INSTITUTO POLITÉCNICO DE BRAGANÇA

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
Type	Semestral	Semester	1	Code	6363-808-1102-00-23		

Workload (hours)	162	Contact hours	T -	TP -	PL -	TC -	S -	E -	OT -	O -

T - Lectures; TP - Lectures and problem-solving; PL - Problem-solving, project or laboratory; TC - 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
2. Understanding the need to preserve the genetic heritage to ensure the sustainability of the forests;
3. 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
2. 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 nº of chromosomes and ploidy in gimnosperms and angiosperms. Poliploidy origin
3. Transmission genetics. Mendelian genetics
   - Mendelian genetics
   - Extensions to Mendel's Laws
   - Partial dominance. Codominance. Pleiotropy. Epistasy. Genetic linkage. Extranuclear heredity
4. 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
5. 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 x environment interaction
   - Estimating genetic parameters
   - Mating design
   - Field design. Data analysis
6. 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 population genetic diversity
7. Genetic variation in natural populations. Geographic variation (between populations)
   - Definitions and concepts related with geographical variation
   - Provenances, seed sources and races. Clines and ecotypes. Varieties and subspecies
   - Patterns of geographic variation in forest trees
   - Implications of geographic variation for seed transfer
8. 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

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Recommended reading

1. Falconer D. S. & T. F. C. Mackay. 1996. Introduction to quantitative genetics. 4th edition.
2. White T. L. , Adams W. T. & Neale D. B. 2007. Forest genetics. CABI publishing.
3. 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

1. 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)
2. Comprehensive exam - (Regular) (Supplementary, Special)
3. 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

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