field design. Data analysis
 Genetic variation in natural populations. Genetic variation within populations

 Quantifying genetic variation
 Genetic diversity in forest trees
 Factors promoting genetic diversity within forest populations
 Mating system dynamics in forest trees
 Spatial and temporal genetic structure within populations
 Practical implications of within populations genetic diversity

 Genetic variation in natural populations. Geographic variation (between populations)

 Definitions and concepts related with geographic variation
 Provenances, seed sources and races. Clines and ecotypes. Varieties and subspecies
 Patterns of geographic variation in forest trees
 - Patterns of geographic variation in forest trees Implications of geographic variation for seed transfer
- 8. Tree improvement
 - Tree improvement Tree improvement programs. Objectives and structure of the programmes of forest improvment The breeding cycle of forest tree improvement programs. Population types Genetic gains and economical value of forest improvement programmes Base populations. Species selection, hybrids and seed source for plantations Defining base populations for tree improvement programs Mass selection. Indirect MS. Selection methods for multiple traits and for irregular stands Genetic tests: types, goals, and functions. Mating designs. Field design

Recommended reading

- Falconer D. S. & T. F. C. Mackay. 1996. Introduction to quantitative genetics. 4th edition.
 White T. L. , Adams W. T. & Neale D. B. 2007. Forest genetics. CABI publishing.
 Zobel B. & Talbert J. 1984. Applied forest tree improvement. Waveland Press Inc.

Teaching and learning methods

Conventional lectures; use of power point presentations and internet resources. Laboratory classes. Course materials available in the e-learning plataform.

Assessment methods

- Continuous evaluation (Regular) (Final)

 Final Written Exam 40% (Final exam)
 Intermediate Written Test 30% (Four individual take home exams)
 Case Studies 30% (Simulation study using the software Populus about genetic drift, selection, and inbreeding)

 Comprehensive exam (Regular) (Supplementary, Special)
 Comprehensive exam (Student Worker) (Final, Supplementary, Special)

Language of instruction

Portuguese, with additional English support for foreign students.

Electronic validation			
Emilia Carolina Fernandes Caminha	Amilcar António Teiga Teixeira	Felícia Maria Silva Fonseca	Maria Sameiro Ferreira Patrício
12-02-2024	12-02-2024	12-02-2024	12-02-2024