# Modulhandbuch

# Course Book

## M.Sc. Agricultural Science and Resource Management in the Tropics and Subtropics (ARTS)

**Studienbeginn ab WS 2020/2021**

**Beginning of studies from WS 2020/2021**


RHEINISCHE FRIEDRICH-WILHELMS-UNIVERSITÄT BONN

AGRAR-, ERNÄHRUNGS- UND INGENIEURWISSENSCHAFTLICHE FAKULTÄT

# Modul-Übersicht/ Directory of modules

## Abkürzungen/Abbreviations:

**Häufigkeit/Course cycle**

SS=Sommersemester/Summer semester

WS=Wintersemester/Winter semester

**Verwendbarkeit des Moduls/Study program allocation**

P/C=Pflichtmodul/Compulsory

WP/E=Wahlpflichtmodul/Elective

fWP/O=freies Wahlpflichtmodul/Optional

PM=Projektmodul/Project module

**Lehr- und Lernformen/Teaching and learning methodes**

V/L=Vorlesung/Lecture

Ü/T=Übung/Tutorial

S=Seminar

P=Praktikum/Practical training

E=Exkursion/Excursion

prÜ/pT=praktische Übung/ Practical course

PS=Projektseminar/Project seminar

T/sT=Tutorium/Student tutorial

K/C=Kolloquium/Colloquium

AG/SG=Arbeitsgemeinschaft/Study group

B-Arb/BT=Bachelorarbeit/Bachelorthesis

M-Arb/MT=Masterarbeit/Masterthesis

Mit Asterisk (*) gekennzeichnet: Lehrveranstaltungen, für die gemäß § 13 Abs. 6 der POO als Voraussetzung für die Teilnahme an Modulprüfungen die verpflichtende Teilnahme festgelegt ist. Die Pflicht zur Teilnahme besteht dann zusätzlich zu etwaigen sonstigen aufgeführten Studienleistungen.

Marked with an asterisk (*): Courses for which, in accordance with § 13 Paragraph 6 of the POO, compulsory attendance is specified as a prerequisite for taking module examinations. The compulsory attendance then exists in addition to any other listed academic achievements.

# Compulsory modules of the first semester (ARTS-A)

**24 ECTS-CP must be completed.**

## Module Title: Ecological conditions and climate change

**Module ID/Code:** ARTS-A01 [780750010]

### 1. Content and intended learning outcomes

| | |
|---|---|
| **Learning content:** | Students aquire the know-how about and a quantitative understanding of the structure and use of resources (soil, water, plant, animal, genes, ecosystem) for agricultural production within their changing biophysical environment, including the effects of agriculture on and the contributions to desertification and climate change. The interdisciplinary lecture is structured into three components aimed at acquiring knowledge, interpreting trends and explaining possible implications:<br>1. Interdisciplinary lecture on ecological conditions for agricultural production, including geodynamics, climate systems, soil and water resources and ecosystem services (- Ecology of the earth, landscape formation, biodiversity; - Climate, agroecological zones, definitions and descriptions; - Soil formation in relation to landscape and climatic factors; - Water resources, management and use in relation to climatic zones; - Land use systems in major climatic zones.);<br>2. Lecture and case study examples of observations, trends and processes of climate change and their implications and trade-offs for crop and animal production systems (- Trends and scenarios of future climate and its impact on agriculture; - Sources and sinks of greenhouse gases; - Political frameworks to combat climate change; - Strategies to reduce emissions from agriculture (mitigation); - Strategies to cope with climate change phenomena (adaptation); - Scenarios of future climate and its impact on agriculture - Trade-offs of major mitigation / adaptation scenarios);<br>3. Seminar presentation on a selected climate change-related issue |

**Learning outcomes**

After a successful completion of the course, the students…
- understand and recognize ecological processes and interactions for agricultural production.
- are able to classify, interprete, compare and critically assess climate observations and trends.
- can summarize and explain observations using a case study example from their home country.

### 2. Prerequisites

| | |
|---|---|
| **obligatory** | |
| **recommended** | |
| **Maximum number of students** | 25 students |

### 3. Study program allocation

| Study program | Compulsory/ Elective | Semester |
|---|---|---|
| M.Sc. Agricultural Science and Resource Management in the Tropics and Subtropics (ARTS) | C | 1. |

### 4. Teaching and learning methodes

| Type of course | Interval | Topic | Language of instruction | Group size | SWS | Workload [h] | |
|---|---|---|---|---|---|---|---|
| | | | | | | Contact time | Self-study |
| L (blocked) | afternoon block | Ecological principles | English | 25 | 1,5 | 20,0 | 30,0 |
| T (blocked) | afternoon block | Observation in climate change | English | 25 | 1,5 | 20,0 | 30,0 |
| S (blocked) | afternoon block | Case study presentation | English | 25 | 1,0 | 20,0 | 60,0 |

| 5. Course cycle | 6. Workload [h] | 7. Duration | 8. Credits (ECTS) |
|---|---|---|---|
| WS | 180 | 1 | 6,0 |

| **Module Title: Ecological conditions and climate change** | | | | |
|---|---|---|---|---|
| **Module ID/Code:** ARTS-A01 [780750010] | | | | |
| **9. Requirements for the rewarding of credits (ECTS)** | | | | |
| **Types of Assessment** | **Prerequisites for admission to the Assessment** | **Graded yes/no** | **Language (exam)** | **Weighting factor** |
| Written exam [780750019] | | graded | English | 75% |
| Report (presentation) [780750018] | | graded | English | 25% |
| **Academic Achievements** | | | | |
| | | | | |
| **10. Module coordination** | | | | |
| **Module coordinator** | | | | |
| Dr. Janina Dierks | | | | |
| **Teaching person** | | | | |
| The teaching persons in the current semester can be found in basis: https://basis.uni-bonn.de/ | | | | |
| **Institute/ Department** | | | | |
| Agrar-, Forst- und Ernährungswissenschaften | | | | |
| **11. Further information** | | | | |
| | | | | |

## Module Title: Food security and sustainable food systems

**Module ID/Code:** ARTS-A06 [780763260]

### 1. Content and intended learning outcomes

| | |
|---|---|
| **Learning content:** | Students will learn to look at agriculture and nutrition through a food systems lens and understand synergies and tradeoffs between human health and planetary health goals. Concepts and measurement of food security, dietary quality, and the triple burden of malnutrition, as well as related policy interventions, will be discussed. Links between agriculture, biodiversity, climate change, diets, nutrition, and health will be analyzed from a global perspective and with empirical examples from low-, middle-, and high-income countries. Case studies will be used to evaluate specific food systems topics from a comprehensive sustainable development perspective. Case studies will include topics such as organic farming, GMOs, meat consumption, palm oil, nutrition-sensitive agriculture, and the supermarket revolution, among others. |

**Learning outcomes**

After a successful completion of the course, the students…
- are able to define key terms related to food security and sustainable diets.
- can explain how food systems relate to the various sustainable development goals (SDGs).
- can identify policy needs and analyze the sustainability implications of specific interventions.
- can evaluate the arguments in the public debate around sustainable agriculture and nutrition.
- can construct and use dietary surveys and nutrition assessment tools.

### 2. Prerequisites

| | |
|---|---|
| **obligatory** | |
| **recommended** | |
| **Maximum number of students** | |

### 3. Study program allocation

| Study program | Compulsory/ Elective | Semester |
|---|---|---|
| M.Sc. Agricultural and Food Economics | E | 3. |
| M.Sc. Agricultural Science and Resource Management in the Tropics and Subtropics (ARTS) | E | 3. |
| M.Sc. Nutrition Science | E | 3. |
| M.Sc. Molecular Food Technology | E | 3. |

### 4. Teaching and learning methodes

| Type of course | Interval | Topic | Language of instruction | Group size | SWS | Workload [h] | |
|---|---|---|---|---|---|---|---|
| | | | | | | Contact time | Self-study |
| L | during the semester | | English | 120 | 4,0 | 56,0 | 124,0 |

| 5. Course cycle | 6. Workload [h] | 7. Duration | 8. Credits (ECTS) |
|---|---|---|---|
| WS | 180 | 1 | 6,0 |

### 9. Requirements for the rewarding of credits (ECTS)

| Types of Assessment | Prerequisites for admission to the Assessment | Graded yes/no | Language (exam) | Weighting factor |
|---|---|---|---|---|
| Written exam [780763269] | | graded | English | |

**Academic Achievements**

| Module Title: Food security and sustainable food systems |
|---|
| **Module ID/Code:** ARTS-A06 [780763260] |
| **10. Module coordination** |
| **Module coordinator** |
| Prof. Dr. Matin Qaim |
| **Teaching person** |
| The teaching persons in the current semester can be found in basis:<br>https://basis.uni-bonn.de/ |
| **Institute/ Department** |
| Agrar-, Forst- und Ernährungswissenschaften |
| **11. Further information** |
| |

## Module Title: Conservation and use of genetic resources

**Module ID/Code:** ARTS-A03 [780750020]

### 1. Content and intended learning outcomes

| | |
|---|---|
| **Learning content:** | Genetic resources form an important basis of crop and livestock production. In this module, students are familiarized with the importance of genetic resources for agriculture, and with methods and approaches to conserve and utilize them. This includes insights into seed sciences, gene bank management, molecular genetics in plants and animals, and modern biotechnological approaches to characterize, utilize and maniputate genes and genomes. The module includes a seminar, in which students present non-graded talks related to the course topic. Participation in the seminar is a prerequisite for participation in the exam. |

**Learning outcomes**

After a successful completion of the course, the students…
- will know the basics of plant and animal genetics as relevant for agriculture.
- will know current methods of conserving and using genetic diversity for agriculture.
- will know state-of the art biotechnological approaches used in agiculture.
- will be able to critically judge, compare and justify different biotechnological approaches and their application in agriculture.
- will be able to integrate their knowledge of different genetic and biotechnological approaches to develop strategies of preserving and using genetic resources.

### 2. Prerequisites

| | |
|---|---|
| **obligatory** | |
| **recommended** | Knowledge of fundamental plant and animal biology |
| **Maximum number of students** | 40 students |

### 3. Study program allocation

| Study program | Compulsory/ Elective | Semester |
|---|---|---|
| M.Sc. Agricultural Science and Resource Management in the Tropics and Subtropics (ARTS) | C | 1. |

### 4. Teaching and learning methodes

| Type of course | Interval | Topic | Language of instruction | Group size | SWS | Workload [h] | |
|---|---|---|---|---|---|---|---|
| | | | | | | Contact time | Self-study |
| L (blocked) | afternoon block | | English | 40 | 3,0 | 40,0 | 80,0 |
| S* (blocked) | afternoon block | | English | 40 | 1,0 | 20,0 | 40,0 |

| 5. Course cycle | 6. Workload [h] | 7. Duration | 8. Credits (ECTS) |
|---|---|---|---|
| WS | 180 | 1 | 6,0 |

### 9. Requirements for the rewarding of credits (ECTS)

| Types of Assessment | Prerequisites for admission to the Assessment | Graded yes/no | Language (exam) | Weighting factor |
|---|---|---|---|---|
| Presentation [780750029] | | not graded | English | 0% |
| Written exam [780750028] | Participation in the seminar | graded | English | 100% |

**Academic Achievements**

| **Module Title: Conservation and use of genetic resources** |
|---|
| **Module ID/Code:** ARTS-A03 [780750020] |
| **10. Module coordination** |
| **Module coordinator** |
| Dr. Mariana Báez |
| **Teaching person** |
| The teaching persons in the current semester can be found in basis:<br>https://basis.uni-bonn.de/ |
| **Institute/ Department** |
| Agrar-, Forst- und Ernährungswissenschaften |
| **11. Further information** |
| |

## Module Title: Agricultural production systems

**Module ID/Code:** ARTS-A04 [780750030]

### 1. Content and intended learning outcomes

| | |
|---|---|
| **Learning content:** | Students aquire the know-how about the structure, use and effects of current plant and animal production systems in different environments of the (sub)tropics.<br><br>1. (sub)tropical plant production<br>Overview of production systems in different climatic zones including: field crops, vegetables, fruits, agro-forestry; - plant diseases and protection; - plant nutritional disorders and nutrient management; - energy value and use of plants; and - management of plant production systems; moelling of agricultural production systems.<br><br>2. (sub)tropical animal production systems<br>Animal production systems in different climatic zones and socio-economic environments including:<br>- breeding, nutrition, animal health, mechanization, differentiation and integration of production goals. |

**Learning outcomes**

After a successful completion of the course, the students…
- recognize different types of production systems.
- understand interactions between system components.

### 2. Prerequisites

| | |
|---|---|
| **obligatory** | |
| **recommended** | |
| **Maximum number of students** | 25 students |

### 3. Study program allocation

| Study program | Compulsory/ Elective | Semester |
|---|---|---|
| M.Sc. Agricultural Science and Resource Management in the Tropics and Subtropics (ARTS) | C | 1. |

### 4. Teaching and learning methodes

| Type of course | Interval | Topic | Language of instruction | Group size | SWS | Workload [h] | |
|---|---|---|---|---|---|---|---|
| | | | | | | Contact time | Self-study |
| L (blocked) | afternoon block | Crop production systems | English | 25 | 2,0 | 30,0 | 60,0 |
| L (blocked) | afternoon block | Animal production systems | English | 25 | 2,0 | 30,0 | 60,0 |

| 5. Course cycle | 6. Workload [h] | 7. Duration | 8. Credits (ECTS) |
|---|---|---|---|
| WS | 180 | 1 | 6,0 |

### 9. Requirements for the rewarding of credits (ECTS)

| Types of Assessment | Prerequisites for admission to the Assessment | Graded yes/no | Language (exam) | Weighting factor |
|---|---|---|---|---|
| Written exam [780750039] | | graded | English | |

**Academic Achievements**

| **Module Title: Agricultural production systems** |
|---|
| **Module ID/Code:** ARTS-A04 [780750030] |
| **10. Module coordination** |
| **Module coordinator** |
| Dr. Bibiana Betancur-Corredor |
| **Teaching person** |
| The teaching persons in the current semester can be found in basis:<br>https://basis.uni-bonn.de/ |
| **Institute/ Department** |
| Agrar-, Forst- und Ernährungswissenschaften |
| **11. Further information** |
| |

# Elective modules of the first semester (ARTS-A)

**Two modules (6 ECTS-CP) must be completed.**

## Module Title: Crop Physiology

**Module ID/Code:** ARTS-AM05a [780800050]

### 1. Content and intended learning outcomes

| | |
|---|---|
| **Learning content:** | Plant physiology is the analysis and causal explanation of live processes. The course will provide an update on the basics of plant physiology with an emphasis on physiological processes important for determination of crop yield. Specifically, this will include topics related to consumable parts of the plant and also physiological adaptations to stress situations. Through description of recent findings of new pathways and metabolic functions the course will emphasize that Crop Physiology integrates cell biology, biochemistry and molecular biology. |

**Learning outcomes**

After a successful completion of the course, the students…
- are able to describe key metabolic pathways.
- are able to explain how plants aquire ressources from the environment.
- are able to describe and explain physiological adaptations underlying the development of consumable parts.

### 2. Prerequisites

| | |
|---|---|
| **obligatory** | |
| **recommended** | |
| **Maximum number of students** | |

### 3. Study program allocation

| Study program | Compulsory/ Elective | Semester |
|---|---|---|
| M.Sc. Agricultural Science and Resource Management in the Tropics and Subtropics (ARTS) | E | 1. |
| M.Sc. Crop Sciences | C | 1. |
| M.Ed. Agricultural Science (Teacher's Training) | E | 1. |

### 4. Teaching and learning methodes

| Type of course | Interval | Topic | Language of instruction | Group size | SWS | Workload [h] | |
|---|---|---|---|---|---|---|---|
| | | | | | | Contact time | Self-study |
| L | during the semester | Crop Physiology | English | 120 | 2,0 | 30,0 | 60,0 |

| 5. Course cycle | 6. Workload [h] | 7. Duration | 8. Credits (ECTS) |
|---|---|---|---|
| WS | 90 | 1 | 3,0 |

### 9. Requirements for the rewarding of credits (ECTS)

| Types of Assessment | Prerequisites for admission to the Assessment | Graded yes/no | Language (exam) | Weighting factor |
|---|---|---|---|---|
| eKlausur 45 min [780800059] | | graded | English | |

**Academic Achievements**

### 10. Module coordination

**Module coordinator**

Prof. Dr. Andreas Meyer

**Teaching person**

The teaching persons in the current semester can be found in basis:
https://basis.uni-bonn.de/

**Institute/ Department**

Agrar-, Forst- und Ernährungswissenschaften

### 11. Further information

## Module Title: Crop Breeding Research

**Module ID/Code:** ARTS-AM05b [780800060]

### 1. Content and intended learning outcomes

| | |
|---|---|
| **Learning content:** | The aim of crop breeding is changing the traits of plants to produce desired characteristics. It makes use of a wide variety of methods, many based on knowledge from genetics and genomics. This lecture presents highlights from classical research and current topics and approaches. Topics include domestication, genetic variation, crop evolution, quantitative traits, phenotyping, molecular breeding tools, population genetics, genetic resources and the concept of germplasm, information management, mapping, QTL analysis, marker assisted selection, introgression, genotype-by-environment interactions, gene transfer, breeding informatics. |

**Learning outcomes**

After a successful completion of the course, the students…
- are able to explain the genetic basis of crop genetic resources.
- are able to discuss the relevance of crop traits in breeding programs.
- are able to explain and differentiate methods for breeding.
- are able to discuss the impact of modern approaches on breeding.

### 2. Prerequisites

| | |
|---|---|
| **obligatory** | |
| **recommended** | Module "Plant breeding" (B.Sc. Agrarwissenschaften) |
| **Maximum number of students** | |

### 3. Study program allocation

| Study program | Compulsory/ Elective | Semester |
|---|---|---|
| M.Sc. Agricultural Science and Resource Management in the Tropics and Subtropics (ARTS) | E | 1. |
| M.Sc. Crop Sciences | C | 1. |
| M.Ed. Agricultural Science (Teacher's Training) | E | 1. |

### 4. Teaching and learning methodes

| Type of course | Interval | Topic | Language of instruction | Group size | SWS | Workload [h] | |
|---|---|---|---|---|---|---|---|
| | | | | | | Contact time | Self-study |
| L | during the semester | Crop Genetics and Breeding | English | 120 | 2,0 | 30,0 | 60,0 |

| 5. Course cycle | 6. Workload [h] | 7. Duration | 8. Credits (ECTS) |
|---|---|---|---|
| WS | 90 | 1 | 3,0 |

### 9. Requirements for the rewarding of credits (ECTS)

| Types of Assessment | Prerequisites for admission to the Assessment | Graded yes/no | Language (exam) | Weighting factor |
|---|---|---|---|---|
| Written exam [780800069] | | graded | English | |

**Academic Achievements**

### 10. Module coordination

**Module coordinator**

Prof. Dr. Annaliese Mason

**Teaching person**

The teaching persons in the current semester can be found in basis:
https://basis.uni-bonn.de/

**Institute/ Department**

Agrar-, Forst- und Ernährungswissenschaften

### 11. Further information

## Module Title: Production ecology

**Module ID/Code:** ARTS-AS05a [780800040]

### 1. Content and intended learning outcomes

| | |
|---|---|
| **Learning content:** | This module focuses on the ecology of crops and cropping systems and is divided into two main parts. The first part deals with biotic interactions e.g. competition, compensation, facilitation, complementation, parasitism, herbivory, symbiotic relationships, and allelopathy. The second part builds on the understanding of these interactions for the design of sustainable cropping systems and concentrates on applications of ecological theory in cropping systems, such as in crop diversification, evolutionary plant breeding, optimal foraging theory in grasslands, and provision of ecosystem services. |

**Learning outcomes**

After a successful completion of the course, the students…
- reproduce the main aspects of biotic interactions and their underlying mechanisms in cropping systems.
- understand the components and complexity of ecological interactions in cropping systems with regard to biotic interactions.
- analyse and evaluate the potential of a diversified cropping system - e.g. as described in a scientific article - to protect resources.
- design a diversified cropping system based on ecological theories.

### 2. Prerequisites

| | |
|---|---|
| **obligatory** | |
| **recommended** | |
| **Maximum number of students** | |

### 3. Study program allocation

| Study program | Compulsory/ Elective | Semester |
|---|---|---|
| M.Sc. Agricultural Science and Resource Management in the Tropics and Subtropics (ARTS) | E | 1. |
| M.Sc. Crop Sciences | C | 1. |
| M.Ed. Agricultural Science (Teacher's Training) | E | 1. |

### 4. Teaching and learning methodes

| Type of course | Interval | Topic | Language of instruction | Group size | SWS | Workload [h] | |
|---|---|---|---|---|---|---|---|
| | | | | | | Contact time | Self-study |
| L | during the semester | Crop Ecology | English | 120 | 1,5 | 22,0 | 45,0 |
| T | during the semester | Cropping System Design II | English | 30 | 0,5 | 8,0 | 15,0 |

| 5. Course cycle | 6. Workload [h] | 7. Duration | 8. Credits (ECTS) |
|---|---|---|---|
| WS | 90 | 1 | 3,0 |

### 9. Requirements for the rewarding of credits (ECTS)

| Types of Assessment | Prerequisites for admission to the Assessment | Graded yes/no | Language (exam) | Weighting factor |
|---|---|---|---|---|
| eKlausur [780800047] | | graded | German and English | 75% |
| Project work [780800048] | | graded | English | 25% |

**Academic Achievements**

| Module Title: Production ecology |
| --- |
| **Module ID/Code:** ARTS-AS05a [780800040] |
| **10. Module coordination** |
| **Module coordinator** |
| Prof. Dr. Thomas Döring |
| **Teaching person** |
| The teaching persons in the current semester can be found in basis:<br>https://basis.uni-bonn.de/ |
| **Institute/ Department** |
| Agrar-, Forst- und Ernährungswissenschaften |
| **11. Further information** |
| |

## Module Title: Resource conservation

**Module ID/Code:** ARTS-AS05b [780800030]

### 1. Content and intended learning outcomes

| | |
|---|---|
| **Learning content:** | This module focuses on the resource conservation in cropping systems and is divided into two main parts. While the first part deal with abiotic interactions (e.g. with regard to water, crop nutrients, and CO2), the second part builds on the understanding of these interactions for the design of sustainable cropping systems. In the second part, the module concentrates on various applications for resource conservation nand the provision of ecosystem services, e.g. through irrigation, tillage, rotation design etc. |

**Learning outcomes**

After a successful completion of the course, the students…
- reproduce the main aspects of abiotic interactions and their underlying mechanisms in cropping systems.
- understand the components and complexity of abiotic interactions in cropping systems.
- analyse and evaluate the potential of a cropping system - e.g. as described in a scientific article - to protect resources.
- design a sustainable cropping system based on knowledge on resource conservation.

### 2. Prerequisites

| | |
|---|---|
| **obligatory** | |
| **recommended** | |
| **Maximum number of students** | |

### 3. Study program allocation

| Study program | Compulsory/ Elective | Semester |
|---|---|---|
| M.Sc. Agricultural Science and Resource Management in the Tropics and Subtropics (ARTS) | E | 1. |
| M.Sc. Crop Sciences | C | 1. |
| M.Ed. Agricultural Science (Teacher's Training) | E | 1. |

### 4. Teaching and learning methodes

| Type of course | Interval | Topic | Language of instruction | Group size | SWS | Workload [h] | |
|---|---|---|---|---|---|---|---|
| | | | | | | Contact time | Self-study |
| L | during the semester | Resource conservation | English | 120 | 1,5 | 22,0 | 45,0 |
| T | during the semester | Cropping system design I | English | 30 | 0,5 | 8,0 | 15,0 |

| 5. Course cycle | 6. Workload [h] | 7. Duration | 8. Credits (ECTS) |
|---|---|---|---|
| WS | 90 | 1 | 3,0 |

### 9. Requirements for the rewarding of credits (ECTS)

| Types of Assessment | Prerequisites for admission to the Assessment | Graded yes/no | Language (exam) | Weighting factor |
|---|---|---|---|---|
| eKlausur [780800037] | | graded | German and English | 75% |
| Project work [780800038] | | graded | English | 25% |

**Academic Achievements**

| Module Title: Resource conservation |
| --- |
| **Module ID/Code:** ARTS-AS05b [780800030] |
| **10. Module coordination** |
| **Module coordinator** |
| Prof. Dr. Thomas Döring |
| **Teaching person** |
| The teaching persons in the current semester can be found in basis:<br>https://basis.uni-bonn.de/ |
| **Institute/ Department** |
| Agrar-, Forst- und Ernährungswissenschaften |
| **11. Further information** |
| |

# Elective modules of the second and third semester (ARTS-B) - System approaches

**You can choose 18-30 ECTS-CP from the elective modules.**
**The specialisation System approaches is only awarded if 24 ECTS-CP from this specialisation are completed.**

## Module Title: Soil resources of the world

**Module ID/Code:** ARTS-BS01 [780790230]

### 1. Content and intended learning outcomes

| | |
|---|---|
| **Learning content:** | In this course students will be introduced to the major soils of the world, their classification, genesis, land-use options, and associated risks.<br>The course is structured in<br>- Lecture + seminar on major soil types according to World Reference Base of Soil Resources (WRB) classification, principles of their genesis, major properties and land-use options. The course provides advanced knowledge on specific processes associated with different soils relevant for global element cycles or food security.<br>- Practical courses: Here the students learn how to classify soils according to WRB and Soil Taxonomy on the basis of analytical data sheets, photographs and/or archived soil monoliths and/or field sites in Western Germany with relicts of tropical soils |

**Learning outcomes**

After a successful completion of the course, the students…
- can describe the major soil properties and classification of soil types occuring around the globe.
- can compare soils according to their potential use for agricultural production.
- can identify risks associated with different types of land-use on these soils.
- can demonstrate soil classification procedures for the major reference groups.

### 2. Prerequisites

| | |
|---|---|
| **obligatory** | |
| **recommended** | ARTS-A01, A02, A03, A04, AS05a and AS05b |
| **Maximum number of students** | 25 students |

### 3. Study program allocation

| Study program | Compulsory/ Elective | Semester |
|---|---|---|
| M.Sc. Agricultural Science and Resource Management in the Tropics and Subtropics (ARTS) | E | 2. |
| M.Sc. Nature Conservation and Landscape Ecology | E | 2. |
| M.Sc. Crop Sciences | E Focus PERC | 2. |

### 4. Teaching and learning methodes

| Type of course | Interval | Topic | Language of instruction | Group size | SWS | Workload [h] | |
|---|---|---|---|---|---|---|---|
| | | | | | | Contact time | Self-study |
| L | during the semester | Soils of the world | English | 25 | 1,5 | 15,0 | 45,0 |
| S* | during the semester | Soil management around the world | English | 25 | 1,0 | 10,0 | 40,0 |
| P* (blocked) | full-day block | Soil classification | English | 25 | 2,0 | 30,0 | 40,0 |

| 5. Course cycle | 6. Workload [h] | 7. Duration | 8. Credits (ECTS) |
|---|---|---|---|
| SS | 180 | 1 | 6,0 |

### 9. Requirements for the rewarding of credits (ECTS)

| Types of Assessment | Prerequisites for admission to the Assessment | Graded yes/no | Language (exam) | Weighting factor |
|---|---|---|---|---|
| Written exam [780790239] | Presentation in the seminar, regular attendance | graded | English | |

**Academic Achievements**

| **Module Title: Soil resources of the world** |
|---|
| **Module ID/Code:** ARTS-BS01 [780790230] |
| **10. Module coordination** |
| **Module coordinator** |
| Dr. Sara Bauke |
| **Teaching person** |
| The teaching persons in the current semester can be found in basis:<br>https://basis.uni-bonn.de/ |
| **Institute/ Department** |
| Agrar-, Forst- und Ernährungswissenschaften |
| **11. Further information** |
| Zech, W., Hintermeier-Erhard, G., Schad P (eds). 2020. Soils of the world. Springer- Verlag, 190 pages |

## Module Title: Crop ecology, water management and bioclimatology

**Module ID/Code:** ARTS-BS02 [780800210]

### 1. Content and intended learning outcomes

| | |
|---|---|
| **Learning content:** | Students acquire in-depth knowledge on the principles of water management and bioclimatology, and on how crop interacts with climate and water. The understanding of processes will enable them to analyze the implications of changing environmental conditions on water management and crop production. In addition, they will be able to apply agro-meteorological methods to determine crop responses. Finally, ecological attributes of crops with major economic importance will be discussed, allowing students to define social-ecological niche environments for major crop production and water management strategies.<br>Contents comprise:<br>General principles on water management.<br>Strategies and implications of water management incl. model applications;<br>Methods & application of bioclimatology in agro-ecosystems;<br>Ecological requirements of major crop types and species;<br>Effects of temperature, precipitation, humidity, radiation, day length and wind on microclimates of non-uniform terrain, and crop responses;<br>Crop adaptation strategies to changing ecological conditions;<br>Case study examples |

**Learning outcomes**

After a successful completion of the course, the students…
- understand key concepts and implications of bioclimatology.
- can apply concepts of water management.
- have aquired the skills to unterstand water models can be used to analyze water demand.
- can relate botanical attributes to ecological requirements of crops.
- can evaluate interactions between climate, management attributes and land use systems.

### 2. Prerequisites

| | |
|---|---|
| **obligatory** | |
| **recommended** | ARTS-A01, A02, A03, A04, AS05a and AS05b |
| **Maximum number of students** | 25 students |

### 3. Study program allocation

| Study program | Compulsory/ Elective | Semester |
|---|---|---|
| M.Sc. Agricultural Science and Resource Management in the Tropics and Subtropics (ARTS) | E | 2. |
| M.Sc. Crop Sciences | E Focus PERC | 2. |

### 4. Teaching and learning methodes

| Type of course | Interval | Topic | Language of instruction | Group size | SWS | Workload [h] | |
|---|---|---|---|---|---|---|---|
| | | | | | | Contact time | Self-study |
| L (blocked) | afternoon block | Bioclimatology, water management and crop ecology | English | 25 | 2,4 | 30,0 | 90,0 |
| S (blocked) | afternoon block | Practical and applied cases on water management, crop ecology and bioclimatology | English | 25 | 1,0 | 10,0 | 40,0 |
| E (blocked) | full-day block | Visit to the International Centre for Water Resources and Global Change (UNESCO), Koblenz | English | 25 | 0,6 | 5,0 | 5,0 |

| 5. Course cycle | 6. Workload [h] | 7. Duration | 8. Credits (ECTS) |
|---|---|---|---|
| SS | 180 | 1 | 6,0 |

| **Module Title: Crop ecology, water management and bioclimatology** | | | | |
|---|---|---|---|---|
| **Module ID/Code:** ARTS-BS02 [780800210] | | | | |
| **9. Requirements for the rewarding of credits (ECTS)** | | | | |
| **Types of Assessment** | **Prerequisites for admission to the Assessment** | **Graded yes/no** | **Language (exam)** | **Weighting factor** |
| Term paper [780800219] | | graded | English | 70% |
| Presentation [780800218] | | graded | English | 30% |
| **Academic Achievements** | | | | |
| | | | | |
| **10. Module coordination** | | | | |
| **Module coordinator** | | | | |
| Prof. Dr. Ana Meijide | | | | |
| **Teaching person** | | | | |
| The teaching persons in the current semester can be found in basis: https://basis.uni-bonn.de/ | | | | |
| **Institute/ Department** | | | | |
| Agrar-, Forst- und Ernährungswissenschaften | | | | |
| **11. Further information** | | | | |
| | | | | |

## Module Title: Land use systems in the tropics and subtropics

**Module ID/Code:** ARTS-BS03 [780750040]

### 1. Content and intended learning outcomes

| | |
|---|---|
| **Learning content:** | Acquire knowledge about land use systems and implications of different land uses on ecosystem services.<br>Understand the attributes and functioning of major tropical production systems and social-ecological interactions.<br>Contents:<br>- Diversity of land use systems<br>- Ecosystem services, threats to biodiversity and conservation practices<br>- Species interactions and adaptation stragegies in different land uses<br>- Attributes and managment in dryland, wetland and forest use systems<br>- Human development and environment policy effects on land use<br>Seminar presentations of case studies and of innovative interventions in traditional land-use systems to improve their sustainability are elaborated and presented by students and findings are discussed |

**Learning outcomes**

After a successful completion of the course, the students…
- understand implications of land use on ecosystem services and threats to biodiversity.
- understand key attributes of major production system types and their interactions with management.
- can apply concepts of ecosystem services and adapted land use practices to case study examples.
- can analyze production and land use systems for developing sustainable alternatives to current land use.
- are sensitized to and can independetly develop sustainable alternatives to traditional land use in the tropics and sub-tropics.
- can apply concepts of conservation agriculture or restoration ecology to case study examples.

### 2. Prerequisites

| | |
|---|---|
| **obligatory** | |
| **recommended** | ARTS-A01, A02, A03, A04, AM05a and AM05b |
| **Maximum number of students** | 25 students |

### 3. Study program allocation

| **Study program** | **Compulsory/ Elective** | **Semester** |
|---|---|---|
| M.Sc. Agricultural Science and Resource Management in the Tropics and Subtropics (ARTS) | E | 2. |

### 4. Teaching and learning methodes

| **Type of course** | **Interval** | **Topic** | **Language of instruction** | **Group size** | **SWS** | **Workload [h]** | |
|---|---|---|---|---|---|---|---|
| | | | | | | **Contact time** | **Self-study** |
| L (blocked) | afternoon block | Land use and production systems | English | 25 | 2,0 | 20,0 | 40,0 |
| T (blocked) | afternoon block | Concepts of conservation / restoration and ecosystem services | English | 25 | 1,5 | 20,0 | 40,0 |
| S (blocked) | afternoon block | Synthesize knowledge on special land use systems | English | 25 | 0,5 | 5,0 | 55,0 |

| **5. Course cycle** | **6. Workload [h]** | **7. Duration** | **8. Credits (ECTS)** |
|---|---|---|---|
| SS | 180 | 1 | 6,0 |

### 9. Requirements for the rewarding of credits (ECTS)

| **Types of Assessment** | **Prerequisites for admission to the Assessment** | **Graded yes/no** | **Language (exam)** | **Weighting factor** |
|---|---|---|---|---|
| Term paper [780750049] | | graded | English | 70% |
| Presentation [780750048] | | graded | English | 30% |

**Academic Achievements**

| Module Title: Land use systems in the tropics and subtropics |
|---|
| **Module ID/Code:** ARTS-BS03 [780750040] |
| **10. Module coordination** |
| **Module coordinator** |
| Jun.-Prof. Dr. Lisa Biber-Freudenberger |
| **Teaching person** |
| The teaching persons in the current semester can be found in basis:<br>https://basis.uni-bonn.de/ |
| **Institute/ Department** |
| |
| **11. Further information** |
| |

## Module Title: Animal production systems in the tropics

**Module ID/Code:** ARTS-BS04 [780810170]

### 1. Content and intended learning outcomes

| | |
|---|---|
| **Learning content:** | The students will be provided with lectures on<br>- animal (Cattle, sheep, goat, bufallo and poultry) production systems in trpical climate<br>- association between production system, species distribution and climate zones<br>- challenges of animal production system in various climatic zones |

**Learning outcomes**

After a successful completion of the course, the students…
- can classify and understand animal production systems in the tropics and subtropics.
- are able to characterize challenges of animal production systems in tropical climate.

### 2. Prerequisites

| | |
|---|---|
| **obligatory** | |
| **recommended** | ARTS-A01, A02, A03, A04, AM05a and AM05b |
| **Maximum number of students** | 25 students |

### 3. Study program allocation

| Study program | Compulsory/ Elective | Semester |
|---|---|---|
| M.Sc. Agricultural Science and Resource Management in the Tropics and Subtropics (ARTS) | E | 2. |
| M.Sc. Animal Science | E | 2. |

### 4. Teaching and learning methodes

| Type of course | Interval | Topic | Language of instruction | Group size | SWS | Workload [h] | |
|---|---|---|---|---|---|---|---|
| | | | | | | Contact time | Self-study |
| L (blocked) | afternoon block | Animal production systems in the tropics | English | 25 | 2,0 | 30,0 | 60,0 |

| 5. Course cycle | 6. Workload [h] | 7. Duration | 8. Credits (ECTS) |
|---|---|---|---|
| SS | 180 | 1 | 6,0 |

### 9. Requirements for the rewarding of credits (ECTS)

| Types of Assessment | Prerequisites for admission to the Assessment | Graded yes/no | Language (exam) | Weighting factor |
|---|---|---|---|---|
| Written exam [780810179] | | graded | English | |

**Academic Achievements**

### 10. Module coordination

**Module coordinator**

Prof. Dr. Thomas Hartinger

**Teaching person**

The teaching persons in the current semester can be found in basis:
https://basis.uni-bonn.de/

**Institute/ Department**

Agrar-, Forst- und Ernährungswissenschaften

### 11. Further information

## Module Title: Element cycles in tropical agroecosystems

**Module ID/Code:** ARTS-BS05 [780800180]

### 1. Content and intended learning outcomes

| | |
|---|---|
| **Learning content:** | Students get acquainted with the principles and processes of element transformation in (sub)tropical environments, including the management of organic waste and other secondary raw materials. Students are exposed to project-related research work, team-oriented work, holistic thinking and the comprehension of abstract relationships and complex interactions. Contents include:<br>Pools, fluxes and transformation processes of major elements (water, C, N, P, S) in tropical environments.<br>Ecological conditions and implications for the nutrition of tropical crops.<br>Waste treatment and treatment technologies (composting, anaerobic digestion) and use of organic waste as fertilizer. Use and potential of staple isotopes.<br><br>He will be able to assess and analyze the availability of major (nutrient)elements in a range of environments and to determine the quantity and quality of organic matter and various secondary raw materials. Finally the students will be able to apply their knowledge to plan intervention strategies for improved crop plant nutrition in environments with variable ecological conditions. |

**Learning outcomes**

After a successful completion of the course, the students…
- are able to assess and analyze the availability of major (nutrient)elements in a range of environments.
- are able to determine the quantity and quality of organic matter and various secondary raw materials.
- are able to plan intervention strategies for improved crop plant nutrition in environments with variable ecological conditions.
- are able to synthesize secondary information on topics related to element cycles in the form of a seminar presentation.

### 2. Prerequisites

| | |
|---|---|
| **obligatory** | |
| **recommended** | ARTS-A01, A02, A03, A04, AS05a and AS05b |
| **Maximum number of students** | 25 students |

### 3. Study program allocation

| **Study program** | **Compulsory/ Elective** | **Semester** |
|---|---|---|
| M.Sc. Agricultural Science and Resource Management in the Tropics and Subtropics (ARTS) | E | 2. |
| M.Sc. Crop Sciences | E Focus PERC | 2. |

### 4. Teaching and learning methodes

| **Type of course** | **Interval** | **Topic** | **Language of instruction** | **Group size** | **SWS** | **Workload [h]** | |
|---|---|---|---|---|---|---|---|
| | | | | | | **Contact time** | **Self-study** |
| L (blocked) | afternoon block | Element cycle lectures | English | 25 | 2,5 | 40,0 | 50,0 |
| S (blocked) | afternoon block | Case studies | English | 25 | 1,5 | 10,0 | 80,0 |

| **5. Course cycle** | **6. Workload [h]** | **7. Duration** | **8. Credits (ECTS)** |
|---|---|---|---|
| SS | 180 | 1 | 6,0 |

### 9. Requirements for the rewarding of credits (ECTS)

| **Types of Assessment** | **Prerequisites for admission to the Assessment** | **Graded yes/no** | **Language (exam)** | **Weighting factor** |
|---|---|---|---|---|
| Report (presentation) [780800189] | | graded | English | |

**Academic Achievements**

| **Module Title: Element cycles in tropical agroecosystems** |
|---|
| **Module ID/Code:** ARTS-BS05 [780800180] |
| **10. Module coordination** |
| **Module coordinator** |
| Dr. Janina Dierks |
| **Teaching person** |
| The teaching persons in the current semester can be found in basis:<br>https://basis.uni-bonn.de/ |
| **Institute/ Department** |
| Agrar-, Forst- und Ernährungswissenschaften |
| **11. Further information** |
| |

## Module Title: Organic Agriculture in the Tropics and Subtropics

**Module ID/Code:** ARTS-BS06 [780800130]

### 1. Content and intended learning outcomes

| | |
|---|---|
| **Learning content:** | The module gives an insight in organic farming sytems mainly under tropical conditions with a special focus on important permanent cash crops. Contents include:<br>Approaches in Organic Agriculture research; development and assessment of sustainable production systems; ecological effects of inappropriate land use; soil fertility management; rotation design, performance of leguminous crops and BNF, agroforestry, alley cropping, ecological challenges in tropical agriculture; organic agriculture and world nutrition; a focus of the module lies on cropping systems and techniques of important crops such as rice, sugar cane, cotton, coffee, cocoa, citrus, vegetables and fruits. |

**Learning outcomes**

After a successful completion of the course, the students…
- have extensive knowlegde on challenges of tropical agriculture.
- understand the principles of field trial design and management.
- are able to give a scientific presentation in english language.
- are able to analysise cropping systems from an agronomic and ecological perspective.

### 2. Prerequisites

| | |
|---|---|
| **obligatory** | |
| **recommended** | |
| **Maximum number of students** | |

### 3. Study program allocation

| Study program | Compulsory/ Elective | Semester |
|---|---|---|
| M.Sc. Agricultural Science and Resource Management in the Tropics and Subtropics (ARTS) | E | 3. |
| M.Sc. Crop Sciences | E Focus PERC | 3. |

### 4. Teaching and learning methodes

| Type of course | Interval | Topic | Language of instruction | Group size | SWS | Workload [h] | |
|---|---|---|---|---|---|---|---|
| | | | | | | Contact time | Self-study |
| L | during the semester | Organic Agriculture in the Tropics and Subtropics | English | 80 | 2,0 | 30,0 | 60,0 |
| S | during the semester | Selected aspects of tropical organic agriculture | English | 20 | 2,0 | 30,0 | 60,0 |

| 5. Course cycle | 6. Workload [h] | 7. Duration | 8. Credits (ECTS) |
|---|---|---|---|
| WS | 180 | 1 | 6,0 |

### 9. Requirements for the rewarding of credits (ECTS)

| Types of Assessment | Prerequisites for admission to the Assessment | Graded yes/no | Language (exam) | Weighting factor |
|---|---|---|---|---|
| Written exam [780800139] | | graded | English | |

**Academic Achievements**

### 10. Module coordination

**Module coordinator**

Dr. Daniel Neuhoff

**Teaching person**

The teaching persons in the current semester can be found in basis:
https://basis.uni-bonn.de/

**Institute/ Department**

Agrar-, Forst- und Ernährungswissenschaften

### 11. Further information

## Module Title: Crop and Ecosystem Analysis and Modelling

**Module ID/Code:** ARTS-BS07 [780790290]

### 1. Content and intended learning outcomes

**Learning content:**

The content of the module can be summarized by the following headings
- Systems theory and methods of systems analysis
- Types of models
- Conceptualizing of crops or ecosystems systems
- Mathematical formulation of relationships (including practical exercises)
- Implementation of mathematical algorithms (including practical exercises)
- Methods of model calibration and parameterisation
- Sensitivity and uncertainty analysis
- Model verification, validation and evaluation

Students learn to analyse and model crops and ecosystems. Important relationships determining crop and ecosystem responses to environmental conditions and how these can be modeled will be understood. Students obtain basic knowledge in mathematical (mainly numerical) modeling and apply these to develop models for selected crop and ecosystem processes. They also learn to apply models to solve practical problems.

**Learning outcomes**

After a successful completion of the course, the students…
- can distinguish different types of systems and models and can give examples.
- are able to construct simple models of cropping systems based on defined assumptions.
- are able to apply dynamic simulation models.
- understand the principles of dynamic modelling.
- are able to use dynamic models for analysing crops and ecosystems.

### 2. Prerequisites

| | |
|---|---|
| **obligatory** | |
| **recommended** | Modul "Pflanzenbau" (B.Sc. Agrarwissenschaften) |
| **Maximum number of students** | 30 students |

### 3. Study program allocation

| Study program | Compulsory/ Elective | Semester |
|---|---|---|
| M.Sc. Agricultural Science and Resource Management in the Tropics and Subtropics (ARTS) | E | 2. |
| M.Sc. Nature Conservation and Landscape Ecology | E | 2. |
| M.Sc. Crop Sciences | E Focus PERC | 2. |

### 4. Teaching and learning methodes

| Type of course | Interval | Topic | Language of instruction | Group size | SWS | Workload [h] | |
|---|---|---|---|---|---|---|---|
| | | | | | | Contact time | Self-study |
| L | during the semester | | English | 30 | 2,0 | 30,0 | 60,0 |
| pT | during the semester | | English | 30 | 2,0 | 30,0 | 60,0 |

| 5. Course cycle | 6. Workload [h] | 7. Duration | 8. Credits (ECTS) |
|---|---|---|---|
| SS | 180 | 1 | 6,0 |

| **Module Title: Crop and Ecosystem Analysis and Modelling** | | | | |
|---|---|---|---|---|
| **Module ID/Code:** ARTS-BS07 [780790290] | | | | |
| **9. Requirements for the rewarding of credits (ECTS)** | | | | |
| **Types of Assessment** | **Prerequisites for admission to the Assessment** | **Graded yes/no** | **Language (exam)** | **Weighting factor** |
| Presentation [780790299] | | graded | English | 50% |
| Report [780790298] | | graded | English | 50% |
| **Academic Achievements** | | | | |
| | | | | |
| **10. Module coordination** | | | | |
| **Module coordinator** | | | | |
| Dr. Thomas Gaiser | | | | |
| **Teaching person** | | | | |
| The teaching persons in the current semester can be found in basis: https://basis.uni-bonn.de/ | | | | |
| **Institute/ Department** | | | | |
| | | | | |
| **11. Further information** | | | | |
| | | | | |

## Module Title: Horticultural Production and Research

**Module ID/Code:** ARTS-BS08 [780800120]

### 1. Content and intended learning outcomes

| | |
|---|---|
| **Learning content:** | - Overview of major horticultural production systems, in regional and global contexts<br>- Overview of horticultural value chains<br>- In-depth discussion of selected critical issues in horticultural production<br>- Horticultural approaches to agricultural development<br>- Sustainability concerns in horticulture<br>- Climate change and its impacts on horticulture<br>- Horticultural modeling<br>- Critical discussion of horticultural literature<br>- Literature search, scientific writing and presenting |

**Learning outcomes**

After a successful completion of the course, the students…
- will be able to critically interpret horticultural literature.
- will be able to explain how major horticultural commodities are produced and provide examples of various production systems.
- will be able to analyze horticultural production systems and identify strengths and weaknesses.
- will be able to assess horticultural literature and provide a balanced and logically rigorous evaluation.
- will be able to compose a scientifically rigorous paper on selected topics, based on extensive analysis of published sources.

### 2. Prerequisites

| | |
|---|---|
| **obligatory** | |
| **recommended** | Modul "Gartenbauliche Kulturen" (B.Sc. Agrarwissenschaften) |
| **Maximum number of students** | 50 students |

### 3. Study program allocation

| Study program | Compulsory/ Elective | Semester |
|---|---|---|
| M.Sc. Agricultural Science and Resource Management in the Tropics and Subtropics (ARTS) | E | 3. |
| M.Sc. Crop Sciences | E Focus PERC | 3. |
| M.Ed. Agricultural Science (Teacher's Training) | E | 3. |

### 4. Teaching and learning methodes

| Type of course | Interval | Topic | Language of instruction | Group size | SWS | Workload [h] | |
|---|---|---|---|---|---|---|---|
| | | | | | | Contact time | Self-study |
| L | during the semester | Horticultural Production and Research | English | 50 | 1,0 | 15,0 | 20,0 |
| S | during the semester | Horticultural literature study | English | 10 | 3,0 | 45,0 | 100,0 |

| 5. Course cycle | 6. Workload [h] | 7. Duration | 8. Credits (ECTS) |
|---|---|---|---|
| WS | 180 | 1 | 6,0 |

### 9. Requirements for the rewarding of credits (ECTS)

| Types of Assessment | Prerequisites for admission to the Assessment | Graded yes/no | Language (exam) | Weighting factor |
|---|---|---|---|---|
| Presentation [780800129] | | graded | English | 20% |
| Term paper [780800128] | | graded | English | 40% |
| Assignment [780800127] | | graded | English | 40% |

**Academic Achievements**

| **Module Title: Horticultural Production and Research** |
|---|
| **Module ID/Code:** ARTS-BS08 [780800120] |
| **10. Module coordination** |
| **Module coordinator** |
| Prof. Dr. Eike Lüdeling |
| **Teaching person** |
| The teaching persons in the current semester can be found in basis:<br>https://basis.uni-bonn.de/ |
| **Institute/ Department** |
| Agrar-, Forst- und Ernährungswissenschaften |
| **11. Further information** |
| Baudoin et al., 2013: Good Agricultural Practices for greenhouse vegetable crops - Principles for Mediterranean climate areas. FAO (http://www.fao.org/3/a-i3284e.pdf)<br>Baudoin et al., 2017: Good Agricultural Practices for greenhouse vegetable production in the South East European countries. FAO (http://www.fao.org/3/a-i6787e.pdf)<br>Dixon & Aldous, 2014: Horticulture: Plants for People and Places (Vol. 1-3). Springer<br>Marcelis & Heuvelink, 2019: Achieving sustainable greenhouse cultivation. Burleigh Dodds<br>Taiz & Zeiger, 2006: Plant Physiology, das Original mit Übersetzungshilfen, Spektrum Akademischer Verlag<br>Tromp et al. (Eds.), 2005: Fundamentals of Temperate Zone Tree Fruit Production. Backhuys Publishers<br>von Zabeltitz, 2011. Integrated Greenhouse Systems for Mild Climates. Springer |

## Module Title: Irrigation agriculture

**Module ID/Code:** ARTS-BS09 [780790430]

### 1. Content and intended learning outcomes

| | |
|---|---|
| **Learning content:** | In this course students will be introduced to agricultural irrigation in Germany and worldwide. The course is structured in lectures, practical courses in the fields and the laboratories at the Campus Poppelsdorf and one excursion of half a day to a farm or company irrigating crops.<br>The lectures provide advanced knowledge on (i) the extent and significance of irrigation in agriculture, (ii) when crops have to be irrigated and how to estimate the irrigation water demand, and (iii) which technical devices are supportive for irrigation.<br>In the practical courses the students learn how relevant measurement devices work (e.g. to measure soil water content or stomatal conductance) and how to use them. |

**Learning outcomes**

After a successful completion of the course, the students…
- can describe the importance of irrigated agriculture around the globe.
- can estimate the irrigation water demand for agricultural production.
- understand and can use several devices that allow measuring the soil or plant water status.

### 2. Prerequisites

| | |
|---|---|
| **obligatory** | |
| **recommended** | Production ecology; Resource conservation; Crop Physiology; Crop ecology, water management and bioclimatology |
| **Maximum number of students** | 20 students |

### 3. Study program allocation

| Study program | Compulsory/ Elective | Semester |
|---|---|---|
| M.Sc. Agricultural Science and Resource Management in the Tropics and Subtropics (ARTS) | E | 2. |
| M.Sc. Nature Conservation and Landscape Ecology | O | 2. |
| M.Sc. Crop Sciences | E Focus PERC | 2. |

### 4. Teaching and learning methodes

| Type of course | Interval | Topic | Language of instruction | Group size | SWS | Workload [h] | |
|---|---|---|---|---|---|---|---|
| | | | | | | Contact time | Self-study |
| L | during the semester | lecture on irrigation agriculture | English | 20 | 1,0 | 15,0 | 35,0 |
| pT | during the semester | usage of measurement devices | English | 20 | 0,7 | 10,0 | 25,0 |
| E | during the semester | half-day excursion to a farm or irrigation company | English | 20 | 0,3 | 4,0 | 1,0 |

| 5. Course cycle | 6. Workload [h] | 7. Duration | 8. Credits (ECTS) |
|---|---|---|---|
| SS | 90 | 1 | 3,0 |

### 9. Requirements for the rewarding of credits (ECTS)

| Types of Assessment | Prerequisites for admission to the Assessment | Graded yes/no | Language (exam) | Weighting factor |
|---|---|---|---|---|
| Oral exam [780790439] | | graded | English | |

**Academic Achievements**

| **Module Title: Irrigation agriculture** |
|---|
| **Module ID/Code:** ARTS-BS09 [780790430] |
| **10. Module coordination** |
| **Module coordinator** |
| Dr. Sabine Seidel |
| **Teaching person** |
| The teaching persons in the current semester can be found in basis:<br>https://basis.uni-bonn.de/ |
| **Institute/ Department** |
| Agrar-, Forst- und Ernährungswissenschaften |
| **11. Further information** |
| |

## Module Title: Simulation of Agricultural and Biological Systems

**Module ID/Code:** ARTS-BS10 [780750090]

### 1. Content and intended learning outcomes

| | |
|---|---|
| **Learning content:** | The course focuses on the principles, tools and practice of working with crop models (and more generally system models). The course begins by teaching two basic tools; the R programming language, which will be used throughout the course, and statistical notions for system modeling. Also a simple crop model from the literature (appropriately named SIMPLE) is presented in detail and discussed. This illustrates the nature of dynamic system models, and is the basis for discussing some basic processes of plant growth and development. Importantly, the model includes effects of CO2 level. Then three essential methods of working with dynamic models are considered in detail; uncertainty and sensitivity analysis, model calibration and model evaluation. Throughout the course, the SIMPLE model, programmed in R, will be used as an example and for exercises. The textbook is "Working with Dynamic Crop Models", of which D. Wallach is first author. |

**Learning outcomes**

After a successful completion of the course, the students…
- will be able to understand existing crop models
- will be capable of calibrating and doing sensitivity analysis for crop models
- will be capable of evaluating crop model performance

### 2. Prerequisites

| | |
|---|---|
| **obligatory** | |
| **recommended** | Module "Crop and Ecosystem analysis and Modelling" |
| **Maximum number of students** | 20 students |

### 3. Study program allocation

| Study program | Compulsory/ Elective | Semester |
|---|---|---|
| M.Sc. Agricultural Science and Resource Management in the Tropics and Subtropics (ARTS) | E | 3. |
| M.Sc. Crop Sciences | E Focus PERC | 3. |

### 4. Teaching and learning methodes

| Type of course | Interval | Topic | Language of instruction | Group size | SWS | Workload [h] | |
|---|---|---|---|---|---|---|---|
| | | | | | | Contact time | Self-study |
| L | during the semester | Dynamic system models, principles and methods | English | 20 | 2,0 | 30,0 | 60,0 |
| T | during the semester | Application of methods using R | English | 20 | 2,0 | 30,0 | 60,0 |

| 5. Course cycle | 6. Workload [h] | 7. Duration | 8. Credits (ECTS) |
|---|---|---|---|
| WS | 180 | 1 | 6,0 |

### 9. Requirements for the rewarding of credits (ECTS)

| Types of Assessment | Prerequisites for admission to the Assessment | Graded yes/no | Language (exam) | Weighting factor |
|---|---|---|---|---|
| Written exam [780750099] | | graded | English | |

**Academic Achievements**

| **Module Title: Simulation of Agricultural and Biological Systems** |
|---|
| **Module ID/Code:** ARTS-BS10 [780750090] |
| **10. Module coordination** |
| **Module coordinator** |
| Dr. Sabine Seidel |
| **Teaching person** |
| The teaching persons in the current semester can be found in basis:<br>https://basis.uni-bonn.de/ |
| **Institute/ Department** |
| Agrar-, Forst- und Ernährungswissenschaften |
| **11. Further information** |
| |

## Module Title: Spatial ecology and conservation biology

**Module ID/Code:** NPW-055 [780800550]

### 1. Content and intended learning outcomes

| | |
|---|---|
| **Learning content:** | Students will learn the basic principles of conservation biology, with a special focus on applications related to spatial ecology and management of natural resources (including those in agroecosystems). The course will cover the goals of conservation, elaborating on the main current threats to biodiversity (e.g. land-use change, habitat loss, climate change, invasive species, etc.), the units of conservation (e.g. genes, populations, species, habitats, ecosystem services, etc.), and the existing conservation measures (e.g. agri-environment schemes, protected areas, etc.) and their evaluation. Students will learn about the biological basis of conservation, including insights from spatial ecology of populations and species. Practical conservation issues, such as how to select areas for conservation, the role of indicator/flagship species in conservation, restoration and rewilding programmes, will be critically discussed. The course will include a practical exercise using spatial data and spatial prioritization softwares on personal laptops. |

**Learning outcomes**

After a successful completion of the course, the students…
- learn key concepts in conservation biology and current pressing threats to biodiversity.
- learn on the different units of conservation, and different spatial scales at which conservation measures act.
- understand the basic principles of spatial ecology and the features of spatial data.
- understand how to evaluate the effectiveness of conservation measures.
- apply basic (spatial) ecology concepts to propose solutions to practical conservation problems.
- present and critically discuss recent published articles in the field of conservation biology and spatial ecology.

### 2. Prerequisites

| | |
|---|---|
| **obligatory** | none |
| **recommended** | Basic knowledge of spatial data/softwares (e.g. ArcGIS, QGIS) is desirable. |
| **Maximum number of students** | 20 students |

### 3. Study program allocation

| Study program | Compulsory/ Elective | Semester |
|---|---|---|
| M.Sc. Agricultural Science and Resource Management in the Tropics and Subtropics (ARTS) | E | 1./3. |
| M.Sc. Nature Conservation and Landscape Ecology | E | 1./3. |
| M.Sc. Crop Sciences | E Focus PERC | 1./3. |

### 4. Teaching and learning methodes

| Type of course | Interval | Topic | Language of instruction | Group size | SWS | Workload [h] | |
|---|---|---|---|---|---|---|---|
| | | | | | | Contact time | Self-study |
| L | during the semester | Theory of spatial ecology and conservation biology | English | 20 | 1,0 | 14,0 | 20,0 |
| S* | during the semester | Presentation and discussion of journal articles | English | 20 | 1,0 | 14,0 | 40,0 |
| pT* | during the semester | Practical exercise with laptop | | 20 | 2,0 | 28,0 | 64,0 |

| 5. Course cycle | 6. Workload [h] | 7. Duration | 8. Credits (ECTS) |
|---|---|---|---|
| WS | 180 | 1 | 6,0 |

| **Module Title: Spatial ecology and conservation biology** | | | | |
|---|---|---|---|---|
| **Module ID/Code:** NPW-055 [780800550] | | | | |
| **9. Requirements for the rewarding of credits (ECTS)** | | | | |
| **Types of Assessment** | **Prerequisites for admission to the Assessment** | **Graded yes/no** | **Language (exam)** | **Weighting factor** |
| Colloquium [780800559] | Participation in journal club and group discussion | not graded | English | 30% |
| Project work [780800558] | Participation in practical exercise | not graded | English | 30% |
| Assignment [780800557] | | graded | English | 40% |
| **Academic Achievements** | | | | |
| | | | | |
| **10. Module coordination** | | | | |
| **Module coordinator** | | | | |
| Stephanie Roilo | | | | |
| **Teaching person** | | | | |
| The teaching persons in the current semester can be found in basis: https://basis.uni-bonn.de/ | | | | |
| **Institute/ Department** | | | | |
| Agrar-, Forst- und Ernährungswissenschaften | | | | |
| **11. Further information** | | | | |
| Spatial Ecology and Conservation Modelling - Springer (https://link.springer.com/book/10.1007/978-3-030-01989-1)<br>Conservation Biology - Springer (https://link.springer.com/book/10.1007/978-3-030-39534-6) | | | | |

## Module Title: Climate-Smart Ecosystem Management

**Module ID/Code:** NPW-059 [780800590]

### 1. Content and intended learning outcomes

| | |
|---|---|
| **Learning content:** | In this course, students will gain insights into Climate-Smart Ecosystem Management (CSEM), focusing on key concepts and strategies for effectively managing diverse ecosystems in a changing climate. Lectures will cover climate change patterns and trends, and its impacts on agriculture, forestry, and peatlands. Students will learn about techniques for measuring greenhouse gas (GHG) and water fluxes from various ecosystems (e.g., chambers, eddy covariance, and remote sensing), including a visit to a GHG measurement station. The course will also address the effects of management practices across these ecosystems as tools to mitigate climatic impacts, with a focus on reducing GHG emissions and increasing soil organic carbon sequestration. International agreements and policies related to climate change mitigation will be presented, alongside emission inventories. Students will become familiar with strategies for climate change adaptation and mitigation, including climate-smart integrated production systems (e.g., agroforestry, etc.). The seminars will include lectures by stakeholders working in CSEM and presentations of case studies by students in groups. This module will equip students with the knowledge and skills to devise innovative solutions for mitigating climatic impacts from diverse ecosystems and building climate-resilient ecosystems. |

**Learning outcomes**

After a successful completion of the course, the students…
- outline the core concepts and practices of CSEM, identify examples from different ecosystems, and describe their impact on climate change mitigation and adaptation.
- describe the mechanisms responsible for GHG production and consumption in ecosystems.
- know about water and energy fluxes in various ecosystems and the microclimatic effects of ecosystem management practices.
- acquire basic knowledge of measurement techniques for GHG and water fluxes from agriculture, forest and peatlands.
- identify international organizations and relevant actors in climate mitigation and adaptation.
- interpret climate change patterns and trends, and discuss their implications on crop yields, forest productivity, water availability, and other relevant factors.
- identify key practices for mitigating GHG emissions and increasing soil organic carbon storage.
- analyse the effectiveness of different climate-smart ecosystem management plans and strategies, and propose modifications and improvements.

### 2. Prerequisites

| | |
|---|---|
| **obligatory** | none |
| **recommended** | |
| **Maximum number of students** | 24 students |

### 3. Study program allocation

| Study program | Compulsory/ Elective | Semester |
|---|---|---|
| M.Sc. Agricultural Science and Resource Management in the Tropics and Subtropics (ARTS) | E | 1./3. |
| M.Sc. Nature Conservation and Landscape Ecology | E | 1./3. |
| M.Sc. Crop Sciences | E | 1./3. |

### 4. Teaching and learning methodes

| Type of course | Interval | Topic | Language of instruction | Group size | SWS | Workload [h] | |
|---|---|---|---|---|---|---|---|
| | | | | | | Contact time | Self-study |
| L | during the semester | CSEM Lectures | English | 24 | 2,0 | 30,0 | 60,0 |
| S* | during the semester | Case studies and stakeholders | English | 24 | 2,0 | 30,0 | 60,0 |

| 5. Course cycle | 6. Workload [h] | 7. Duration | 8. Credits (ECTS) |
|---|---|---|---|
| WS | 180 | 1 | 6,0 |

| **Module Title: Climate-Smart Ecosystem Management** | | | | |
|---|---|---|---|---|
| **Module ID/Code:** NPW-059 [780800590] | | | | |
| **9. Requirements for the rewarding of credits (ECTS)** | | | | |
| **Types of Assessment** | **Prerequisites for admission to the Assessment** | **Graded yes/no** | **Language (exam)** | **Weighting factor** |
| Presentation [780800599] | Participation in project work | graded | English | 30% |
| Report (presentation) [780800598] | Report in form of a poster - doing a presentation is a prerequisite | graded | English | 30% |
| Oral exam [780800597] | | graded | English | 40% |
| **Academic Achievements** | | | | |
| | | | | |
| **10. Module coordination** | | | | |
| **Module coordinator** | | | | |
| Prof. Dr. Ana Meijide | | | | |
| **Teaching person** | | | | |
| The teaching persons in the current semester can be found in basis: https://basis.uni-bonn.de/ | | | | |
| **Institute/ Department** | | | | |
| Agrar-, Forst- und Ernährungswissenschaften | | | | |
| **11. Further information** | | | | |
| Guest lectures from key stakeholders and experts in the field (N.N.), including representatives from private companies and international organizations | | | | |

## Module Title: Ecological climatology

**Module ID/Code:** NPW-060 [780800600]

### 1. Content and intended learning outcomes

| | |
|---|---|
| **Learning content:** | Students will learn about the atmospheric processes responsible of local and global climates and how they influence ecosystem processes and fluxes in the plant-soil-air interface. They will also understand how ecosystems feed back to the atmosphere at local and global scales. This will set the basis for understanding the impact of climate change on ecosystems. The lectures will give an overview on atmospheric variables such as radiation, humidity, temperature, and wind and their interactions with terrestrial ecosystems. In the seminar/exercise class, the understanding will be deepened by quantitative exercises and group presentations. The students will be trained in quantitative and qualitative scientific methods to describe and study climate-dependent physical, chemical and biological processes in terrestrial ecosystems enabling them to understand and evaluate the current discussion on climate change and its impact on terrestrial ecosystems. |

**Learning outcomes**

After a successful completion of the course, the students…
- identify the key components of cycles of earth systems and climate.
- recall the most important climatological and hydrological variables and what governs them at different scales.
- explain how climate controls the functioning and distribution of plants in different terrestrial environments.
- comprehend how interactions between climate and terrestrial ecosystems function and how these may feed back into climate change.
- illustrate the climatological, hydrological and nutrient conditions in different terrestrial environments.
- assess how changes in land cover or land use impact the climatological, hydrological and nutrient conditions at local and regional scales.
- evaluate how changes in climate reflect on different terrestrial ecosystems.
- recognise suitable approaches and methods to study interactions between climate and terrestrial ecosystems.

### 2. Prerequisites

| | |
|---|---|
| **obligatory** | none |
| **recommended** | |
| **Maximum number of students** | 24 students |

### 3. Study program allocation

| Study program | Compulsory/ Elective | Semester |
|---|---|---|
| M.Sc. Agricultural Science and Resource Management in the Tropics and Subtropics (ARTS) | E | 1./3. |
| M.Sc. Nature Conservation and Landscape Ecology | O | 1./3. |
| M.Sc. Crop Sciences | E | 1./3. |

### 4. Teaching and learning methodes

| Type of course | Interval | Topic | Language of instruction | Group size | SWS | Workload [h] | |
|---|---|---|---|---|---|---|---|
| | | | | | | Contact time | Self-study |
| L | during the semester | Basics of ecological climatology | English | 24 | 2,0 | 30,0 | 60,0 |
| S* | during the semester | Practical exercises related to the course | English | 24 | 2,0 | 30,0 | 60,0 |

| 5. Course cycle | 6. Workload [h] | 7. Duration | 8. Credits (ECTS) |
|---|---|---|---|
| WS | 180 | 1 | 6,0 |

| **Module Title: Ecological climatology** | | | | |
|---|---|---|---|---|
| **Module ID/Code:** NPW-060 [780800600] | | | | |
| **9. Requirements for the rewarding of credits (ECTS)** | | | | |
| **Types of Assessment** | **Prerequisites for admission to the Assessment** | **Graded yes/no** | **Language (exam)** | **Weighting factor** |
| Oral exam [780800609] | | graded | English | 50% |
| Presentation [780800608] | participation in project work and its presentations | graded | English | 50% |
| **Academic Achievements** | | | | |
| | | | | |
| **10. Module coordination** | | | | |
| **Module coordinator** | | | | |
| Prof. Dr. Ana Meijide | | | | |
| **Teaching person** | | | | |
| The teaching persons in the current semester can be found in basis: https://basis.uni-bonn.de/ | | | | |
| **Institute/ Department** | | | | |
| Agrar-, Forst- und Ernährungswissenschaften | | | | |
| **11. Further information** | | | | |
| We will partially follow the structure and use some of the material form the book "Ecological Climatology" 2016, by Bonan Gordon. | | | | |

## Module Title: Introduction to Tropical Forestry

**Module ID/Code:** ARTS-BS11 [780750110]

### 1. Content and intended learning outcomes

**Learning content:**

Tropical forests harbor vast biodiversity and provide essential ecosystem functions such as water regulation and erosion control. However, climate change, deforestation and unsustainable land use practices threaten many tropical forest ecosystems, creating the need for forest restoration and smart and sustainable management of remaining forest resources. This is an introductory module for students with an interest in tropical forestry. No previous forestry knowledge is required.
The module gives an overview of global forest resources, dynamics and threats. It classifies important forest types across the tropics, covering the moist to dry tropics and azonal forest types such as mountain forests or mangroves. For each forest type, importance and key functions, management-relevant characteristics and examples of sustainable management strategies are discussed. The module covers forest management approaches such as conservation-oriented close-to-nature forestry with extensive resource exploitation (e.g. of non-timber forest products), wood production-oriented management in (near) natural and secondary tropical forests, agroforestry and plantation forestry, which will also be discussed in the context of community forestry approaches and the design of resilient and sustainable landscapes. The acquired knowledge on sustainable forest management will be consolidated in field trips to nearby forest stands.
Students have to give a 10 min oral presentation on a forestry-related topic (30% of the grade for this module) and moderate the presentation of one colleague. At the end of the winter semester, there is a written exam (70% of the grade).

Note: The module 'Introduction to Tropical Forestry' (winter semester, 2 SWS, 3 credits) combines well will the module 'Basics of Central European Forestry' (summer semester, 2 SWS, 3 credits). For students with an interest in forestry, it is recommended to take both these modules.

**Learning outcomes**

After a successful completion of the course, the students…
- have acquired knowledge on important tropical forest types, their distribution and defining characteristics.
- have obtained knowledge on sustainable forest management principles.
- can apply acquired knowledge on tropical forests to identify potential mangement options for a given tropical region.
- can apply obtained knowledge on sustainable forest management to critically assess land-use practices across the tropics.
- can give and moderate a scientific presentation on a selected forest ecosystem to fellow students (mandatory student presentation).

### 2. Prerequisites

| | |
|---|---|
| **obligatory** | |
| **recommended** | interest in forest ecology and/or forest management |
| **Maximum number of students** | |

### 3. Study program allocation

| Study program | Compulsory/ Elective | Semester |
|---|---|---|
| M.Sc. Agricultural Science and Resource Management in the Tropics and Subtropics (ARTS) | E | 1./3. |
| M.Sc. Nature Conservation and Landscape Ecology | E | 1./3. |

### 4. Teaching and learning methodes

| Type of course | Interval | Topic | Language of instruction | Group size | SWS | Workload [h] | |
|---|---|---|---|---|---|---|---|
| | | | | | | Contact time | Self-study |
| S | during the semester | tropical forestry | English | 30 | 2,0 | 30,0 | 60,0 |

| 5. Course cycle | 6. Workload [h] | 7. Duration | 8. Credits (ECTS) |
|---|---|---|---|
| WS | 90 | 1 | 3,0 |

| **Module Title: Introduction to Tropical Forestry** | | | | |
|---|---|---|---|---|
| **Module ID/Code:** ARTS-BS11 [780750110] | | | | |
| **9. Requirements for the rewarding of credits (ECTS)** | | | | |
| **Types of Assessment** | **Prerequisites for admission to the Assessment** | **Graded yes/no** | **Language (exam)** | **Weighting factor** |
| Written exam [780750119] | | graded | English | 70% |
| Presentation [780750118] | | graded | English | 30% |
| **Academic Achievements** | | | | |
| | | | | |
| **10. Module coordination** | | | | |
| **Module coordinator** | | | | |
| Dr. Alexander Röll | | | | |
| **Teaching person** | | | | |
| The teaching persons in the current semester can be found in basis: https://basis.uni-bonn.de/ | | | | |
| **Institute/ Department** | | | | |
| Agrar-, Forst- und Ernährungswissenschaften | | | | |
| **11. Further information** | | | | |
| | | | | |

## Module Title: Basics of Central European Forestry

**Module ID/Code:** ARTS-BS12 [780750120]

### 1. Content and intended learning outcomes

**Learning content:**

Forests harbor vast biodiversity and provide essential ecosystem functions such as water regulation and erosion control. Climate change and unsustainable land-use practices are a threat to many forest ecosystems, creating the need for resilient and sustainable restoration and management of the remaining forest resources. This is an introductory module for students with an interest in forest ecology and forest management. No previous forestry knowledge is required.
The module 'Basics of Central European Forestry' covers the history, ecology and sustainable management of forests in Central Europe and particularly in Germany. This includes forest management approaches such as conservation-oriented close-to-nature forestry, wood production-oriented management, agroforestry and plantation forestry, which will also be discussed in the context of resilient and sustainable landscape design. Part of the module will take place in the field as exercises related to forest inventory, vegetation ecology, pedology and silviculture. In this context, students have to give a 10 min poster presentation (30% of the grade for this module). At the end of the summer semester, there is a written exam (70% of the grade).

Note: The module 'Basics of Central European Forestry' (summer semester, 2 SWS, 3 credits) combines well will the module 'Introduction to Tropical Forestry' (winter semester, 2 SWS, 3 credits). For students with an interest in forestry, it is recommended to take both these modules.

**Learning outcomes**

After a successful completion of the course, the students…
- have acquired knowledge on important Central European forest types, their distribution and defining characteristics.
- have obtained knowledge on sustainable forest management principles.
- can apply acquired silvicultural knowledge to identify potential mangement options for a given forest stand.
- can apply obtained knowledge on sustainable forest management to critically assess land-use practices across Central Europe.
- can give a scientific poster presentation on a selected silvicultural method to fellow students (mandatory student presentation).

### 2. Prerequisites

| | |
|---|---|
| **obligatory** | |
| **recommended** | interest in forest ecology and/or forest management |
| **Maximum number of students** | |

### 3. Study program allocation

| Study program | Compulsory/ Elective | Semester |
|---|---|---|
| M.Sc. Agricultural Science and Resource Management in the Tropics and Subtropics (ARTS) | E | 2./4. |
| M.Sc. Nature Conservation and Landscape Ecology | E | 2./4. |

### 4. Teaching and learning methodes

| Type of course | Interval | Topic | Language of instruction | Group size | SWS | Workload [h] | |
|---|---|---|---|---|---|---|---|
| | | | | | | Contact time | Self-study |
| S | during the semester | Central European forestry | English | 30 | 2,0 | 30,0 | 60,0 |

| 5. Course cycle | 6. Workload [h] | 7. Duration | 8. Credits (ECTS) |
|---|---|---|---|
| SS | 90 | 1 | 3,0 |

### 9. Requirements for the rewarding of credits (ECTS)

| Types of Assessment | Prerequisites for admission to the Assessment | Graded yes/no | Language (exam) | Weighting factor |
|---|---|---|---|---|
| Written exam [780750129] | | graded | English | 70% |
| Presentation [780750128] | | graded | English | 30% |

**Academic Achievements**

| **Module Title: Basics of Central European Forestry** |
|---|
| **Module ID/Code:** ARTS-BS12 [780750120] |
| **10. Module coordination** |
| **Module coordinator** |
| Dr. Alexander Röll |
| **Teaching person** |
| The teaching persons in the current semester can be found in basis:<br>https://basis.uni-bonn.de/ |
| **Institute/ Department** |
| Agrar-, Forst- und Ernährungswissenschaften |
| **11. Further information** |
| |

## Module Title: Soundscape Ecology: Theory and Passive Acoustic Monitoring

**Module ID/Code:** NALA-044 [780790470]

### 1. Content and intended learning outcomes

**Learning content:**

Students will learn the fundamentals, methods, and applications of soundscape ecology in agricultural landscapes. They will gain an understanding of the ecological importance of sounds and learn to use acoustic monitoring devices (e.g., AudioMoth) for passive acoustic monitoring (PAM) of biodiversity. They will critically discuss how PAM can contribute to advancing the understanding of ecological communities and addressing the biodiversity crisis in European agroecosystems. The course encompasses both the ecological principles of soundscape ecology, highlighting the role of sound in shaping society's relationship with nature, the physics of sound and applications in biodiversity monitoring and conservation.

Module content:
-Terminology, development and interdisciplinary nature of soundscape ecology as a discipline
- Components of the soundscape and basics of the physics of sound
- Ecological significance of sound in various ecosystems
- Basic principles of PAM and important monitoring devices
- Hands-on experience with PAM devices (e.g., AudioMoth) such as setting up and deploying them in the field, calibration, data storage and troubleshooting
- Processing and visualizing acoustic data (e.g., spectrograms)
- Human-nature interactions and benefits of nature's sounds to human well-being
- Recent developments in research and application

**Learning outcomes**

After a successful completion of the course, the students…
- recall key terminology, concepts and principles of soundscape ecology.
- interpret spectrograms collected from field samples.
- implement PAM in various field conditions.
- use sound recognition models to analyze audio data.
- evaluate PAM field design and acoustic data analysis methods.
- propose and develop research questions making use of PAM technology.

### 2. Prerequisites

| | |
|---|---|
| **obligatory** | none |
| **recommended** | Basic knowledge of community or landscape ecology is recommended |
| **Maximum number of students** | 15 students |

### 3. Study program allocation

| Study program | Compulsory/ Elective | Semester |
|---|---|---|
| M.Sc. Agricultural Science and Resource Management in the Tropics and Subtropics (ARTS) | O | 2. |
| M.Sc. Nature Conservation and Landscape Ecology | O | 2. |

### 4. Teaching and learning methodes

| Type of course | Interval | Topic | Language of instruction | Group size | SWS | Workload [h] | |
|---|---|---|---|---|---|---|---|
| | | | | | | Contact time | Self-study |
| L | during the semester | Principles of soundscape ecology and PAM | English | 15 | 1,0 | 15,0 | 35,0 |
| S* | during the semester | Applications in research and practice | English | 15 | 2,0 | 30,0 | 50,0 |
| pT* (blocked) | full-day block | Practical work (preparatory, field & post-processing) | English | 5 | 2,0 | 30,0 | 20,0 |

| 5. Course cycle | 6. Workload [h] | 7. Duration | 8. Credits (ECTS) |
|---|---|---|---|
| SS | 180 | 1 | 6,0 |

| **Module Title: Soundscape Ecology: Theory and Passive Acoustic Monitoring** | | | | |
|---|---|---|---|---|
| **Module ID/Code:** NALA-044 [780790470] | | | | |
| **9. Requirements for the rewarding of credits (ECTS)** | | | | |
| **Types of Assessment** | **Prerequisites for admission to the Assessment** | **Graded yes/no** | **Language (exam)** | **Weighting factor** |
| Report [780790479] | Participation in practical courses | graded | English | 50% |
| Presentation [780790478] | Regular class attendance | graded | English | 50% |
| **Academic Achievements** | | | | |
| | | | | |
| **10. Module coordination** | | | | |
| **Module coordinator** | | | | |
| Prof. Dr. Anna Cord | | | | |
| **Teaching person** | | | | |
| The teaching persons in the current semester can be found in basis: https://basis.uni-bonn.de/ | | | | |
| **Institute/ Department** | | | | |
| Agrar-, Forst- und Ernährungswissenschaften | | | | |
| **11. Further information** | | | | |
| Useful literature:<br>Principles of Soundscape Ecology: Discovering Our Sonic World (Bryan C. Pijanowski; https://press.uchicago.edu/ucp/books/book/chicago/P/bo187218508.html) | | | | |

# Elective modules of the second and third semester (ARTS-B) - Molecular approaches

**You can choose 18-30 ECTS-CP from the elective modules.**
**The specialisation Molecular approaches is only awarded if 24 ECTS-CP from this specialisation are completed.**

## Module Title: Genome Analysis in Plant Breeding

**Module ID/Code:** ARTS-BM01 [780800480]

### 1. Content and intended learning outcomes

| | |
|---|---|
| **Learning content:** | The students will be introduced to the theoretical and practical aspects of plant genomes analysis techniques which are relevant to plant breeding. The primary learning aim is focused on the molecular analysis of inheritable traits in crops and transfer of improved traits for establishing new crop varieties. This area is located at the junction of classical plant breeding and the relatively recent field of molecular genetics and biology. Therefore, the students have the opportunity to learn a broad range of methods for genome analysis using DNA marker techniques and recent state-of-the art whole genome DNA sequencing. In addition, this module offers in depth learning of marker by trait association, gene isolation and functional analyses of genes as well as the concept of molecular breeding for the establishment of new varieties. |

**Learning outcomes**

After a successful completion of the course, the students…
- comprehend and are able to apply DNA marker techniques.
- comprehend and are able to apply high-throughput genotyping.
- comprehend and are able to apply genome analysis using next generation sequencing methods.
- comprehend and are able to apply genetic linkage analysis and development of linkage maps.
- comprehend and are able to apply trait by gene associations analyses (QTL mapping, GWAS).
- comprehend and are able to apply gene mapping associated to qualitative and quantitative traits.
- comprehend and are able to apply isolation of genes and their allelic diversity.
- comprehend and are able to apply marker-assisted selection and transfer of favorable alleles in crop varieties.
- comprehend and are able to apply molecular breeding and development of improved crop varieties.

### 2. Prerequisites

| | |
|---|---|
| **obligatory** | |
| **recommended** | Basic knowledge of genetics and genome as heredity material<br>ARTS-A01, A02, A03, A04, AM05a and AM05b |
| **Maximum number of students** | 70 students |

### 3. Study program allocation

| Study program | Compulsory/ Elective | Semester |
|---|---|---|
| M.Sc. Agricultural Science and Resource Management in the Tropics and Subtropics (ARTS) | E | 3. |
| M.Sc. Crop Sciences | E | 3. |
| M.Sc. Plant Sciences | | |

### 4. Teaching and learning methodes

| Type of course | Interval | Topic | Language of instruction | Group size | SWS | Workload [h] | |
|---|---|---|---|---|---|---|---|
| | | | | | | Contact time | Self-study |
| L | during the semester | | English | 70 | 2,0 | 30,0 | 60,0 |
| P (blocked) | full-day block | | English | 10 | 2,0 | 30,0 | 60,0 |

| 5. Course cycle | 6. Workload [h] | 7. Duration | 8. Credits (ECTS) |
|---|---|---|---|
| WS | 180 | 1 | 6,0 |

### 9. Requirements for the rewarding of credits (ECTS)

| Types of Assessment | Prerequisites for admission to the Assessment | Graded yes/no | Language (exam) | Weighting factor |
|---|---|---|---|---|
| Written exam [780800489] | | graded | English | 100% |
| Report (presentation) [780800488] | | not graded | English | 0% |

**Academic Achievements**

| **Module Title: Genome Analysis in Plant Breeding** |
|---|
| **Module ID/Code:** ARTS-BM01 [780800480] |
| **10. Module coordination** |
| **Module coordinator** |
| Prof. Dr. Annaliese Mason |
| **Teaching person** |
| The teaching persons in the current semester can be found in basis:<br>https://basis.uni-bonn.de/ |
| **Institute/ Department** |
| Agrar-, Forst- und Ernährungswissenschaften |
| **11. Further information** |
| |

## Module Title: Crop Abiotic Stresses

**Module ID/Code:** ARTS-BM02 [780800220]

### 1. Content and intended learning outcomes

| | |
|---|---|
| **Learning content:** | Students carry out experiments in the greenhouse, in which crops are exposed to different abiotic stresses (nutrient deficiencies, salinity, drought, submergence and iron toxicity). Stress responses in contrasting genotypes are monitored regularly by non-invavise measurements including manual phenotying, spectral reflectance measurements, gas exchange measurements, etc. Plants are then harvested and subjected to biochemical analyses in the laboratory, such as mineral analyses. At the end of the module, students present a seminar talk and a report, in which they provide scientific background on one particular abiotic stress, present a scientific paper dealing with this stress, and present their own results. |

**Learning outcomes**

After a successful completion of the course, the students…
- will be able to prepare and execute stress experiments with crops.
- will be able to diagniose and analyze stress response in plants.
- will be able to compare and evaluates the stress response in different genotypes.
- will be abe to devise and design meaningful stess experiments with crops.
- summarize, report and write-up results and drw cronclusions from them.

### 2. Prerequisites

| | |
|---|---|
| **obligatory** | |
| **recommended** | Basic understanding of plant stress biology and (bio)chemistry |
| **Maximum number of students** | 30 students |

### 3. Study program allocation

| Study program | Compulsory/ Elective | Semester |
|---|---|---|
| M.Sc. Agricultural Science and Resource Management in the Tropics and Subtropics (ARTS) | E | 2. |
| M.Sc. Crop Sciences | E Focus PERC | 2. |

### 4. Teaching and learning methodes

| Type of course | Interval | Topic | Language of instruction | Group size | SWS | Workload [h] | |
|---|---|---|---|---|---|---|---|
| | | | | | | Contact time | Self-study |
| P* (blocked) | afternoon block | | English | 15 | 4,0 | 60,0 | 120,0 |

| 5. Course cycle | 6. Workload [h] | 7. Duration | 8. Credits (ECTS) |
|---|---|---|---|
| SS | 180 | 1 | 6,0 |

### 9. Requirements for the rewarding of credits (ECTS)

| Types of Assessment | Prerequisites for admission to the Assessment | Graded yes/no | Language (exam) | Weighting factor |
|---|---|---|---|---|
| Presentation [780800229] | Participation in the practical work | graded | English | 50% |
| Report [780800228] | Participation in the practical work | graded | English | 50% |

**Academic Achievements**

| **Module Title: Crop Abiotic Stresses** |
|---|
| **Module ID/Code:** ARTS-BM02 [780800220] |
| **10. Module coordination** |
| **Module coordinator** |
| Dr. Shyam Pariyar |
| **Teaching person** |
| The teaching persons in the current semester can be found in basis:<br>https://basis.uni-bonn.de/ |
| **Institute/ Department** |
| Agrar-, Forst- und Ernährungswissenschaften |
| **11. Further information** |
| |

## Module Title: Soil microbiology

**Module ID/Code:** ARTS-BM04 [780790180]

### 1. Content and intended learning outcomes

| | |
|---|---|
| **Learning content:** | In this module, students gain advanced knowledge in soil microbiology. In the lectures, the soil as habitat for microorganisms is introduced and the role of microorganisms in soils is discussed. This includes their contribution to biogeochemical cycles, especially their important role in carbon and nitrogen cycling. Furthermore, biotic and abiotic factors that determine life of soil microorganisms will be discussed. Methodological approaches will be explained that allow to analyze the presence and activity of microorganisms in soil.<br>In the tutorial, recently published research articles will be jointly discussed. Students have to read these articles in advance.<br>In the seminar, each student will present a specific research article. |

**Learning outcomes**

After a successful completion of the course, the students…
- have obtained knowledge about the life of microorganisms in soil, the functions microorganisms fulfill in soil and about methods used to study soil microorganisms.
- can summarize the findings of and discuss research articles in the field of soil microbiology.
- are able to prepare and present research results and discuss them with the audience.
- can critically evaluate research articles.

### 2. Prerequisites

| | |
|---|---|
| **obligatory** | |
| **recommended** | |
| **Maximum number of students** | 20 students |

### 3. Study program allocation

| Study program | Compulsory/ Elective | Semester |
|---|---|---|
| M.Sc. Agricultural Science and Resource Management in the Tropics and Subtropics (ARTS) | E | 2. |
| M.Sc. Nature Conservation and Landscape Ecology | E | 2. |
| M.Sc. Crop Sciences | E Focus MCS | 2. |

### 4. Teaching and learning methodes

| Type of course | Interval | Topic | Language of instruction | Group size | SWS | Workload [h] | |
|---|---|---|---|---|---|---|---|
| | | | | | | Contact time | Self-study |
| L | during the semester | | English | 20 | 2,0 | 20,0 | 60,0 |
| T | during the semester | | English | 20 | 0,5 | 5,0 | 40,0 |
| S | during the semester | | English | 20 | 1,5 | 15,0 | 40,0 |

| 5. Course cycle | 6. Workload [h] | 7. Duration | 8. Credits (ECTS) |
|---|---|---|---|
| SS | 180 | 1 | 6,0 |

### 9. Requirements for the rewarding of credits (ECTS)

| Types of Assessment | Prerequisites for admission to the Assessment | Graded yes/no | Language (exam) | Weighting factor |
|---|---|---|---|---|
| Presentation [780790189] | | graded | English | 50% |
| Written exam [780790188] | | graded | English | 50% |

**Academic Achievements**

| **Module Title: Soil microbiology** |
| --- |
| **Module ID/Code:** ARTS-BM04 [780790180] |
| **10. Module coordination** |
| **Module coordinator** |
| Prof. Dr. Claudia Knief |
| **Teaching person** |
| The teaching persons in the current semester can be found in basis:<br>https://basis.uni-bonn.de/ |
| **Institute/ Department** |
| Agrar-, Forst- und Ernährungswissenschaften |
| **11. Further information** |
| |

## Module Title: Animal breeding and genetics

**Module ID/Code:** ARTS-BM05 [780750050]

### 1. Content and intended learning outcomes

| | |
|---|---|
| **Learning content:** | From this course students are going to learn<br>- principles of animal breeding and genetics<br>- animal genetic resources<br>- modern animal breeding techniques<br>- breeding for sustainable animal production and diversity |

**Learning outcomes**

After a successful completion of the course, the students…
- understand the scientific explanation about animal breeeding and genetics.
- understand breeding strategies.
- understand various animal genetic resources and their effective utilizations.

### 2. Prerequisites

| | |
|---|---|
| **obligatory** | |
| **recommended** | ARTS-A01, A02, A03, A04, AM05a and AM05b |
| **Maximum number of students** | 25 students |

### 3. Study program allocation

| Study program | Compulsory/ Elective | Semester |
|---|---|---|
| M.Sc. Agricultural Science and Resource Management in the Tropics and Subtropics (ARTS) | E | 2. |

### 4. Teaching and learning methodes

| Type of course | Interval | Topic | Language of instruction | Group size | SWS | Workload [h] | |
|---|---|---|---|---|---|---|---|
| | | | | | | Contact time | Self-study |
| L (blocked) | afternoon block | | English | 25 | 1,0 | 15,0 | 75,0 |
| S (blocked) | afternoon block | | English | 25 | 1,0 | 15,0 | 75,0 |

| 5. Course cycle | 6. Workload [h] | 7. Duration | 8. Credits (ECTS) |
|---|---|---|---|
| SS | 180 | 1 | 6,0 |

### 9. Requirements for the rewarding of credits (ECTS)

| Types of Assessment | Prerequisites for admission to the Assessment | Graded yes/no | Language (exam) | Weighting factor |
|---|---|---|---|---|
| Written exam [780750059] | | graded | English | 70% |
| Presentation [780750058] | | graded | English | 30% |

**Academic Achievements**

### 10. Module coordination

**Module coordinator**

Dr. Ernst Tholen

**Teaching person**

The teaching persons in the current semester can be found in basis:
https://basis.uni-bonn.de/

**Institute/ Department**

Agrar-, Forst- und Ernährungswissenschaften

### 11. Further information

## Module Title: Advances in Plant Breeding Methodology

**Module ID/Code:** ARTS-BM07 [780800470]

### 1. Content and intended learning outcomes

| | |
|---|---|
| **Learning content:** | The students will learn to construct a plant breeding program by regarding several scenarios. The goal is to maximize the selection response of different populations when different restrictions are met. New analytical and molecular methods will be taught in this module to establish experties in the area of plant breeding. |

**Learning outcomes**

After a successful completion of the course, the students…
- know and understand innovation in breeding methodology.
- know and understand field evaluations for optimized selection process.
- know and understand high-throughtput phenotyping.
- know and understand genetic gain and selection theory.
- know and understand future breeding methodologies.
- know and understand CRISPR-Cas mediated precision breeding.

### 2. Prerequisites

| | |
|---|---|
| **obligatory** | |
| **recommended** | Fundamental of knowledge of plant breeding and genetics |
| **Maximum number of students** | 30 students |

### 3. Study program allocation

| Study program | Compulsory/ Elective | Semester |
|---|---|---|
| M.Sc. Agricultural Science and Resource Management in the Tropics and Subtropics (ARTS) | E | 2. |
| M.Sc. Crop Sciences | E | 2. |
| M.Sc. Plant Sciences | | |

### 4. Teaching and learning methodes

| Type of course | Interval | Topic | Language of instruction | Group size | SWS | Workload [h] | |
|---|---|---|---|---|---|---|---|
| | | | | | | Contact time | Self-study |
| L | during the semester | | English | 30 | 2,0 | 30,0 | 60,0 |
| S (blocked) | full-day block | | English | 15 | 2,0 | 30,0 | 60,0 |

| 5. Course cycle | 6. Workload [h] | 7. Duration | 8. Credits (ECTS) |
|---|---|---|---|
| SS | 180 | 1 | 6,0 |

### 9. Requirements for the rewarding of credits (ECTS)

| Types of Assessment | Prerequisites for admission to the Assessment | Graded yes/no | Language (exam) | Weighting factor |
|---|---|---|---|---|
| Project work [780800479] | | graded | English | 100% |
| Report (presentation) [780800478] | | not graded | English | 0% |

**Academic Achievements**

| **Module Title: Advances in Plant Breeding Methodology** |
|---|
| **Module ID/Code:** ARTS-BM07 [780800470] |
| **10. Module coordination** |
| **Module coordinator** |
| Dr. Mariana Báez |
| **Teaching person** |
| The teaching persons in the current semester can be found in basis:<br>https://basis.uni-bonn.de/ |
| **Institute/ Department** |
| Agrar-, Forst- und Ernährungswissenschaften |
| **11. Further information** |
| |

## Module Title: Projects in Crop Protection Research

**Module ID/Code:** ARTS-BM08 [780800270]

### 1. Content and intended learning outcomes

| | |
|---|---|
| **Learning content:** | Project activities are conducted in close association with ongoing research projects, permitting the application of state-of-the art methodologies and leading to an in-depth understanding of research concepts and problems associated with microbial and animal pathogenic organisms. |

**Learning outcomes**

After a successful completion of the course, the students…
- are able to appropriately select and apply methods required for specific research questions.
- are able to understand and analyze scientific literature.
- are able to plan a scientific project.

### 2. Prerequisites

| | |
|---|---|
| **obligatory** | |
| **recommended** | |
| **Maximum number of students** | 10 students |

### 3. Study program allocation

| Study program | Compulsory/ Elective | Semester |
|---|---|---|
| M.Sc. Agricultural Science and Resource Management in the Tropics and Subtropics (ARTS) | E | 2./3. |
| M.Sc. Crop Sciences | E Focus PERC | 2./3. |

### 4. Teaching and learning methodes

| Type of course | Interval | Topic | Language of instruction | Group size | SWS | Workload [h] | |
|---|---|---|---|---|---|---|---|
| | | | | | | Contact time | Self-study |
| Proj | during the semester | | English | 10 | 3,0 | 45,0 | 90,0 |
| S | during the semester | | English | 10 | 1,0 | 15,0 | 30,0 |

| 5. Course cycle | 6. Workload [h] | 7. Duration | 8. Credits (ECTS) |
|---|---|---|---|
| WS/SS | 180 | 1 | 6,0 |

### 9. Requirements for the rewarding of credits (ECTS)

| Types of Assessment | Prerequisites for admission to the Assessment | Graded yes/no | Language (exam) | Weighting factor |
|---|---|---|---|---|
| Report (presentation) [780800279] | | graded | English | 80% |
| Assignment [780800278] | | graded | English | 20% |

**Academic Achievements**

### 10. Module coordination

**Module coordinator**

Prof. Dr. Florian Grundler

**Teaching person**

The teaching persons in the current semester can be found in basis:
https://basis.uni-bonn.de/

**Institute/ Department**

Agrar-, Forst- und Ernährungswissenschaften

### 11. Further information

# Cross-cutting modules of the second and third semester

## You can choose 18-30 ECTS-CP from the elective modules.

## Module Title: Land use and land degradation

**Module ID/Code:** ARTS-BC02 [780750060]

### 1. Content and intended learning outcomes

| | |
|---|---|
| **Learning content:** | Learn about land uses, resource management strategies and their implications<br>Apply simple field methods for ecosystem analysis<br>Present case studies |

**Learning outcomes**

After a successful completion of the course, the students…
- land uses, resource management strategies.
- ability to analyze implications of different strategies.
- compile a case study and present to plenum.

### 2. Prerequisites

| | |
|---|---|
| **obligatory** | |
| **recommended** | Completion of >24 ECTS out of ARTS-A |
| **Maximum number of students** | 25 students |

### 3. Study program allocation

| Study program | Compulsory/ Elective | Semester |
|---|---|---|
| M.Sc. Agricultural Science and Resource Management in the Tropics and Subtropics (ARTS) | E | 2. |

### 4. Teaching and learning methodes

| Type of course | Interval | Topic | Language of instruction | Group size | SWS | Workload [h] | |
|---|---|---|---|---|---|---|---|
| | | | | | | Contact time | Self-study |
| E (blocked) | full-day block | | English | 25 | 4,0 | 60,0 | 120,0 |

| 5. Course cycle | 6. Workload [h] | 7. Duration | 8. Credits (ECTS) |
|---|---|---|---|
| SS | 180 | 1 | 6,0 |

### 9. Requirements for the rewarding of credits (ECTS)

| Types of Assessment | Prerequisites for admission to the Assessment | Graded yes/no | Language (exam) | Weighting factor |
|---|---|---|---|---|
| Presentation [780750069] | | not graded | English | 0% |
| Report [780750068] | | graded | English | 100% |

**Academic Achievements**

### 10. Module coordination

**Module coordinator**

PD Dr. Johannes Botschek

**Teaching person**

The teaching persons in the current semester can be found in basis:
https://basis.uni-bonn.de/

**Institute/ Department**

Agrar-, Forst- und Ernährungswissenschaften

### 11. Further information

## Module Title: Development Economics

**Module ID/Code:** ARTS-BC03 [780763240]

### 1. Content and intended learning outcomes

| | |
|---|---|
| **Learning content:** | Empirical patterns in economic development, economic growth models, causes of differential economic growth and development across countries, including the role of institutions, labor markets and migration. Sustainable management of natural resources for development and poverty reduction: key theoretical concepts, critical discussion of empirical policy problems, specifically, regarding water and land management, energy access and transition, the impact of high resource endowments on development, opportunities and challenges posed by climate change in developing countries. |

**Learning outcomes**

After a successful completion of the course, the students…
- are able to describe key concepts and structure of economic growth models and drivers of socio-economic development.
- can explain the role of institutions, labor markets, migration and sustainable natural resource management for economic development.
- are able to apply learned concepts for analysis of development polices.
- can contrast methods for conducting research on sustainable natural resource management topics.
- will appraise empirical examples through case studies.
- are able to generalize lessons learnt from case studies to broader development issues.

### 2. Prerequisites

| | |
|---|---|
| **obligatory** | |
| **recommended** | Modules "Advanced Applied Econometrics", "Research Seminar on agricultural and development policy" and "Economics of Sustainability" |
| **Maximum number of students** | |

### 3. Study program allocation

| **Study program** | **Compulsory/ Elective** | **Semester** |
|---|---|---|
| M.Sc. Agricultural and Food Economics | E | 2. |
| M.Sc. Agricultural Science and Resource Management in the Tropics and Subtropics (ARTS) | E | 2. |

### 4. Teaching and learning methodes

| **Type of course** | **Interval** | **Topic** | **Language of instruction** | **Group size** | **SWS** | **Workload [h]** | |
|---|---|---|---|---|---|---|---|
| | | | | | | **Contact time** | **Self-study** |
| L | during the semester | Development Economics | English | 25 | 2,0 | 30,0 | 60,0 |
| T | during the semester | Assignement | English | 25 | 2,0 | 30,0 | 60,0 |

| **5. Course cycle** | **6. Workload [h]** | **7. Duration** | **8. Credits (ECTS)** |
|---|---|---|---|
| SS | 180 | 1 | 6,0 |

### 9. Requirements for the rewarding of credits (ECTS)

| **Types of Assessment** | **Prerequisites for admission to the Assessment** | **Graded yes/no** | **Language (exam)** | **Weighting factor** |
|---|---|---|---|---|
| Written exam [780763249] | | graded | English | |

**Academic Achievements**

| Module Title: Development Economics |
| --- |
| **Module ID/Code:** ARTS-BC03 [780763240] |
| **10. Module coordination** |
| **Module coordinator** |
| Prof. Dr. Matin Qaim |
| **Teaching person** |
| The teaching persons in the current semester can be found in basis:<br>https://basis.uni-bonn.de/ |
| **Institute/ Department** |
| Agrar-, Forst- und Ernährungswissenschaften |
| **11. Further information** |
| |

## Module Title: Decision Analysis and Forecasting in Agriculture

**Module ID/Code:** ARTS-BC05 [780800230]

### 1. Content and intended learning outcomes

| | |
|---|---|
| **Learning content:** | - Introduction to decision analysis<br>- Forecasting and cognitive biases<br>- Calibration training<br>- Participatory modeling building<br>- Decision modeling in R<br>- Group project on decision analysis |

**Learning outcomes**

After a successful completion of the course, the students…
- will understand the value of decision analysis approaches for agricultural research.
- will be able to recognize their own biases and provide accurate range estimates for uncertain variables.
- will be able to analyze a decision context.
- will be able to draw conclusions from a decision model and recommend steps forward.
- will be able to develop decision models, comprehensively evaluate their findings and compose a report about the model they developed.

### 2. Prerequisites

| | |
|---|---|
| **obligatory** | |
| **recommended** | |
| **Maximum number of students** | 30 students |

### 3. Study program allocation

| Study program | Compulsory/ Elective | Semester |
|---|---|---|
| M.Sc. Agricultural Science and Resource Management in the Tropics and Subtropics (ARTS) | E | 2. |
| M.Sc. Crop Sciences | E Focus PERC | 2. |

### 4. Teaching and learning methodes

| Type of course | Interval | Topic | Language of instruction | Group size | SWS | Workload [h] | |
|---|---|---|---|---|---|---|---|
| | | | | | | Contact time | Self-study |
| L (blocked) | during the semester | Decision analysis and participatory modeling | English | 24 | 2,0 | 30,0 | 30,0 |
| PS (blocked) | during the semester | Practical decision analysis project | English | 12 | 2,0 | 30,0 | 90,0 |

| 5. Course cycle | 6. Workload [h] | 7. Duration | 8. Credits (ECTS) |
|---|---|---|---|
| SS | 180 | 1 | 6,0 |

### 9. Requirements for the rewarding of credits (ECTS)

| Types of Assessment | Prerequisites for admission to the Assessment | Graded yes/no | Language (exam) | Weighting factor |
|---|---|---|---|---|
| Project work [780800239] | | not graded | English | 0% |
| Report [780800238] | Project work complete, so that a report on it can be composed | graded | English | 100% |

**Academic Achievements**

| **Module Title: Decision Analysis and Forecasting in Agriculture** |
|---|
| **Module ID/Code:** ARTS-BC05 [780800230] |
| **10. Module coordination** |
| **Module coordinator** |
| Dr. Cory Whitney |
| **Teaching person** |
| The teaching persons in the current semester can be found in basis:<br>https://basis.uni-bonn.de/ |
| **Institute/ Department** |
| Agrar-, Forst- und Ernährungswissenschaften |
| **11. Further information** |
| Hubbard, 2014. How to Measure Anything: Finding the Value of "Intangibles" in Business (3rd edition). Wiley.<br>Luedeling and Shepherd, 2016. Decision-focused agricultural research. Solutions 7, 46-54.<br>https://www.thesolutionsjournal.com/article/decision-focused-agricultural-research/<br>Whitney et al., 2018. Decision analysis methods guide. Working paper, World Agroforestry Centre, Nairobi.<br>https://www.researchgate.net/publication/324978583_Decision_analysis_methods_guide_agricultural_policy_for_nutrition<br>Lanzanova et al., 2019. Improving development efficiency through decision analysis: Reservoir protection in Burkina Faso. Environmental Modelling & Software 115: 164–175. (contact instructors)<br>Shepherd et al., 2015. Development goals should enable decision-making. Nature 523: 152–154.<br>https://www.nature.com/news/policy-development-goals-should-enable-decision-making-1.17915<br>Whitney et al., 2017. Homegardens and the future of food and nutrition security in southwest Uganda. Agricultural Systems 154: 133–144. (contact instructors) |

## Module Title: Agricultural Entomology

**Module ID/Code:** ARTS-BC06 [780800080]

### 1. Content and intended learning outcomes

| | |
|---|---|
| **Learning content:** | Insects are major pests in agriculture but can provide benefitial effects such as pollination or pest control. This module increases the in-depth understanding of enthomological aspects in agriculture and presents examples of beneficial and harmful organisms regarding the follogiwng aspects:<br>- Functional morphology and anatomy<br>- Identification of insects<br>- Host-parasite interactions<br>- Development of symptoms<br>- Case studies from major crop types<br>- Antagonists of insect pests<br>- Use of insects in IPM apporaches<br>- Options for insect control<br>- Insecticide resistance |

**Learning outcomes**

After a successful completion of the course, the students…
- have obtained specific entomological knowledge.
- are able to comprehend and explain complex biological interactions.
- can explain specific problem issues related to biocontrol or the use of insecticides.

### 2. Prerequisites

| | |
|---|---|
| **obligatory** | |
| **recommended** | |
| **Maximum number of students** | 20 students |

### 3. Study program allocation

| Study program | Compulsory/ Elective | Semester |
|---|---|---|
| M.Sc. Agricultural Science and Resource Management in the Tropics and Subtropics (ARTS) | E | 2. |
| M.Sc. Crop Sciences | E Focus PERC | 2. |

### 4. Teaching and learning methodes

| Type of course | Interval | Topic | Language of instruction | Group size | SWS | Workload [h] | |
|---|---|---|---|---|---|---|---|
| | | | | | | Contact time | Self-study |
| L (blocked) | full-day block | Agricultural Entomology | | 20 | 2,0 | 10,0 | 50,0 |
| T | during the semester | Agricultural Entomology | English | 20 | 1,0 | 40,0 | 20,0 |
| S | during the semester | Agricultural Entomology | English | 20 | 1,0 | 40,0 | 20,0 |

| 5. Course cycle | 6. Workload [h] | 7. Duration | 8. Credits (ECTS) |
|---|---|---|---|
| SS | 180 | 1 | 6,0 |

### 9. Requirements for the rewarding of credits (ECTS)

| Types of Assessment | Prerequisites for admission to the Assessment | Graded yes/no | Language (exam) | Weighting factor |
|---|---|---|---|---|
| Report (presentation) [780800089] | | graded | English | 80% |
| Assignment [780800088] | | graded | English | 20% |

**Academic Achievements**

| **Module Title: Agricultural Entomology** |
| --- |
| **Module ID/Code:** ARTS-BC06 [780800080] |
| **10. Module coordination** |
| **Module coordinator** |
| Prof. Dr. Florian Grundler |
| **Teaching person** |
| The teaching persons in the current semester can be found in basis:<br>https://basis.uni-bonn.de/ |
| **Institute/ Department** |
| Agrar-, Forst- und Ernährungswissenschaften |
| **11. Further information** |
| |

## Module Title: Agricultural Nematology

**Module ID/Code:** ARTS-BC07 [780800090]

### 1. Content and intended learning outcomes

| | |
|---|---|
| **Learning content:** | The module provides in-depth knowledge in Agricultural Nematology. The biology of the most important groups of plant-parasitic and entomopathogenic nematodes is presented including the following topics:<br>-functional morphology and anatomy<br>-identification of nematodes<br>-host-parasite interactions and their mechanisms<br>-development of plant symptoms<br>-case studies in important crop plants<br>-nematode antagonists<br>-application and mode of action of entomopathogenic nematode<br>-options for nematode control |

**Learning outcomes**

After a successful completion of the course, the students…
- familiar with specific nematological expertise.
- able to present and explain complex biological situations.
- explain and evaluate specific problems in nematode pest control and application of beneficial nematodes.

### 2. Prerequisites

| | |
|---|---|
| **obligatory** | |
| **recommended** | |
| **Maximum number of students** | 25 students |

### 3. Study program allocation

| Study program | Compulsory/ Elective | Semester |
|---|---|---|
| M.Sc. Agricultural Science and Resource Management in the Tropics and Subtropics (ARTS) | E | 3. |
| M.Sc. Crop Sciences | E Focus PERC | 3. |

### 4. Teaching and learning methodes

| Type of course | Interval | Topic | Language of instruction | Group size | SWS | Workload [h] | |
|---|---|---|---|---|---|---|---|
| | | | | | | Contact time | Self-study |
| L | during the semester | Agricultural Nematology | English | 25 | 2,0 | 30,0 | 60,0 |
| T | during the semester | Agricultural Nematology | English | 25 | 1,0 | 15,0 | 30,0 |
| S | during the semester | Agricultural Nematology | English | 25 | 1,0 | 15,0 | 30,0 |

| 5. Course cycle | 6. Workload [h] | 7. Duration | 8. Credits (ECTS) |
|---|---|---|---|
| WS | 180 | 1 | 6,0 |

### 9. Requirements for the rewarding of credits (ECTS)

| Types of Assessment | Prerequisites for admission to the Assessment | Graded yes/no | Language (exam) | Weighting factor |
|---|---|---|---|---|
| Report (presentation) [780800099] | | graded | English | 80% |
| Assignment [780800098] | | graded | English | 20% |

**Academic Achievements**

| **Module Title: Agricultural Nematology** |
|---|
| **Module ID/Code:** ARTS-BC07 [780800090] |
| **10. Module coordination** |
| **Module coordinator** |
| Prof. Dr. Florian Grundler |
| **Teaching person** |
| The teaching persons in the current semester can be found in basis:<br>https://basis.uni-bonn.de/ |
| **Institute/ Department** |
| Agrar-, Forst- und Ernährungswissenschaften |
| **11. Further information** |
| |

## Module Title: Sustainable Entrepreneurship & Venturing

**Module ID/Code:** ARTS-BC08 [780750100]

### 1. Content and intended learning outcomes

| | |
|---|---|
| **Learning content:** | The module "Sustainable Entrepreneurship & Venturing" is designed for students interested in start-ups and how entrepreneurship may help foster urgent sustainability transformations. The module provides an overview of the entrepreneurial process of discovering, evaluating, and implementing new business ideas and models to promote sustainable development. During the course, students will explore the concept of sustainable entrepreneurship, which encompasses the fundamentals of entrepreneurship and sustainable business models as well as entrepreneurial tools for sustainability.<br>Building on this, sustainable venturing embraces an active role and aims to harness the innovative power of entrepreneurship to solve global social and environmental challenges. In this context, students will work in teams to develop a sustainable business idea. Course participants will be able to identify social and environmental problems, develop ideas for solutions, analyse and evaluate alternatives, and develop plans to implement their solution. Students are guided through the process of applying entrepreneurial tools to advance their entrepreneurial ideas and turn them into business models. Students are also familiarized with concepts and tools for presenting their business idea. |

**Learning outcomes**

After a successful completion of the course, the students…
- understand the specifies and requirements of sustainable entrepreneurship.
- are able to apply tools for sustainability-oriented idea generation and evaluation.
- have knowledge and skills to identify, develop, evaluate, and determine sustainable business models.
- create the foundations of an entrepreneurial mindset.

### 2. Prerequisites

| | |
|---|---|
| **obligatory** | none |
| **recommended** | none |
| **Maximum number of students** | 25 students |

### 3. Study program allocation

| Study program | Compulsory/ Elective | Semester |
|---|---|---|
| M.Sc. Agricultural Science and Resource Management in the Tropics and Subtropics (ARTS) | E | 2. |
| M.Sc. Nutrition Science | O | 2. |
| M.Sc. Molecular Food Technology | E | 2. |

### 4. Teaching and learning methodes

| Type of course | Interval | Topic | Language of instruction | Group size | SWS | Workload [h] | |
|---|---|---|---|---|---|---|---|
| | | | | | | Contact time | Self-study |
| S | during the semester | | English | 25 | 4,0 | 60,0 | 120,0 |

| 5. Course cycle | 6. Workload [h] | 7. Duration | 8. Credits (ECTS) |
|---|---|---|---|
| SS | 180 | 1 | 6,0 |

### 9. Requirements for the rewarding of credits (ECTS)

| Types of Assessment | Prerequisites for admission to the Assessment | Graded yes/no | Language (exam) | Weighting factor |
|---|---|---|---|---|
| Project work [780750109] | Regular participation | graded | English | |

**Academic Achievements**

| **Module Title: Sustainable Entrepreneurship & Venturing** |
|---|
| **Module ID/Code:** ARTS-BC08 [780750100] |
| **10. Module coordination** |
| **Module coordinator** |
| Prof. Dr. Denise Fischer-Kreer |
| **Teaching person** |
| The teaching persons in the current semester can be found in basis:<br>https://basis.uni-bonn.de/ |
| **Institute/ Department** |
| Agrar-, Forst- und Ernährungswissenschaften |
| **11. Further information** |
| |

# Compulsory modules of the second and third semester (ARTS-C)

**30 ECTS-CP must be completed.**

## Module Title: Current issues of research management

**Module ID/Code:** ARTS-C01 [780750070]

### 1. Content and intended learning outcomes

| | |
|---|---|
| **Learning content:** | New trends in resource management<br>(presentations by invited guest speakers)<br>Participation at international conference (Tropentag) |

**Learning outcomes**

After a successful completion of the course, the students…
- have learned about current issues in resource management.
- have exercised discussing implications with speakers.
- are able to analyze and synthesize information acquired at Tropentag conference.

### 2. Prerequisites

| | |
|---|---|
| **obligatory** | |
| **recommended** | |
| **Maximum number of students** | 60 students |

### 3. Study program allocation

| Study program | Compulsory/ Elective | Semester |
|---|---|---|
| M.Sc. Agricultural Science and Resource Management in the Tropics and Subtropics (ARTS) | C | 2.+3. |

### 4. Teaching and learning methodes

| Type of course | Interval | Topic | Language of instruction | Group size | SWS | Workload [h] | |
|---|---|---|---|---|---|---|---|
| | | | | | | Contact time | Self-study |
| L | during the semester | | English | 60 | 3,0 | 50,0 | 50,0 |
| S* | during the semester | | English | 60 | 1,0 | 20,0 | 60,0 |

| 5. Course cycle | 6. Workload [h] | 7. Duration | 8. Credits (ECTS) |
|---|---|---|---|
| WS+SS | 180 | 2 | 6,0 |

### 9. Requirements for the rewarding of credits (ECTS)

| Types of Assessment | Prerequisites for admission to the Assessment | Graded yes/no | Language (exam) | Weighting factor |
|---|---|---|---|---|
| Presentation [780750079] | Participation (presence) at >20 lectures/seminars | not graded | English | |

**Academic Achievements**

### 10. Module coordination

**Module coordinator**

Jan Ellenberger

**Teaching person**

The teaching persons in the current semester can be found in basis:
https://basis.uni-bonn.de/

**Institute/ Department**

Agrar-, Forst- und Ernährungswissenschaften

### 11. Further information

## Module Title: Scientific communication

**Module ID/Code:** ARTS-C02 [780800190]

### 1. Content and intended learning outcomes

| | |
|---|---|
| **Learning content:** | Students aquire technical skills to effectively communicate with other scientists (writing of research papers and theses, preparing posters, oral presentations) |

**Learning outcomes**

After a successful completion of the course, the students…
- know about scientific communication strategies.
- are able to target reserach journals based on aim and scopes.
- can structure scientific data for oral presentations.
- can arrange research data in the form of posters.
- can analyze research papers.
- can compose own reserach paper.

### 2. Prerequisites

| | |
|---|---|
| **obligatory** | |
| **recommended** | all compulsory modules ARTS A |
| **Maximum number of students** | 50 students |

### 3. Study program allocation

| Study program | Compulsory/ Elective | Semester |
|---|---|---|
| M.Sc. Agricultural Science and Resource Management in the Tropics and Subtropics (ARTS) | C | 3. |
| M.Sc. Crop Sciences | E Focus PERC | 3. |

### 4. Teaching and learning methodes

| Type of course | Interval | Topic | Language of instruction | Group size | SWS | Workload [h] | |
|---|---|---|---|---|---|---|---|
| | | | | | | Contact time | Self-study |
| L (blocked) | afternoon block | | English | 50 | 2,0 | 30,0 | 70,0 |
| P (blocked) | afternoon block | | English | 50 | 2,0 | 20,0 | 60,0 |

| 5. Course cycle | 6. Workload [h] | 7. Duration | 8. Credits (ECTS) |
|---|---|---|---|
| WS | 180 | 1 | 6,0 |

### 9. Requirements for the rewarding of credits (ECTS)

| Types of Assessment | Prerequisites for admission to the Assessment | Graded yes/no | Language (exam) | Weighting factor |
|---|---|---|---|---|
| none | | | | |

**Academic Achievements**

at least 3 group exercises must be submitted

### 10. Module coordination

**Module coordinator**

Dr. Janina Dierks

**Teaching person**

The teaching persons in the current semester can be found in basis:
https://basis.uni-bonn.de/

**Institute/ Department**

Agrar-, Forst- und Ernährungswissenschaften

### 11. Further information

| **Module Title: Sustainability and Risk** | |
|---|---|
| **Module ID/Code:** ARTS-C03 [780764260] | |
| **1. Content and intended learning outcomes** | |
| **Learning content:** | Knowledge about sustainability, risk(s) and transformation is key to understanding the societal challenges of global change and to considering them in one's own field of action. In this course we take an interdisciplinary approach to teaching these concepts integrating knowledge from social and natural theory and science.<br><br>Starting from the current state of global sustainability problems and transformation perspectives as well as associated political processes, this interdisciplinary and multi-perspective course first illustrates the fundamentals of the terms 'sustainability', 'risk' and ' transformation' as well as other related concepts and terms. Building on this theoretical unterpinning, particular attention is paid to the 2030 Agenda for Sustainable Development by critically discussing aspects such as implementation and measurement of the Sustainable Development Goals (SDGs) including the basics and critical aspects of economic growth.<br><br>Furthermore, we explore how farmers, consumers and insurances take decisions in the face of increasing risks associated with global change as well as transformation. This is done by providing insights into the field of sustainable consumption, such as on types, motives and barriers of sustainable production and consumption, as well as on measures to promote sustainable consumer behaviour. We furthermore explore how natural ecosystems manage risks and if and how these principles could be also applied in an agricultural context e.g. in the context of pest management. Furthermore, we introduce complex systems thinking as a tool to deal with risks.<br><br>The examples used during the course often refer to agriculture and the food industry, but are intentionally not limited to them. Besides the continuous use of built-in short exercises, interactive teaching formats (e.g. live quizzes, case studies, simulation game), students will be engaged in lively discussions on the topics and encouraged to bring in own perspectives.<br><br>As a basis for the grading, students will engage in group work to develop and implement either a board game or a small self-experiment (will be decided each year) incorporating aspects of risks, sustainability or transformation. The results of this group work will be presented during a public game or poster presentation. |
| **Learning outcomes** | |
| After a successful completion of the course, the students…<br>- know about the different scientific and political debates as well as their development in the context of sustainability, risks and transformation.<br>- have developed a general and interdisciplinary understanding of complex challenges and concepts related to sustainability, risks and transformation.<br>- understand the practical challenges and chances related to these concepts for agriculture in different contexts (different countries, different farm sizes etc.).<br>- are able to apply these concepts in the context of research questions related to agriculture and land use. | |
| **2. Prerequisites** | |
| **obligatory** | |
| **recommended** | |
| **Maximum number of students** | 50 students |

## Module Title: Sustainability and Risk

**Module ID/Code:** ARTS-C03 [780764260]

### 3. Study program allocation

| Study program | Compulsory/ Elective | Semester |
|---|---|---|
| M.Sc. Agricultural and Food Economics | E | 3. |
| M.Sc. Agricultural Science and Resource Management in the Tropics and Subtropics (ARTS) | C | 3. |
| M.Sc. Crop Sciences | E Focus PERC | 3. |

### 4. Teaching and learning methodes

| Type of course | Interval | Topic | Language of instruction | Group size | SWS | Workload [h] | |
|---|---|---|---|---|---|---|---|
| | | | | | | Contact time | Self-study |
| L | during the semester | | English | 80 | 4,0 | 45,0 | 135,0 |

| 5. Course cycle | 6. Workload [h] | 7. Duration | 8. Credits (ECTS) |
|---|---|---|---|
| WS | 180 | 1 | 6,0 |

### 9. Requirements for the rewarding of credits (ECTS)

| Types of Assessment | Prerequisites for admission to the Assessment | Graded yes/no | Language (exam) | Weighting factor |
|---|---|---|---|---|
| Presentation [780764269] | | graded | English | |

**Academic Achievements**

### 10. Module coordination

**Module coordinator**

Jun.-Prof. Dr. Lisa Biber-Freudenberger

**Teaching person**

The teaching persons in the current semester can be found in basis:
https://basis.uni-bonn.de/

**Institute/ Department**

Agrar-, Forst- und Ernährungswissenschaften

### 11. Further information

External guests e.g. farmers to talk about their perspectives on sustainability, risks and transformation

## Module Title: International research management and proposal writing

**Module ID/Code:** ARTS-C04 [780750080]

### 1. Content and intended learning outcomes

| | |
|---|---|
| **Learning content:** | International organizations for technical, scientific and financial support<br>Donors for international reserach and development projects (aims, scope, requirements)<br>Discussion strategies for reserach planning<br>Technical aspects of proposal planning and development (budget, time plan, break-down structure, Log Frame)<br>Do's and don't's in proposal writing<br>basic understanding of team work and research ethics<br>Principles of peer-reviewing<br>Proposal writing, presentation and defense |

**Learning outcomes**

After a successful completion of the course, the students…
- know about donors and potential partners.
- can effectively select and approach donors and partners.
- can plan and develop elements of a research proposal.
- can effectively review and assess the work of others (peer reviewing).
- can formulate a reserach proposal and target it to donors.
- can present and defend the content of the proposal to a donor or reviewer.

### 2. Prerequisites

| | |
|---|---|
| **obligatory** | |
| **recommended** | ARTS A modules (knowledge and comprehension of resources for agricultural production) |
| **Maximum number of students** | 25 students |

### 3. Study program allocation

| Study program | Compulsory/ Elective | Semester |
|---|---|---|
| M.Sc. Agricultural Science and Resource Management in the Tropics and Subtropics (ARTS) | C | 3. |

### 4. Teaching and learning methodes

| Type of course | Interval | Topic | Language of instruction | Group size | SWS | Workload [h] | |
|---|---|---|---|---|---|---|---|
| | | | | | | Contact time | Self-study |
| L (blocked) | afternoon block | International organizations | English | 25 | 1,0 | 10,0 | 20,0 |
| T* (blocked) | afternoon block | Proposal elements | English | 25 | 1,0 | 10,0 | 40,0 |
| S (blocked) | afternoon block | Assessing proposal quality | English | 25 | 1,0 | 10,0 | 20,0 |
| PS (blocked) | afternoon block | Developping a reserach proposal | English | 25 | 1,0 | 10,0 | 60,0 |

| 5. Course cycle | 6. Workload [h] | 7. Duration | 8. Credits (ECTS) |
|---|---|---|---|
| WS | 180 | 1 | 6,0 |

### 9. Requirements for the rewarding of credits (ECTS)

| Types of Assessment | Prerequisites for admission to the Assessment | Graded yes/no | Language (exam) | Weighting factor |
|---|---|---|---|---|
| Project work [780750089] | Presence at >10 lectures / exercises | graded | English | 100% |
| Assignment [780750088] | Homework exercise on breakdown, budget table Ghannt chart | not graded | English | 0% |
| Colloquium [780750087] | Presentation of at least 1 homework assignment | not graded | English | 0% |

**Academic Achievements**

| **Module Title: International research management and proposal writing** |
|---|
| **Module ID/Code:** ARTS-C04 [780750080] |
| **10. Module coordination** |
| **Module coordinator** |
| Jun. Prof. Dr. Janina Dierks |
| **Teaching person** |
| The teaching persons in the current semester can be found in basis:<br>https://basis.uni-bonn.de/ |
| **Institute/ Department** |
| Agrar-, Forst- und Ernährungswissenschaften |
| **11. Further information** |
| |

## Module Title: Data Analysis and Visualization

**Module ID/Code:** ARTS-C05 [780800010]

### 1. Content and intended learning outcomes

| | |
|---|---|
| **Learning content:** | Introduction to planning of field experiments and their analysis (Feldversuchswesen). Introduction to statistics and to statistical software „R“: exploratory data analysis and visualization of data, hypothesis testing, analysis of variance, regression. Introduction to research data management. Introduction to system analysis and modeling. |

**Learning outcomes**

After a successful completion of the course, the students…
- can generate and interpret box piots, histograms, scatter plots.
- can perform and interpret basic hypothesis tests, ANOVA and linear regression.

### 2. Prerequisites

| | |
|---|---|
| **obligatory** | |
| **recommended** | at least 5 successfully completed modules in ARTS-A |
| **Maximum number of students** | |

### 3. Study program allocation

| Study program | Compulsory/ Elective | Semester |
|---|---|---|
| M.Sc. Agricultural Science and Resource Management in the Tropics and Subtropics (ARTS) | C | 3. |
| M.Sc. Crop Sciences | C | 1. |

### 4. Teaching and learning methodes

| Type of course | Interval | Topic | Language of instruction | Group size | SWS | Workload [h] | |
|---|---|---|---|---|---|---|---|
| | | | | | | Contact time | Self-study |
| L | during the semester | Methods for agricultural research data | English | 120 | 3,0 | 45,0 | 45,0 |
| P | during the semester | Computer exercises methods for agricultural research data | English | 30 | 2,0 | 30,0 | 60,0 |

| 5. Course cycle | 6. Workload [h] | 7. Duration | 8. Credits (ECTS) |
|---|---|---|---|
| WS | 180 | 1 | 6,0 |

### 9. Requirements for the rewarding of credits (ECTS)

| Types of Assessment | Prerequisites for admission to the Assessment | Graded yes/no | Language (exam) | Weighting factor |
|---|---|---|---|---|
| Assignment [780800019] | | graded | English | |

**Academic Achievements**

### 10. Module coordination

**Module coordinator**

Prof. Dr. Heiko Schoof

**Teaching person**

The teaching persons in the current semester can be found in basis:
https://basis.uni-bonn.de/

**Institute/ Department**

Agrar-, Forst- und Ernährungswissenschaften, Mathematik

### 11. Further information

# Free elective module

**A maximum of 12 ECTS-CP can be completed from free elective modules.**

## Module Title: Technology and Sensors in Precision Crop Production

**Module ID/Code:** NPW-002 [780800020]

### 1. Content and intended learning outcomes

| | |
|---|---|
| **Learning content:** | Knowledge of the sensors used in precision farming and the motivation for their use. Including the fundamentals and use of precision localisation systems (e.g. GNSS and differential GNSS) for control traffic farming, planting and site specific management. The use of different sensors and sensing technology to estimate farm and crop health including multi-spectral imagery at different scales (e.g. from satellites, UAVs). |

**Learning outcomes**

After a successful completion of the course, the students…
- will have an understanding of precision farming principles.
- will understand the function of different sensors and their use in precision farming.
- will have an understanding of GNSS and differential GNSS.

### 2. Prerequisites

| | |
|---|---|
| **obligatory** | |
| **recommended** | Module "Precision Farming" (B.Sc. Agrarwissenschaften) |
| **Maximum number of students** | |

### 3. Study program allocation

| Study program | Compulsory/ Elective | Semester |
|---|---|---|
| M.Sc. Agricultural Science and Resource Management in the Tropics and Subtropics (ARTS) | O | 3. |
| M.Sc. Crop Sciences | C | 1. |
| M.Ed. Agricultural Science (Teacher's Training) | E | 1. |

### 4. Teaching and learning methodes

| Type of course | Interval | Topic | Language of instruction | Group size | SWS | Workload [h] | |
|---|---|---|---|---|---|---|---|
| | | | | | | Contact time | Self-study |
| L | during the semester | | English | 120 | 2,0 | 30,0 | 60,0 |
| S | during the semester | | English | 30 | 2,0 | 30,0 | 60,0 |

| 5. Course cycle | 6. Workload [h] | 7. Duration | 8. Credits (ECTS) |
|---|---|---|---|
| WS | 180 | 1 | 6,0 |

### 9. Requirements for the rewarding of credits (ECTS)

| Types of Assessment | Prerequisites for admission to the Assessment | Graded yes/no | Language (exam) | Weighting factor |
|---|---|---|---|---|
| Written exam [780800029] | | graded | English | |

**Academic Achievements**

### 10. Module coordination

**Module coordinator**

Dr. Lasse Klingbeil

**Teaching person**

The teaching persons in the current semester can be found in basis:
https://basis.uni-bonn.de/

**Institute/ Department**

Agrar-, Forst- und Ernährungswissenschaften, Vermessungswesen

### 11. Further information

## Module Title: Tree phenology analysis in R

**Module ID/Code:** NPW-034 [780800340]

### 1. Content and intended learning outcomes

| | |
|---|---|
| **Learning content:** | Using the chillR package for R, data on the timing of tree life cycle events will be related to temperature data and analyzed in a number of ways. Students will learn how to:<br>- Efficiently compute common chill and heat metrics<br>- Illustrate and evaluate temporal trends in thermal metrics<br>- Design functions for additional metrics<br>- Relate phenology data to temperature records using multivariate statistics<br>- Identify temperature response phases of temperate tree crops<br>- Generate past and future temperature scenarios using a weather generator<br>- Evaluate past and prospective future impacts of climate change on thermal metrics<br>- Participate in a phenology monitoring experiment under semi-controlled conditions<br>- Analyze a phenology dataset and compile a report about their findings<br>- Use git and github for version control and collaboration and R-Markdown for report writing |

**Learning outcomes**

After a successful completion of the course, the students…
- will be able to apply R functions and develop code using version control (github).
- will be able to analyze phenology records and relate them to temperature data.
- will be able to evaluate climate change impacts on thermal metrics.
- will be able to compile a comprehensive and fully reproducible report on the agroclimatic history and prospects for a particular context, combining results from several analyses.
- will be familiar with phenology monitoring protocols and able to apply them.

### 2. Prerequisites

| | |
|---|---|
| **obligatory** | |
| **recommended** | |
| **Maximum number of students** | 12 students |

### 3. Study program allocation

| Study program | Compulsory/ Elective | Semester |
|---|---|---|
| M.Sc. Crop Sciences | E Focus DA | 3. |
| M.Sc. Agricultural Science and Resource Management in the Tropics and Subtropics (ARTS) | O | 3. |

### 4. Teaching and learning methodes

| Type of course | Interval | Topic | Language of instruction | Group size | SWS | Workload [h] | |
|---|---|---|---|---|---|---|---|
| | | | | | | Contact time | Self-study |
| PS | during the semester | Phenology data analysis | English | 12 | 1,0 | 15,0 | 15,0 |
| P | during the semester | Phenology monitoring and data analysis exercises | English | 12 | 3,0 | 45,0 | 105,0 |

| 5. Course cycle | 6. Workload [h] | 7. Duration | 8. Credits (ECTS) |
|---|---|---|---|
| WS | 180 | 1 | 6,0 |

### 9. Requirements for the rewarding of credits (ECTS)

| Types of Assessment | Prerequisites for admission to the Assessment | Graded yes/no | Language (exam) | Weighting factor |
|---|---|---|---|---|
| Term paper [780800349] | | graded | English | |

**Academic Achievements**

## Module Title: Tree phenology analysis in R

**Module ID/Code:** NPW-034 [780800340]

### 10. Module coordination

**Module coordinator**

Prof. Dr. Eike Lüdeling

**Teaching person**

The teaching persons in the current semester can be found in basis:
https://basis.uni-bonn.de/

**Institute/ Department**

Agrar-, Forst- und Ernährungswissenschaften

### 11. Further information

Luedeling, 2019. chillR: Statistical methods for phenology analysis in temperate fruit trees. https://cran.r-project.org/web/packages/chillR/index.html
Luedeling et al., 2011. Climate Change Affects Winter Chill for Temperate Fruit and Nut Trees. PLoS ONE 6, e20155. https://doi.org/10.1371/journal.pone.0020155
Luedeling, 2012. Climate change impacts on winter chill for temperate fruit and nut production: A review. Scientia Horticulturae 144, 218–229. https://doi.org/10.1016/j.scienta.2012.07.011
Luedeling and Gassner, 2012. Partial Least Squares Regression for analyzing walnut phenology in California. Agricultural and Forest Meteorology 158–159, 43–52. https://doi.org/10.1016/j.agrformet.2011.10.020
Luedeling et al., 2013. Differential responses of trees to temperature variation during the chilling and forcing phases. Agricultural and Forest Meteorology 181, 33–42. https://doi.org/10.1016/j.agrformet.2013.06.018
Guo et al., 2015. Responses of spring phenology in temperate zone trees to climate warming: A case study of apricot flowering in China. Agricultural and Forest Meteorology 201, 1–7. https://doi.org/10.1016/j.agrformet.2014.10.016
Benmoussa et al., 2018. Climate change threatens central Tunisian nut orchards. Int J Biometeorol 62, 2245–2255. https://doi.org/10.1007/s00484-018-1628-x
Benmoussa et al., 2017. Performance of pistachio (Pistacia vera L.) in warming Mediterranean orchards. Environmental and Experimental Botany 140, 76–85. https://doi.org/10.1016/j.envexpbot.2017.05.007

Each student needs a computer for the exercises.

## Module Title: Lecture Series on Future Competent Agricultural and Food Systems

**Module ID/Code:** NPW-053 [780800530]

### 1. Content and intended learning outcomes

| | |
|---|---|
| **Learning content:** | The interdisciplinary lecture series will take up the societal debate on the future of Agriculture and Food Systems. It will cover important aspects of sustainability, supply chains, planetary health, innovative production systems, biodiversity, life cycle assessment, digitalization among others to discuss the transformation of the current systems into future competent ones. In this context a system approach will be taken to discuss the challenges and how the different scientific fields could contribute to the solutions. |

**Learning outcomes**

After a successful completion of the course, the students…
- obtain an overview of a specific research field.
- will have an understanding of agricultural and nutritional sciences in a societal context.
- will understand the possible interactions between agriculture, food systems, and sustainability.
- are able to discuss key topics of agricultural and food systems, sustainability, food supply chains.
- will be able to take part in scientific discourse.
- communicate and discuss findings and evaluations with colleagues/other students.

### 2. Prerequisites

| | |
|---|---|
| **obligatory** | |
| **recommended** | For each lecture a list of additional readings will be offered. |
| **Maximum number of students** | 25 students |

### 3. Study program allocation

| Study program | Compulsory/ Elective | Semester |
|---|---|---|
| M.Sc. Agricultural Science and Resource Management in the Tropics and Subtropics (ARTS) | E | 1./3. |
| M.Sc. Crop Sciences | E | 1./3. |

### 4. Teaching and learning methodes

| Type of course | Interval | Topic | Language of instruction | Group size | SWS | Workload [h] | |
|---|---|---|---|---|---|---|---|
| | | | | | | Contact time | Self-study |
| L | during the semester | | English | 500 | 1,5 | 22,0 | 30,0 |
| S | | single appointment | English | 25 | 0,3 | 4,0 | 10,0 |
| C | | single appointment | English | 25 | 0,3 | 4,0 | 20,0 |

| 5. Course cycle | 6. Workload [h] | 7. Duration | 8. Credits (ECTS) |
|---|---|---|---|
| WS | 90 | 1 | 3,0 |

### 9. Requirements for the rewarding of credits (ECTS)

| Types of Assessment | Prerequisites for admission to the Assessment | Graded yes/no | Language (exam) | Weighting factor |
|---|---|---|---|---|
| Term paper [780800539] | Participation at minimum of 80% of lectures | graded | English | 100% |
| Colloquium [780800538] | Participation at minimum of 80% of lectures | not graded | English | 0% |

**Academic Achievements**

| **Module Title: Lecture Series on Future Competent Agricultural and Food Systems** |
|---|
| **Module ID/Code:** NPW-053 [780800530] |
| **10. Module coordination** |
| **Module coordinator** |
| Dr. Thorsten Kraska |
| **Teaching person** |
| The teaching persons in the current semester can be found in basis:<br>https://basis.uni-bonn.de/ |
| **Institute/ Department** |
| |
| **11. Further information** |
| The „Fakultätentag“ is the official oganization of Agricultural and / or Nutritional Sciences faculties at Germany Universities. Member faculties come from the Universities of Berlin, Bonn, Gießen, Göttingen, Halle, Hohenheim, Jena, Kassel-Witzenhausen, Kiel, Munich, andRostock.<br><br>The lectures will be given by scientists from member faculties or by invited speakers. The program will be corporately organized by the members of the Fakultätentag.<br><br>While the examination is limited to 25 students of the M.Sc. programs, the lecture series open for guests. |

## Module Title: Lecture Series on Current Topics in Agricultural and Food Research

**Module ID/Code:** NPW-058 [780800580]

### 1. Content and intended learning outcomes

| | |
|---|---|
| **Learning content:** | The interdisciplinary lecture series will take up current research topics from the member faculties of the "Fakultätentag Agrarwissenschaften und Ökotrophologie. It will highlight ongoing research and future research fields. |

**Learning outcomes**

After a successful completion of the course, the students…
- obtain an overview of a specific research field.
- will have an understanding of agricultural and nutritional research topics.
- will understand the possible interactions between agriculture, food systems, and sustainability.
- are able to discuss key topics of agricultural and food research, sustainability, food supply chains.
- will be able to take part in scientific discourse.
- communicate and discuss findings and evaluations with colleagues/other students.

### 2. Prerequisites

| | |
|---|---|
| **obligatory** | none |
| **recommended** | For each lecture a list of additional readings will be offered. |
| **Maximum number of students** | 30 students |

### 3. Study program allocation

| Study program | Compulsory/ Elective | Semester |
|---|---|---|
| M.Sc. Agricultural Science and Resource Management in the Tropics and Subtropics (ARTS) | O | 1./3. |
| M.Sc. Nature Conservation and Landscape Ecology | O | 1./3. |
| M.Sc. Crop Sciences | E | 1./3. |

### 4. Teaching and learning methodes

| Type of course | Interval | Topic | Language of instruction | Group size | SWS | Workload [h] | |
|---|---|---|---|---|---|---|---|
| | | | | | | Contact time | Self-study |
| L | during the semester | Agricultural and food systems of the future | English | 500 | 1,5 | 22,0 | 22,0 |
| S* | | Preparation for colloquium | English | 30 | 0,3 | 4,0 | 10,0 |
| C* | | Presentation and discussion of selected topics from the lecture series | English | 30 | 0,2 | 4,0 | 28,0 |

| 5. Course cycle | 6. Workload [h] | 7. Duration | 8. Credits (ECTS) |
|---|---|---|---|
| WS | 90 | 1 | 3,0 |

### 9. Requirements for the rewarding of credits (ECTS)

| Types of Assessment | Prerequisites for admission to the Assessment | Graded yes/no | Language (exam) | Weighting factor |
|---|---|---|---|---|
| Presentation [780800589] | Participation at minimum of 80% of lectures | graded | English | |

**Academic Achievements**

| **Module Title: Lecture Series on Current Topics in Agricultural and Food Research** |
|---|
| **Module ID/Code:** NPW-058 [780800580] |
| **10. Module coordination** |
| **Module coordinator** |
| Dr. Thorsten Kraska |
| **Teaching person** |
| The teaching persons in the current semester can be found in basis:<br>https://basis.uni-bonn.de/ |
| **Institute/ Department** |
| Agrar-, Forst- und Ernährungswissenschaften |
| **11. Further information** |
| The „Fakultätentag“ is the official oganization of Agricultural and / or Nutritional Sciences faculties at Germany Universities. Member faculties come from the Universities of Berlin, Bonn, Gießen, Göttingen, Halle, Hohenheim, Jena, Kassel-Witzenhausen, Kiel, Munich, and Rostock.<br><br>The lectures will be given by scientists from member faculties or by invited speakers. The program will be corporately organized by the members of the Fakultätentag.<br><br>While the examination is limited to 30 students of the M.Sc. programs, the lecture series is open for guests.<br><br>This lecture series will be every 2nd year |

## Module Title: Environmental Governance

**Module ID/Code:** ILR-03 [780760030]

### 1. Content and intended learning outcomes

| | |
|---|---|
| **Learning content:** | Governance is a set of social processes and structures guiding individual, group and organizational behavior. The course provides a detailed overview of different governance theories and approaches to address environmental and sustainability challenges. The course examines why collective action problems arise between individual and group interests, and how different governance theories help explain different ways of organizing society and social institutions to shape our behavior, incentives and outcomes. A variety of different governance theories will be reviewed to compare their analytical potential and challenges, and furthermore examine how different governance theories from different disciplinary perspectives are useful for understanding the current complexity of environmental and sustainability problems. The role of interdisciplinary science will be explored in order to advance the understanding of complex human-environmental systems and their governance. |

**Learning outcomes**

After a successful completion of the course, the students…
- understand of how governance problems arise, the role of collective action and collective action problems, and why governance is a central social factor guiding individual, group and organizational behavior.
- know of key social science terminology and concepts including institutions, rules, norms, social networks, and human behavior.
- know of scales and cross-scale issues.
- understand the most prominent environmental governance theories across disciplines, their differences, analytical advantages and shortcomings.
- critical think about environmental problems with a detailed understanding of how social institutions and organizations are organized and could be re-organized.
- know of systems thinking approaches and current research frontiers in environmental governance.
- know of real case studies with different governance problems and solutions.
- are able to diagnose governance challenges in new cases with existing theories and frameworks.

### 2. Prerequisites

| | |
|---|---|
| **obligatory** | none |
| **recommended** | Knowledge of institutional economics or political science<br>Knowledge of social and environmental sustainability concepts |
| **Maximum number of students** | |

### 3. Study program allocation

| Study program | Compulsory/ Elective | Semester |
|---|---|---|
| M.Sc. Agricultural and Food Economics | O | 1.-3. |
| M.Sc. Agricultural Science and Resource Management in the Tropics and Subtropics (ARTS) | O | 1.-3. |
| M.Sc. Nature Conservation and Landscape Ecology | O | 1.-3. |

### 4. Teaching and learning methodes

| Type of course | Interval | Topic | Language of instruction | Group size | SWS | Workload [h] | |
|---|---|---|---|---|---|---|---|
| | | | | | | Contact time | Self-study |
| L | during the semester | Environmental Governance | English | 180 | 4,0 | 45,0 | 135,0 |

| 5. Course cycle | 6. Workload [h] | 7. Duration | 8. Credits (ECTS) |
|---|---|---|---|
| WS/SS | 180 | 1 | 6,0 |

**Module Title: Environmental Governance**

**Module ID/Code:** ILR-03 [780760030]

## 9. Requirements for the rewarding of credits (ECTS)

| Types of Assessment | Prerequisites for admission to the Assessment | Graded yes/no | Language (exam) | Weighting factor |
|---|---|---|---|---|
| Written exam [780760039] | | graded | English | 33,299999999999997% |
| Presentation [780760038] | | graded | English | 33,299999999999997% |
| Project work [780760037] | | graded | English | 33,3% |

**Academic Achievements**

## 10. Module coordination

**Module coordinator**

Prof. Dr. Stefan Partelow

**Teaching person**

The teaching persons in the current semester can be found in basis:
https://basis.uni-bonn.de/

**Institute/ Department**

Agrar-, Forst- und Ernährungswissenschaften

## 11. Further information

## Module Title: Data Analysis of Ecosystem-Atmosphere Interactions

**Module ID/Code:** NALA-045

### 1. Content and intended learning outcomes

**Learning content:**

This module introduces students to key concepts and methodologies for understanding and evaluating environmental interactions between ecosystems (soils and plants), and the atmosphere and how to use different environmental data. The course will introduce theory of different processes and mechanisms related to ecosystem-atmosphere interactions, but has a strong focus on practical exercises of data analysis approaches. It will cover greenhouse gas emissions (e.g., $CO_2$ and $N_2O$), evapotranspiration, photosynthesis and ecosystem respiration, air quality, drought indicators as well as the evaluation of meteorological variables such as precipitation, air temperature or soil moisture, including long-term data series to assess climate change. Using measured data and open-source datasets (Fluxnet, ERA5, etc.) a practical exercise focusing on each of these topics will be performed every 1-2 weeks. The course offers training in handling time-series of environmental data, focusing on data preparation, quality control and trend detection to assess climate change and its effects on ecosystem-atmosphere interactions, and will introduce spatial analysis methods for mapping spatial variability. Through practical exercises, students will learn about the different ecosystem-atmosphere interaction processes and mechanisms and how to integrate spatial and temporal data to monitor and evaluate environmental changes..

**Learning outcomes**

- Identify main ecosystem-atmosphere interaction processes ad mechanisms ,
- Are aware of most relevant open-source environmental and climate datasets to analyze soil-plant-atmosphere interactions,
- Identify data needed to address questions on ecosystem-atmosphere interactions,
- Prepare and perform quality-control of time-series data,
- Compute ecosystem greenhouse gas (GHG) fluxes and water fluxes based on different data sources,
- Evaluate trends and patterns of different environmental data (i.e. climate data, ecosystem fluxes, air quality, drought, etc.),
- Conduct spatial data analysis and mapping to assess spatial variability in meteorological, climatological and flux data,
- Integrate multiple environmental datasets to assess ecosystem-atmosphere processes and interactions with the climate.

### 2. Prerequisites

| | |
|---|---|
| **obligatory** | Basic knowledge of R is recommended |
| **recommended** | |
| **Maximum number of students** | 15 |

### 3. Study program allocation

| Study program | Compulsory/ Elective | Semester |
|---|---|---|
| M.Sc. Agricultural Science and Resource Management in the Tropics and Subtropics (ARTS) | O | 1./3. |
| M. Sc. Nature Conservation and Landscape Ecology | O | 1./3. |
| M.Sc. Crop Science | O | 1./3. |

### 4. Teaching and learning methodes

| Type of course | Interval | Topic | Language of instruction | Group size | SWS | Workload [h] | |
|---|---|---|---|---|---|---|---|
| | | | | | | Contact time | Self-study |
| L | during the semester | | English | 15 | 1 | 15 | 30 |
| P | during the semester | Practical exercises of ecosystem-atmosphere interactions | English | 15 | 3 | 45 | 90 |

| 5. Course cycle | 6. Workload [h] | 7. Duration | 8. Credits (ECTS) |
|---|---|---|---|
| WS | 180 | 1 | 6,0 |

### 9. Requirements for the rewarding of credits (ECTS)

| Types of Assessment | Prerequisites for admission to the Assessment | Graded yes/no | Language (exam) | Weighting factor |
|---|---|---|---|---|
| Report | | graded | English | 40 % |
| Project work | Having submitted all individual reports for each exercise | graded | English | 60 % |

**Academic Achievements**

| **Module Title: Data Analysis of Ecosystem-Atmosphere Interactions** |
|---|
| **Module ID/Code:** NALA-045 |
| **10. Module coordination** |
| **Module coordinator** |
| Prof. Dr. Ana Meijide |
| **Teaching person** |
| The teaching persons in the current semester can be found in basis:<br>https://basis.uni-bonn.de/ |
| **Institute/ Department** |
| INRES |
| **11. Further information** |
| Students will have to submit the outcome of each of the individual exercises (i.e. figure or map evaluating different data); Final examination will be an individual project work evaluating specific datasets. |

| **Module Title: Agricultural Excursion to the Tropics and Subtropics** |
|---|
| **Module ID/Code: ARTS-F01** |

## Module Title: Agricultural Excursion to the Tropics and Subtropics

**Module ID/Code: ARTS-F01**

### 1. Content and intended learning outcomes

**Learning content:**

This module provides students with the opportunity to deepen their understanding of agricultural systems in tropical and subtropical regions through a combination of preparatory sessions, a field excursion, and a written report.

During the lecture period of the summer semester, several in-person meetings will be scheduled. In the first session, the structure and objectives of the excursion planned for the current semester will be introduced. Following this, students will collaboratively define presentation topics related to the specific focus of the excursion. In subsequent meetings, students will present their assigned topics, followed by group discussions. These presentations, along with the discussions, contribute 33% to the final grade.

The excursion itself usually takes place in September and lasts between 6 and 10 days. It typically includes visits to multiple agricultural enterprises in the destination country. Additionally, the program aims to facilitate exchanges with local universities and companies from related sectors, such as agricultural input suppliers or processing industries.

Following the excursion, each student is required to submit a written report of approximately five pages. The report should include a general reflection on experiences in the destination country and place a particular focus on the topic covered in the student's pre-excursion presentation. The written report contributes 67 % to the final grade.

**Learning outcomes**

After a successful completion of the course, the students…
- have gained specific knowledge on the agroecological zone(s) visited in the excursion. They are able to recall local cropping systems and the specific challenges for agriculture in the region.
- can classify observed agricultural systems, find examples of similar agricultural systems in other parts of the world, and compare these systems.
- can give and moderate a scientific presentation on a selected agricultural practice or processing technique (mandatory student presentation).
- are able to check and critique production methods in joint discussions with local farmers.

### 2. Prerequisites

| | |
|---|---|
| **obligatory** | Students must fulfill the legal requirements for entry into the destination country. This includes visa requirements and mandatory vaccinations. |
| **recommended** | |
| **Maximum number of students** | 10 |

### 3. Study program allocation

| Study program | Compulsory/ Elective | Semester |
|---|---|---|
| M.Sc. Agricultural Science and Resource Management in the Tropics and Subtropics (ARTS) | E | 1./3. |

### 4. Teaching and learning methodes

| Type of course | Interval | Topic | Language of instruction | Group size | SWS | Workload [h] | |
|---|---|---|---|---|---|---|---|
| | | | | | | Contact time | Self-study |
| S | during the semester | Excursion preparation and presentation | English | 10 | 1,0 | 10,0 | 35,0 |
| E | during the semester | | English | 10 | 3,0 | 50,0 | 85,0 |

| 5. Course cycle | 6. Workload [h] | 7. Duration | 8. Credits (ECTS) |
|---|---|---|---|
| WS | 180 | 1 | 6,0 |

### 9. Requirements for the rewarding of credits (ECTS)

| Types of Assessment | Prerequisites for admission to the Assessment | Graded yes/no | Language (exam) | Weighting factor |
|---|---|---|---|---|
| Presentation | | graded | English | 33 % |
| Report | | graded | English | 67 % |

| **Module Title: Agricultural Excursion to the Tropics and Subtropics** |
|---|
| **Module ID/Code: ARTS-F01** |
| **Academic Achievements** |
| |
| **10. Module coordination** |
| **Module coordinator** |
| Dr. Jan Ellenberger |
| **Teaching person** |
| The teaching persons in the current semester can be found in basis:<br>https://basis.uni-bonn.de/ |
| **Institute/ Department** |
| INRES |
| **11. Further information** |
| |

# Masterthesis and Colloquium

**The masterthesis credits 20 ECTS-CP and the colloquium 10 ECTS-CP.**

## Module Title: Masterthesis

**Module ID/Code:** ARTS-D1 [8900]

### 1. Content and intended learning outcomes

| | |
|---|---|
| **Learning content:** | Formulate a relevant research question<br>Elaborate a research proposal<br>Present the proposal at a department seminar<br>Conduct independently thesis reserach activity<br>Summerize and write-up reserach findings<br>Discuss own results in relation to the state of knowledge<br>Present key findings and defend thesis during a reserach colloquium |

**Learning outcomes**

After a successful completion of the course, the students…
- has shown proof to be able to independently formulate a research question.
- ability to conduct research under guidance.
- ability to synthesize results and present them in public.Die Bearbeitungsdauer beträgt mindestens zwei und höchstens sechs Monate.

### 2. Prerequisites

| | |
|---|---|
| **obligatory** | All compulsory modules of the first and third semester are completed (54 ECTS credit points)<br>At least 24 credit points have been achieved in the elective course modules |
| **recommended** | Reserach concept has been presented during a departmet seminar |
| **Maximum number of students** | |

### 3. Study program allocation

| Study program | Compulsory/ Elective | Semester |
|---|---|---|
| M.Sc. Agricultural Science and Resource Management in the Tropics and Subtropics (ARTS) | C | 4. |

### 4. Teaching and learning methodes

| Type of course | Interval | Topic | Language of instruction | Group size | SWS | Workload [h] | |
|---|---|---|---|---|---|---|---|
| | | | | | | Contact time | Self-study |
| Proj | during the semester | individually agreed upon with supervisor | English | 1 | | 0,0 | 900,0 |

| 5. Course cycle | 6. Workload [h] | 7. Duration | 8. Credits (ECTS) |
|---|---|---|---|
| SS | 600 | 1 | 20,0 |

### 9. Requirements for the rewarding of credits (ECTS)

| Types of Assessment | Prerequisites for admission to the Assessment | Graded yes/no | Language (exam) | Weighting factor |
|---|---|---|---|---|
| Masterthesis [8900] | | graded | English | |

**Academic Achievements**

### 10. Module coordination

**Module coordinator**

All independent teaching staff

**Teaching person**

The teaching persons in the current semester can be found in basis:
https://basis.uni-bonn.de/

**Institute/ Department**

Agrar-, Forst- und Ernährungswissenschaften

### 11. Further information

## Module Title: Colloquium

**Module ID/Code:** ARTS-D2 [8901]

### 1. Content and intended learning outcomes

| | |
|---|---|
| **Learning content:** | |

**Learning outcomes**

After a successful completion of the course, the students…
-

### 2. Prerequisites

| | |
|---|---|
| **obligatory** | |
| **recommended** | |
| **Maximum number of students** | |

### 3. Study program allocation

| Study program | Compulsory/ Elective | Semester |
|---|---|---|
| M.Sc. Agricultural Science and Resource Management in the Tropics and Subtropics (ARTS) | C | 4. |

### 4. Teaching and learning methodes

| Type of course | Interval | Topic | Language of instruction | Group size | SWS | Workload [h] | |
|---|---|---|---|---|---|---|---|
| | | | | | | Contact time | Self-study |
| | | | | | | | |

| 5. Course cycle | 6. Workload [h] | 7. Duration | 8. Credits (ECTS) |
|---|---|---|---|
| SS | 300 | 1 | 10,0 |

### 9. Requirements for the rewarding of credits (ECTS)

| Types of Assessment | Prerequisites for admission to the Assessment | Graded yes/no | Language (exam) | Weighting factor |
|---|---|---|---|---|
| [8901] | | | | |

**Academic Achievements**

### 10. Module coordination

**Module coordinator**

All independent teaching staff

**Teaching person**

The teaching persons in the current semester can be found in basis:
https://basis.uni-bonn.de/

**Institute/ Department**

### 11. Further information