

# **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**



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## 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.**

<b>Module Title: Ecological conditions and climate change</b>							
<b>Module ID/Code:</b> ARTS-A01 [780750010]							
<b>1. Content and intended learning outcomes</b>							
<b>Learning content:</b>	Students acquire 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: 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.); 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); 3. Seminar presentation on a selected climate change-related issue						
<b>Learning outcomes</b>							
After a successful completion of the course, the students... - understand and recognize ecological processes and interactions for agricultural production. - are able to classify, interpret, compare and critically assess climate observations and trends. - can summarize and explain observations using a case study example from their home country.							
<b>2. Prerequisites</b>							
<b>obligatory</b>							
<b>recommended</b>							
<b>Maximum number of students</b>	25 students						
<b>3. Study program allocation</b>							
<b>Study program</b>					<b>Compulsory/ Elective</b>		<b>Semester</b>
M.Sc. Agricultural Science and Resource Management in the Tropics and Subtropics (ARTS)					C		1.
<b>4. Teaching and learning methodes</b>							
<b>Type of course</b>	<b>Interval</b>	<b>Topic</b>	<b>Language of instruction</b>	<b>Group size</b>	<b>SWS</b>	<b>Workload [h]</b>	
						<b>Contact time</b>	<b>Self-study</b>
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
<b>5. Course cycle</b>			<b>6. Workload [h]</b>		<b>7. Duration</b>		<b>8. Credits (ECTS)</b>
WS			180		1		6,0

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

## Module Title: Food security and sustainable food systems

Module ID/Code: ARTS-A06 [780763260]

### 1. Content and intended learning outcomes

<b>Learning content:</b>	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.
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### 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

<b>obligatory</b>	
<b>recommended</b>	
<b>Maximum number of students</b>	

### 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

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

<b>Module Title: Conservation and use of genetic resources</b>								
<b>Module ID/Code:</b> ARTS-A03 [780750020]								
<b>1. Content and intended learning outcomes</b>								
<b>Learning content:</b>	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 manipulate 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.							
<b>Learning outcomes</b>								
After a successful completion of the course, the students...								
<ul style="list-style-type: none"><li>- will know the basics of plant and animal genetics as relevant for agriculture.</li><li>- will know current methods of conserving and using genetic diversity for agriculture.</li><li>- will know state-of the art biotechnological approaches used in agriculture.</li><li>- will be able to critically judge, compare and justify different biotechnological approaches and their application in agriculture.</li><li>- will be able to integrate their knowledge of different genetic and biotechnological approaches to develop strategies of preserving and using genetic resources.</li></ul>								
<b>2. Prerequisites</b>								
<b>obligatory</b>								
<b>recommended</b>	Knowledge of fundamental plant and animal biology							
<b>Maximum number of students</b>	40 students							
<b>3. Study program allocation</b>								
<b>Study program</b>					<b>Compulsory/ Elective</b>		<b>Semester</b>	
M.Sc. Agricultural Science and Resource Management in the Tropics and Subtropics (ARTS)					C		1.	
<b>4. Teaching and learning methodes</b>								
<b>Type of course</b>	<b>Interval</b>	<b>Topic</b>		<b>Language of instruction</b>	<b>Group size</b>	<b>SWS</b>	<b>Workload [h]</b>	
							<b>Contact time</b>	<b>Self-study</b>
L (blocked)	afternoon block			English	40	3,0	40,0	80,0
S* (blocked)	afternoon block			English	40	1,0	20,0	40,0
<b>5. Course cycle</b>				<b>6. Workload [h]</b>		<b>7. Duration</b>		<b>8. Credits (ECTS)</b>
WS				180		1		6,0
<b>9. Requirements for the rewarding of credits (ECTS)</b>								
<b>Types of Assessment</b>		<b>Prerequisites for admission to the Assessment</b>			<b>Graded yes/no</b>		<b>Language (exam)</b>	<b>Weighting factor</b>
Presentation [780750029]					not graded		English	0%
Written exam [780750028]		Participation in the seminar			graded		English	100%
<b>Academic Achievements</b>								

<b>Module Title: Conservation and use of genetic resources</b>
<b>Module ID/Code:</b> ARTS-A03 [780750020]
<b>10. Module coordination</b>
<b>Module coordinator</b>
Dr. Mariana Báez
<b>Teaching person</b>
The teaching persons in the current semester can be found in basis: <a href="https://basis.uni-bonn.de/">https://basis.uni-bonn.de/</a>
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<b>11. Further information</b>

<b>Module Title: Agricultural production systems</b>										
<b>Module ID/Code:</b> ARTS-A04 [780750030]										
<b>1. Content and intended learning outcomes</b>										
<b>Learning content:</b>	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.									
	1. (sub)tropical plant production 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.									
	2. (sub)tropical animal production systems Animal production systems in different climatic zones and socio-economic environments including:									
	- breeding, nutrition, animal health, mechanization, differentiation and integration of production goals.									
<b>Learning outcomes</b>										
After a successful completion of the course, the students...										
- recognize different types of production systems.										
- understand interactions between system components.										
<b>2. Prerequisites</b>										
<b>obligatory</b>										
<b>recommended</b>										
<b>Maximum number of students</b>		25 students								
<b>3. Study program allocation</b>										
<b>Study program</b>					<b>Compulsory/ Elective</b>		<b>Semester</b>			
M.Sc. Agricultural Science and Resource Management in the Tropics and Subtropics (ARTS)					C		1.			
<b>4. Teaching and learning methodes</b>										
<b>Type of course</b>	<b>Interval</b>	<b>Topic</b>		<b>Language of instruction</b>	<b>Group size</b>	<b>SWS</b>	<b>Workload [h]</b>			
							<b>Contact time</b>	<b>Self-study</b>		
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		
<b>5. Course cycle</b>				<b>6. Workload [h]</b>		<b>7. Duration</b>		<b>8. Credits (ECTS)</b>		
WS				180		1		6,0		
<b>9. Requirements for the rewarding of credits (ECTS)</b>										
<b>Types of Assessment</b>		<b>Prerequisites for admission to the Assessment</b>			<b>Graded yes/no</b>		<b>Language (exam)</b>		<b>Weighting factor</b>	
Written exam [780750039]					graded		English			
<b>Academic Achievements</b>										

<b>Module Title: Agricultural production systems</b>
<b>Module ID/Code:</b> ARTS-A04 [780750030]
<b>10. Module coordination</b>
<b>Module coordinator</b>
Prof. Dr. Mathias Becker
<b>Teaching person</b>
The teaching persons in the current semester can be found in basis: <a href="https://basis.uni-bonn.de/">https://basis.uni-bonn.de/</a>
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<b>11. Further information</b>

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

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

<b>Module Title: Crop Physiology</b>								
<b>Module ID/Code:</b> ARTS-AM05a [780800050]								
<b>1. Content and intended learning outcomes</b>								
<b>Learning content:</b>	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.							
<b>Learning outcomes</b>								
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.								
<b>2. Prerequisites</b>								
<b>obligatory</b>								
<b>recommended</b>								
<b>Maximum number of students</b>								
<b>3. Study program allocation</b>								
<b>Study program</b>					<b>Compulsory/ Elective</b>		<b>Semester</b>	
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.	
<b>4. Teaching and learning methodes</b>								
<b>Type of course</b>	<b>Interval</b>	<b>Topic</b>		<b>Language of instruction</b>	<b>Group size</b>	<b>SWS</b>	<b>Workload [h]</b>	
							<b>Contact time</b>	<b>Self-study</b>
L	during the semester	Crop Physiology		English	120	2,0	30,0	60,0
<b>5. Course cycle</b>			<b>6. Workload [h]</b>		<b>7. Duration</b>		<b>8. Credits (ECTS)</b>	
WS			90		1		3,0	
<b>9. Requirements for the rewarding of credits (ECTS)</b>								
<b>Types of Assessment</b>		<b>Prerequisites for admission to the Assessment</b>			<b>Graded yes/no</b>		<b>Language (exam)</b>	
eKlausur 45 min [780800059]					graded		English	
<b>Academic Achievements</b>								
<b>10. Module coordination</b>								
<b>Module coordinator</b>								
Prof. Dr. Andreas Meyer								
<b>Teaching person</b>								
The teaching persons in the current semester can be found in basis: <a href="https://basis.uni-bonn.de/">https://basis.uni-bonn.de/</a>								
<b>Institute/ Department</b>								
Agrar-, Forst- und Ernährungswissenschaften								
<b>11. Further information</b>								

<b>Module Title: Crop Breeding Research</b>							
<b>Module ID/Code:</b> ARTS-AM05b [780800060]							
<b>1. Content and intended learning outcomes</b>							
<b>Learning content:</b>	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.						
<b>Learning outcomes</b>							
After a successful completion of the course, the students...							
<ul style="list-style-type: none"><li>- are able to explain the genetic basis of crop genetic resources.</li><li>- are able to discuss the relevance of crop traits in breeding programs.</li><li>- are able to explain and differentiate methods for breeding.</li><li>- are able to discuss the impact of modern approaches on breeding.</li></ul>							
<b>2. Prerequisites</b>							
<b>obligatory</b>							
<b>recommended</b>	Module "Plant breeding" (B.Sc. Agrarwissenschaften)						
<b>Maximum number of students</b>							
<b>3. Study program allocation</b>							
<b>Study program</b>					<b>Compulsory/ Elective</b>		<b>Semester</b>
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.
<b>4. Teaching and learning methodes</b>							
<b>Type of course</b>	<b>Interval</b>	<b>Topic</b>	<b>Language of instruction</b>	<b>Group size</b>	<b>SWS</b>	<b>Workload [h]</b>	
						<b>Contact time</b>	<b>Self-study</b>
L	during the semester	Crop Genetics and Breeding	English	120	2,0	30,0	60,0
<b>5. Course cycle</b>			<b>6. Workload [h]</b>		<b>7. Duration</b>		<b>8. Credits (ECTS)</b>
WS			90		1		3,0
<b>9. Requirements for the rewarding of credits (ECTS)</b>							
<b>Types of Assessment</b>	<b>Prerequisites for admission to the Assessment</b>			<b>Graded yes/no</b>	<b>Language (exam)</b>	<b>Weighting factor</b>	
Written exam [780800069]				graded	English		
<b>Academic Achievements</b>							
<b>10. Module coordination</b>							
<b>Module coordinator</b>							
Dr. Agim Ballvora							
<b>Teaching person</b>							
The teaching persons in the current semester can be found in basis: <a href="https://basis.uni-bonn.de/">https://basis.uni-bonn.de/</a>							
<b>Institute/ Department</b>							
Agrar-, Forst- und Ernährungswissenschaften							
<b>11. Further information</b>							

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...							
<ul style="list-style-type: none"><li>- reproduce the main aspects of biotic interactions and their underlying mechanisms in cropping systems.</li><li>- understand the components and complexity of ecological interactions in cropping systems with regard to biotic interactions.</li><li>- analyse and evaluate the potential of a diversified cropping system - e.g. as described in a scientific article - to protect resources.</li><li>- design a diversified cropping system based on ecological theories.</li></ul>							
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							

<b>Module Title: Production ecology</b>
<b>Module ID/Code:</b> ARTS-AS05a [780800040]
<b>10. Module coordination</b>
<b>Module coordinator</b>
Prof. Dr. Thomas Döring
<b>Teaching person</b>
The teaching persons in the current semester can be found in basis: <a href="https://basis.uni-bonn.de/">https://basis.uni-bonn.de/</a>
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<b>Module Title: Resource conservation</b>							
<b>Module ID/Code:</b> ARTS-AS05b [780800030]							
<b>1. Content and intended learning outcomes</b>							
<b>Learning content:</b>	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.						
<b>Learning outcomes</b>							
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.							
<b>2. Prerequisites</b>							
<b>obligatory</b>							
<b>recommended</b>							
<b>Maximum number of students</b>							
<b>3. Study program allocation</b>							
<b>Study program</b>					<b>Compulsory/ Elective</b>		<b>Semester</b>
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.
<b>4. Teaching and learning methodes</b>							
<b>Type of course</b>	<b>Interval</b>	<b>Topic</b>	<b>Language of instruction</b>	<b>Group size</b>	<b>SWS</b>	<b>Workload [h]</b>	
						<b>Contact time</b>	<b>Self-study</b>
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
<b>5. Course cycle</b>			<b>6. Workload [h]</b>		<b>7. Duration</b>		<b>8. Credits (ECTS)</b>
WS			90		1		3,0
<b>9. Requirements for the rewarding of credits (ECTS)</b>							
<b>Types of Assessment</b>	<b>Prerequisites for admission to the Assessment</b>				<b>Graded yes/no</b>	<b>Language (exam)</b>	<b>Weighting factor</b>
eKlausur [780800037]					graded	German and English	75%
Project work [780800038]					graded	English	25%
<b>Academic Achievements</b>							

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

## **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**

<b>Learning content:</b>	<p>In this course students will be introduced to the major soils of the world, their classification, genesis, land-use options, and associated risks.</p> <p>The course is structured in</p> <ul style="list-style-type: none"> <li>- 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.</li> <li>- 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</li> </ul>
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**Learning outcomes**

After a successful completion of the course, the students...

- can describe the major soil properties and classification of soil types occurring 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**

<b>obligatory</b>	
<b>recommended</b>	ARTS-A01, A02, A03, A04, AS05a and AS05b
<b>Maximum number of students</b>	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**

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

<b>Module Title: Crop ecology, water management and bioclimatology</b>							
<b>Module ID/Code:</b> ARTS-BS02 [780800210]							
<b>1. Content and intended learning outcomes</b>							
<b>Learning content:</b>	Students acquire in-depth knowledge on crop interactions of corps with climate and water. The understanding of processes will enable them to analyze the implications of changing environmental conditions on water management and production. In addition, they will be able to apply agro-meteorological methods to determine crop responses. Finally, botanical and ecological attributes of corps with major economic importance will be discussed, allowing students to define social-ecological niche environments for major crop production and water management strategies. Contents comprise: Strategies and implications of water management incl. model applications; Methods & application of climatology in agro-ecosystems; Botany and ecological requirements of major crop types and species; Effects of temperature, precipitation, humidity, radiation, day length and wind on microclimates of non-uniform terrain, and crop responses; Crop adaptation strategies to changing ecological conditions; Case study examples						
<b>Learning outcomes</b>							
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 use water models to analyze water demand. - can relate botanical attributes to ecological requirements of crops. - can evaluate interactions between climate, management attributes and land use systems.							
<b>2. Prerequisites</b>							
<b>obligatory</b>							
<b>recommended</b>	ARTS-A01, A02, A03, A04, AS05a and AS05b						
<b>Maximum number of students</b>	25 students						
<b>3. Study program allocation</b>							
<b>Study program</b>					<b>Compulsory/ Elective</b>		<b>Semester</b>
M.Sc. Agricultural Science and Resource Management in the Tropics and Subtropics (ARTS)					E		2.
M.Sc. Crop Sciences					E Focus PERC		2.
<b>4. Teaching and learning methodes</b>							
<b>Type of course</b>	<b>Interval</b>	<b>Topic</b>	<b>Language of instruction</b>	<b>Group size</b>	<b>SWS</b>	<b>Workload [h]</b>	
						<b>Contact time</b>	<b>Self-study</b>
L (blocked)	afternoon block	Bioclimatology	English	25	1,3	15,0	45,0
T (blocked)	afternoon block	Water management and model applications	English	25	1,3	15,0	45,0
S (blocked)	afternoon block	Crop botany and ecological adaptation	English	25	1,3	15,0	45,0
<b>5. Course cycle</b>			<b>6. Workload [h]</b>		<b>7. Duration</b>		<b>8. Credits (ECTS)</b>
SS			180		1		6.0

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

<b>Module Title: Land use systems in the tropics and subtropics</b>							
<b>Module ID/Code:</b> ARTS-BS03 [780750040]							
<b>1. Content and intended learning outcomes</b>							
<b>Learning content:</b>	Acquire knowledge about land use systems and implications of different land uses on ecosystem services. Understand the attributes and functioning of major tropical production systems and social-ecological interactions. Contents: - Diversity of land use systems - Ecosystem services, threats to biodiversity and conservation practices - Species interactions and adaptation strategies in different land uses - Attributes and management in dryland, wetland and forest use systems - Human development and environment policy effects on land use 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						
<b>Learning outcomes</b>							
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 independently 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.							
<b>2. Prerequisites</b>							
<b>obligatory</b>							
<b>recommended</b>	ARTS-A01, A02, A03, A04, AM05a and AM05b						
<b>Maximum number of students</b>	25 students						
<b>3. Study program allocation</b>							
<b>Study program</b>					<b>Compulsory/ Elective</b>		<b>Semester</b>
M.Sc. Agricultural Science and Resource Management in the Tropics and Subtropics (ARTS)					E		2.
<b>4. Teaching and learning methodes</b>							
<b>Type of course</b>	<b>Interval</b>	<b>Topic</b>	<b>Language of instruction</b>	<b>Group size</b>	<b>SWS</b>	<b>Workload [h]</b>	
						<b>Contact time</b>	<b>Self-study</b>
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
<b>5. Course cycle</b>			<b>6. Workload [h]</b>		<b>7. Duration</b>		<b>8. Credits (ECTS)</b>
SS			180		1		6,0
<b>9. Requirements for the rewarding of credits (ECTS)</b>							
<b>Types of Assessment</b>	<b>Prerequisites for admission to the Assessment</b>			<b>Graded yes/no</b>	<b>Language (exam)</b>	<b>Weighting factor</b>	
Term paper [780750049]				graded	English	70%	
Presentation [780750048]				graded	English	30%	
<b>Academic Achievements</b>							

<b>Module Title:</b> Land use systems in the tropics and subtropics
<b>Module ID/Code:</b> ARTS-BS03 [780750040]
<b>10. Module coordination</b>
<b>Module coordinator</b>
Prof. Dr. Mathias Becker
<b>Teaching person</b>
The teaching persons in the current semester can be found in basis: <a href="https://basis.uni-bonn.de/">https://basis.uni-bonn.de/</a>
<b>Institute/ Department</b>
<b>11. Further information</b>

<b>Module Title: Animal production systems in the tropics</b>								
<b>Module ID/Code:</b> ARTS-BS04 [780810170]								
<b>1. Content and intended learning outcomes</b>								
<b>Learning content:</b>	The students will be provided with lectures on - animal (Cattle, sheep, goat, buffalo and poultry) production systems in trpical climate - association between production system, species distribution and climate zones - challenges of animal production system in various climatic zones							
<b>Learning outcomes</b>								
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.								
<b>2. Prerequisites</b>								
<b>obligatory</b>								
<b>recommended</b>	ARTS-A01, A02, A03, A04, AM05a and AM05b							
<b>Maximum number of students</b>	25 students							
<b>3. Study program allocation</b>								
<b>Study program</b>					<b>Compulsory/ Elective</b>		<b>Semester</b>	
M.Sc. Agricultural Science and Resource Management in the Tropics and Subtropics (ARTS)					E		2.	
M.Sc. Animal Science					E		2.	
<b>4. Teaching and learning methodes</b>								
<b>Type of course</b>	<b>Interval</b>	<b>Topic</b>	<b>Language of instruction</b>	<b>Group size</b>	<b>SWS</b>	<b>Workload [h]</b>		
						<b>Contact time</b>	<b>Self-study</b>	
L (blocked)	afternoon block	Animal production systems in the tropics	English	25	2,0	30,0	60,0	
<b>5. Course cycle</b>			<b>6. Workload [h]</b>		<b>7. Duration</b>		<b>8. Credits (ECTS)</b>	
SS			180		1		6,0	
<b>9. Requirements for the rewarding of credits (ECTS)</b>								
<b>Types of Assessment</b>		<b>Prerequisites for admission to the Assessment</b>			<b>Graded yes/no</b>		<b>Language (exam)</b>	<b>Weighting factor</b>
Written exam [780810179]					graded		English	
<b>Academic Achievements</b>								
<b>10. Module coordination</b>								
<b>Module coordinator</b>								
Prof. Dr. Karl-Heinz Südekum								
<b>Teaching person</b>								
The teaching persons in the current semester can be found in basis: <a href="https://basis.uni-bonn.de/">https://basis.uni-bonn.de/</a>								
<b>Institute/ Department</b>								
Agrar-, Forst- und Ernährungswissenschaften								
<b>11. Further information</b>								

## Module Title: Element cycles in tropical agroecosystems

Module ID/Code: ARTS-BS05 [780800180]

### 1. Content and intended learning outcomes

<b>Learning content:</b>	<p>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:</p> <p>Pools, fluxes and transformation processes of major elements (water, C, N, P, S) in tropical environments.</p> <p>Ecological conditions and implications for the nutrition of tropical crops.</p> <p>Waste treatment and treatment technologies (composting, anaerobic digestion) and use of organic waste as fertilizer. Use and potential of staple isotopes.</p> <p>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.</p>
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### 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

<b>obligatory</b>	
<b>recommended</b>	ARTS-A01, A02, A03, A04, AS05a and AS05b
<b>Maximum number of students</b>	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

<b>Module Title: Element cycles in tropical agroecosystems</b>
<b>Module ID/Code:</b> ARTS-BS05 [780800180]
<b>10. Module coordination</b>
<b>Module coordinator</b>
Prof. Dr. Mathias Becker
<b>Teaching person</b>
The teaching persons in the current semester can be found in basis: <a href="https://basis.uni-bonn.de/">https://basis.uni-bonn.de/</a>
<b>Institute/ Department</b>
Agrar-, Forst- und Ernährungswissenschaften
<b>11. Further information</b>

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

Module ID/Code: ARTS-BS06 [780800130]

### 1. Content and intended learning outcomes

<b>Learning content:</b>	The module gives an insight in organic farming systems mainly under tropical conditions with a special focus on important permanent cash crops. Contents include: 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.
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### Learning outcomes

After a successful completion of the course, the students...

- have extensive knowledge 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 analyse cropping systems from an agronomic and ecological perspective.

### 2. Prerequisites

<b>obligatory</b>	
<b>recommended</b>	
<b>Maximum number of students</b>	

### 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 methods

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

<b>Module Title: Organic Agriculture in the Tropics and Subtropics</b>
<b>Module ID/Code:</b> ARTS-BS06 [780800130]
<b>10. Module coordination</b>
<b>Module coordinator</b>
Dr. Daniel Neuhoff
<b>Teaching person</b>
The teaching persons in the current semester can be found in basis: <a href="https://basis.uni-bonn.de/">https://basis.uni-bonn.de/</a>
<b>Institute/ Department</b>
Agrar-, Forst- und Ernährungswissenschaften
<b>11. Further information</b>

## Module Title: Crop and Ecosystem Analysis and Modelling

Module ID/Code: ARTS-BS07 [780790290]

### 1. Content and intended learning outcomes

<b>Learning content:</b>	<p>The content of the module can be summarized by the following headings</p> <ul style="list-style-type: none"> <li>- Systems theory and methods of systems analysis</li> <li>- Types of models</li> <li>- Conceptualizing of crops or ecosystems systems</li> <li>- Mathematical formulation of relationships (including practical exercises)</li> <li>- Implementation of mathematical algorithms (including practical exercises)</li> <li>- Methods of model calibration and parameterisation</li> <li>- Sensitivity and uncertainty analysis</li> <li>- Model verification, validation and evaluation</li> </ul> <p>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.</p>
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### 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

<b>obligatory</b>	
<b>recommended</b>	Modul "Pflanzenbau" (B.Sc. Agrarwissenschaften)
<b>Maximum number of students</b>	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

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

<b>Module Title: Horticultural Production and Research</b>							
<b>Module ID/Code:</b> ARTS-BS08 [780800120]							
<b>1. Content and intended learning outcomes</b>							
<b>Learning content:</b>	<ul style="list-style-type: none"><li>- Overview of major horticultural production systems, in regional and global contexts</li><li>- Overview of horticultural value chains</li><li>- In-depth discussion of selected critical issues in horticultural production</li><li>- Horticultural approaches to agricultural development</li><li>- Sustainability concerns in horticulture</li><li>- Climate change and its impacts on horticulture</li><li>- Horticultural modeling</li><li>- Critical discussion of horticultural literature</li><li>- Literature search, scientific writing and presenting</li></ul>						
<b>Learning outcomes</b>							
After a successful completion of the course, the students...							
<ul style="list-style-type: none"><li>- will be able to critically interpret horticultural literature.</li><li>- will be able to explain how major horticultural commodities are produced and provide examples of various production systems.</li><li>- will be able to analyze horticultural production systems and identify strengths and weaknesses.</li><li>- will be able to assess horticultural literature and provide a balanced and logically rigorous evaluation.</li><li>- will be able to compose a scientifically rigorous paper on selected topics, based on extensive analysis of published sources.</li></ul>							
<b>2. Prerequisites</b>							
<b>obligatory</b>							
<b>recommended</b>	Modul "Gartenbauliche Kulturen" (B.Sc. Agrarwissenschaften)						
<b>Maximum number of students</b>	50 students						
<b>3. Study program allocation</b>							
<b>Study program</b>					<b>Compulsory/ Elective</b>		<b>Semester</b>
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.
<b>4. Teaching and learning methodes</b>							
<b>Type of course</b>	<b>Interval</b>	<b>Topic</b>	<b>Language of instruction</b>	<b>Group size</b>	<b>SWS</b>	<b>Workload [h]</b>	
						<b>Contact time</b>	<b>Self-study</b>
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
<b>5. Course cycle</b>			<b>6. Workload [h]</b>		<b>7. Duration</b>		<b>8. Credits (ECTS)</b>
WS			180		1		6,0
<b>9. Requirements for the rewarding of credits (ECTS)</b>							
<b>Types of Assessment</b>	<b>Prerequisites for admission to the Assessment</b>				<b>Graded yes/no</b>	<b>Language (exam)</b>	<b>Weighting factor</b>
Presentation [780800129]					graded	English	20%
Term paper [780800128]					graded	English	40%
Assignment [780800127]					graded	English	40%
<b>Academic Achievements</b>							

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

<b>Module Title: Irrigation agriculture</b>								
<b>Module ID/Code:</b> ARTS-BS09 [780790430]								
<b>1. Content and intended learning outcomes</b>								
<b>Learning content:</b>	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. 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. 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.							
<b>Learning outcomes</b>								
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.								
<b>2. Prerequisites</b>								
<b>obligatory</b>								
<b>recommended</b>		Production ecology; Resource conservation; Crop Physiology; Crop ecology, water management and bioclimatology						
<b>Maximum number of students</b>		20 students						
<b>3. Study program allocation</b>								
<b>Study program</b>					<b>Compulsory/ Elective</b>		<b>Semester</b>	
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.	
<b>4. Teaching and learning methodes</b>								
<b>Type of course</b>	<b>Interval</b>	<b>Topic</b>	<b>Language of instruction</b>	<b>Group size</b>	<b>SWS</b>	<b>Workload [h]</b>		
						<b>Contact time</b>	<b>Self-study</b>	
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	
<b>5. Course cycle</b>			<b>6. Workload [h]</b>		<b>7. Duration</b>		<b>8. Credits (ECTS)</b>	
SS			90		1		3,0	
<b>9. Requirements for the rewarding of credits (ECTS)</b>								
<b>Types of Assessment</b>		<b>Prerequisites for admission to the Assessment</b>			<b>Graded yes/no</b>	<b>Language (exam)</b>	<b>Weighting factor</b>	
Oral exam [780790439]					graded	English		
<b>Academic Achievements</b>								

<b>Module Title: Irrigation agriculture</b>
<b>Module ID/Code:</b> ARTS-BS09 [780790430]
<b>10. Module coordination</b>
<b>Module coordinator</b>
Dr. Sabine Seidel
<b>Teaching person</b>
The teaching persons in the current semester can be found in basis: <a href="https://basis.uni-bonn.de/">https://basis.uni-bonn.de/</a>
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<b>11. Further information</b>

## Module Title: Simulation of Agricultural and Biological Systems

Module ID/Code: ARTS-BS10 [780750090]

### 1. Content and intended learning outcomes

<b>Learning content:</b>	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 CO <sub>2</sub> 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.
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### 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

<b>obligatory</b>	
<b>recommended</b>	Module "Crop and Ecosystem analysis and Modelling"
<b>Maximum number of students</b>	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

<b>Module Title: Simulation of Agricultural and Biological Systems</b>
<b>Module ID/Code:</b> ARTS-BS10 [780750090]
<b>10. Module coordination</b>
<b>Module coordinator</b>
Dr. Sabine Seidel
<b>Teaching person</b>
The teaching persons in the current semester can be found in basis: <a href="https://basis.uni-bonn.de/">https://basis.uni-bonn.de/</a>
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## **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.**

<b>Module Title: Genome Analysis in Plant Breeding</b>							
<b>Module ID/Code:</b> ARTS-BM01 [780800480]							
<b>1. Content and intended learning outcomes</b>							
<b>Learning content:</b>	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.						
<b>Learning outcomes</b>							
After a successful completion of the course, the students...							
<ul style="list-style-type: none"><li>- comprehend and are able to apply DNA marker techniques.</li><li>- comprehend and are able to apply high-throughput genotyping.</li><li>- comprehend and are able to apply genome analysis using next generation sequencing methods.</li><li>- comprehend and are able to apply genetic linkage analysis and development of linkage maps.</li><li>- comprehend and are able to apply trait by gene associations analyses (QTL mapping, GWAS).</li><li>- comprehend and are able to apply gene mapping associated to qualitative and quantitative traits.</li><li>- comprehend and are able to apply isolation of genes and their allelic diversity.</li><li>- comprehend and are able to apply marker-assisted selection and transfer of favorable alleles in crop varieties.</li><li>- comprehend and are able to apply molecular breeding and development of improved crop varieties.</li></ul>							
<b>2. Prerequisites</b>							
<b>obligatory</b>							
<b>recommended</b>	Basic knowledge of genetics and genome as heredity material ARTS-A01, A02, A03, A04, AM05a and AM05b						
<b>Maximum number of students</b>	70 students						
<b>3. Study program allocation</b>							
<b>Study program</b>					<b>Compulsory/ Elective</b>		<b>Semester</b>
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							
<b>4. Teaching and learning methodes</b>							
<b>Type of course</b>	<b>Interval</b>	<b>Topic</b>	<b>Language of instruction</b>	<b>Group size</b>	<b>SWS</b>	<b>Workload [h]</b>	
						<b>Contact time</b>	<b>Self-study</b>
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
<b>5. Course cycle</b>			<b>6. Workload [h]</b>		<b>7. Duration</b>		<b>8. Credits (ECTS)</b>
WS			180		1		6,0

<b>Module Title: Genome Analysis in Plant Breeding</b>				
<b>Module ID/Code:</b> ARTS-BM01 [780800480]				
<b>9. Requirements for the rewarding of credits (ECTS)</b>				
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%
<b>Academic Achievements</b>				
<b>10. Module coordination</b>				
<b>Module coordinator</b>				
Dr. Agim Ballvora				
<b>Teaching person</b>				
The teaching persons in the current semester can be found in basis: <a href="https://basis.uni-bonn.de/">https://basis.uni-bonn.de/</a>				
<b>Institute/ Department</b>				
Agrar-, Forst- und Ernährungswissenschaften				
<b>11. Further information</b>				

<b>Module Title: Crop Abiotic Stresses</b>								
<b>Module ID/Code:</b> ARTS-BM02 [780800220]								
<b>1. Content and intended learning outcomes</b>								
<b>Learning content:</b>	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-invasive measurements including manual phenotyping, 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.							
<b>Learning outcomes</b>								
After a successful completion of the course, the students...								
<ul style="list-style-type: none"><li>- will be able to prepare and execute stress experiments with crops.</li><li>- will be able to diagnose and analyze stress response in plants.</li><li>- will be able to compare and evaluate the stress response in different genotypes.</li><li>- will be able to devise and design meaningful stress experiments with crops.</li><li>- summarize, report and write-up results and draw conclusions from them.</li></ul>								
<b>2. Prerequisites</b>								
<b>obligatory</b>								
<b>recommended</b>	Basic understanding of plant stress biology and (bio)chemistry							
<b>Maximum number of students</b>	30 students							
<b>3. Study program allocation</b>								
<b>Study program</b>					<b>Compulsory/ Elective</b>		<b>Semester</b>	
M.Sc. Agricultural Science and Resource Management in the Tropics and Subtropics (ARTS)					E		2.	
M.Sc. Crop Sciences					E Focus PERC		2.	
<b>4. Teaching and learning methods</b>								
<b>Type of course</b>	<b>Interval</b>	<b>Topic</b>		<b>Language of instruction</b>	<b>Group size</b>	<b>SWS</b>	<b>Workload [h]</b>	
							<b>Contact time</b>	<b>Self-study</b>
P* (blocked)	afternoon block			English	15	4,0	60,0	120,0
<b>5. Course cycle</b>				<b>6. Workload [h]</b>		<b>7. Duration</b>		<b>8. Credits (ECTS)</b>
SS				180		1		6,0
<b>9. Requirements for the rewarding of credits (ECTS)</b>								
<b>Types of Assessment</b>		<b>Prerequisites for admission to the Assessment</b>			<b>Graded yes/no</b>	<b>Language (exam)</b>	<b>Weighting factor</b>	
Presentation [780800229]		Participation in the practical work			graded	English	50%	
Report [780800228]		Participation in the practical work			graded	English	50%	
<b>Academic Achievements</b>								

<b>Module Title: Crop Abiotic Stresses</b>
<b>Module ID/Code:</b> ARTS-BM02 [780800220]
<b>10. Module coordination</b>
<b>Module coordinator</b>
Prof. Dr. Mathias Becker
<b>Teaching person</b>
The teaching persons in the current semester can be found in basis: <a href="https://basis.uni-bonn.de/">https://basis.uni-bonn.de/</a>
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<b>11. Further information</b>

<b>Module Title: Soil microbiology</b>							
<b>Module ID/Code:</b> ARTS-BM04 [780790180]							
<b>1. Content and intended learning outcomes</b>							
<b>Learning content:</b>	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. In the tutorial, recently published research articles will be jointly discussed. Students have to read these articles in advance. In the seminar, each student will present a specific research article.						
<b>Learning outcomes</b>							
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.							
<b>2. Prerequisites</b>							
<b>obligatory</b>							
<b>recommended</b>							
<b>Maximum number of students</b>	20 students						
<b>3. Study program allocation</b>							
<b>Study program</b>					<b>Compulsory/ Elective</b>		<b>Semester</b>
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.
<b>4. Teaching and learning methodes</b>							
<b>Type of course</b>	<b>Interval</b>	<b>Topic</b>	<b>Language of instruction</b>	<b>Group size</b>	<b>SWS</b>	<b>Workload [h]</b>	
						<b>Contact time</b>	<b>Self-study</b>
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
<b>5. Course cycle</b>			<b>6. Workload [h]</b>		<b>7. Duration</b>		<b>8. Credits (ECTS)</b>
SS			180		1		6,0
<b>9. Requirements for the rewarding of credits (ECTS)</b>							
<b>Types of Assessment</b>	<b>Prerequisites for admission to the Assessment</b>				<b>Graded yes/no</b>	<b>Language (exam)</b>	<b>Weighting factor</b>
Presentation [780790189]					graded	English	50%
Written exam [780790188]					graded	English	50%
<b>Academic Achievements</b>							

<b>Module Title: Soil microbiology</b>
<b>Module ID/Code:</b> ARTS-BM04 [780790180]
<b>10. Module coordination</b>
<b>Module coordinator</b>
Prof. Dr. Claudia Knief
<b>Teaching person</b>
The teaching persons in the current semester can be found in basis: <a href="https://basis.uni-bonn.de/">https://basis.uni-bonn.de/</a>
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<b>11. Further information</b>

<b>Module Title: Animal breeding and genetics</b>							
<b>Module ID/Code:</b> ARTS-BM05 [780750050]							
<b>1. Content and intended learning outcomes</b>							
<b>Learning content:</b>	From this course students are going to learn - principles of animal breeding and genetics - animal genetic resources - modern animal breeding techniques - breeding for sustainable animal production and diversity						
<b>Learning outcomes</b>							
After a successful completion of the course, the students... - understand the scientific explanation about animal breeding and genetics. - understand breeding strategies. - understand various animal genetic resources and their effective utilizations.							
<b>2. Prerequisites</b>							
<b>obligatory</b>							
<b>recommended</b>	ARTS-A01, A02, A03, A04, AM05a and AM05b						
<b>Maximum number of students</b>	25 students						
<b>3. Study program allocation</b>							
<b>Study program</b>					<b>Compulsory/ Elective</b>		<b>Semester</b>
M.Sc. Agricultural Science and Resource Management in the Tropics and Subtropics (ARTS)					E		2.
<b>4. Teaching and learning methodes</b>							
<b>Type of course</b>	<b>Interval</b>	<b>Topic</b>	<b>Language of instruction</b>	<b>Group size</b>	<b>SWS</b>	<b>Workload [h]</b>	
						<b>Contact time</b>	<b>Self-study</b>
L (blocked)	afternoon block		English	25	1,0	15,0	75,0
S (blocked)	afternoon block		English	25	1,0	15,0	75,0
<b>5. Course cycle</b>			<b>6. Workload [h]</b>		<b>7. Duration</b>		<b>8. Credits (ECTS)</b>
SS			180		1		6,0
<b>9. Requirements for the rewarding of credits (ECTS)</b>							
<b>Types of Assessment</b>	<b>Prerequisites for admission to the Assessment</b>			<b>Graded yes/no</b>	<b>Language (exam)</b>	<b>Weighting factor</b>	
Written exam [780750059]				graded	English	70%	
Presentation [780750058]				graded	English	30%	
<b>Academic Achievements</b>							
<b>10. Module coordination</b>							
<b>Module coordinator</b>							
Dr. Ernst Tholen							
<b>Teaching person</b>							
The teaching persons in the current semester can be found in basis: <a href="https://basis.uni-bonn.de/">https://basis.uni-bonn.de/</a>							
<b>Institute/ Department</b>							
Agrar-, Forst- und Ernährungswissenschaften							
<b>11. Further information</b>							

**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 expertises 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-throughput 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**

<b>Module Title: Advances in Plant Breeding Methodology</b>
<b>Module ID/Code:</b> ARTS-BM07 [780800470]
<b>10. Module coordination</b>
<b>Module coordinator</b>
Dr. Mariana Báez
<b>Teaching person</b>
The teaching persons in the current semester can be found in basis: <a href="https://basis.uni-bonn.de/">https://basis.uni-bonn.de/</a>
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<b>11. Further information</b>

<b>Module Title: Projects in Crop Protection Research</b>								
<b>Module ID/Code:</b> ARTS-BM08 [780800270]								
<b>1. Content and intended learning outcomes</b>								
<b>Learning content:</b>	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.							
<b>Learning outcomes</b>								
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.								
<b>2. Prerequisites</b>								
<b>obligatory</b>								
<b>recommended</b>								
<b>Maximum number of students</b>	10 students							
<b>3. Study program allocation</b>								
<b>Study program</b>					<b>Compulsory/ Elective</b>	<b>Semester</b>		
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.		
<b>4. Teaching and learning methodes</b>								
<b>Type of course</b>	<b>Interval</b>	<b>Topic</b>		<b>Language of instruction</b>	<b>Group size</b>	<b>SWS</b>	<b>Workload [h]</b>	
							<b>Contact time</b>	<b>Self-study</b>
Proj	during the semester			English	10	3,0	45,0	90,0
S	during the semester			English	10	1,0	15,0	30,0
<b>5. Course cycle</b>			<b>6. Workload [h]</b>		<b>7. Duration</b>		<b>8. Credits (ECTS)</b>	
WS/SS			180		1		6,0	
<b>9. Requirements for the rewarding of credits (ECTS)</b>								
<b>Types of Assessment</b>	<b>Prerequisites for admission to the Assessment</b>				<b>Graded yes/no</b>	<b>Language (exam)</b>	<b>Weighting factor</b>	
Report (presentation) [780800279]					graded	English	80%	
Assignment [780800278]					graded	English	20%	
<b>Academic Achievements</b>								
<b>10. Module coordination</b>								
<b>Module coordinator</b>								
Prof. Dr. Florian Grundler								
<b>Teaching person</b>								
The teaching persons in the current semester can be found in basis: <a href="https://basis.uni-bonn.de/">https://basis.uni-bonn.de/</a>								
<b>Institute/ Department</b>								
Agrar-, Forst- und Ernährungswissenschaften								
<b>11. Further information</b>								

## **Cross-cutting modules of the second and third semester**

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

<b>Module Title: Land use and land degradation</b>							
<b>Module ID/Code:</b> ARTS-BC02 [780750060]							
<b>1. Content and intended learning outcomes</b>							
<b>Learning content:</b>	Learn about land uses, resource management strategies and their implications Apply simple field methods for ecosystem analysis Present case studies						
<b>Learning outcomes</b>							
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.							
<b>2. Prerequisites</b>							
<b>obligatory</b>							
<b>recommended</b>	Completion of >24 ECTS out of ARTS-A						
<b>Maximum number of students</b>	25 students						
<b>3. Study program allocation</b>							
<b>Study program</b>					<b>Compulsory/ Elective</b>		<b>Semester</b>
M.Sc. Agricultural Science and Resource Management in the Tropics and Subtropics (ARTS)					E		2.
<b>4. Teaching and learning methodes</b>							
<b>Type of course</b>	<b>Interval</b>	<b>Topic</b>	<b>Language of instruction</b>	<b>Group size</b>	<b>SWS</b>	<b>Workload [h]</b>	
						<b>Contact time</b>	<b>Self-study</b>
E (blocked)	full-day block		English	25	4,0	60,0	120,0
<b>5. Course cycle</b>			<b>6. Workload [h]</b>		<b>7. Duration</b>		<b>8. Credits (ECTS)</b>
SS			180		1		6,0
<b>9. Requirements for the rewarding of credits (ECTS)</b>							
<b>Types of Assessment</b>	<b>Prerequisites for admission to the Assessment</b>			<b>Graded yes/no</b>	<b>Language (exam)</b>	<b>Weighting factor</b>	
Presentation [780750069]				not graded	English	0%	
Report [780750068]				graded	English	100%	
<b>Academic Achievements</b>							
<b>10. Module coordination</b>							
<b>Module coordinator</b>							
PD Dr. Johannes Botschek							
<b>Teaching person</b>							
The teaching persons in the current semester can be found in basis: <a href="https://basis.uni-bonn.de/">https://basis.uni-bonn.de/</a>							
<b>Institute/ Department</b>							
Agrar-, Forst- und Ernährungswissenschaften							
<b>11. Further information</b>							

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...										
<ul style="list-style-type: none"><li>- are able to describe key concepts and structure of economic growth models and drivers of socio-economic development.</li><li>- can explain the role of institutions, labor markets, migration and sustainable natural resource management for economic development.</li><li>- are able to apply learned concepts for analysis of development policies.</li><li>- can contrast methods for conducting research on sustainable natural resource management topics.</li><li>- will appraise empirical examples through case studies.</li><li>- are able to generalize lessons learnt from case studies to broader development issues.</li></ul>										
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	Assigement	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										

<b>Module Title: Development Economics</b>
<b>Module ID/Code:</b> ARTS-BC03 [780763240]
<b>10. Module coordination</b>
<b>Module coordinator</b>
Prof. Dr. Matin Qaim
<b>Teaching person</b>
The teaching persons in the current semester can be found in basis: <a href="https://basis.uni-bonn.de/">https://basis.uni-bonn.de/</a>
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<b>11. Further information</b>

<b>Module Title: Decision Analysis and Forecasting in Agriculture</b>								
<b>Module ID/Code:</b> ARTS-BC05 [780800230]								
<b>1. Content and intended learning outcomes</b>								
<b>Learning content:</b>	<div>- Introduction to decision analysis</div> <div>- Forecasting and cognitive biases</div> <div>- Calibration training</div> <div>- Participatory modeling building</div> <div>- Decision modeling in R</div> <div>- Group project on decision analysis</div>							
<b>Learning outcomes</b>								
After a successful completion of the course, the students...								
<div>- will understand the value of decision analysis approaches for agricultural research.</div> <div>- will be able to recognize their own biases and provide accurate range estimates for uncertain variables.</div> <div>- will be able to analyze a decision context.</div> <div>- will be able to draw conclusions from a decision model and recommend steps forward.</div> <div>- will be able to develop decision models, comprehensively evaluate their findings and compose a report about the model they developed.</div>								
<b>2. Prerequisites</b>								
<b>obligatory</b>								
<b>recommended</b>								
<b>Maximum number of students</b>		30 students						
<b>3. Study program allocation</b>								
<b>Study program</b>					<b>Compulsory/ Elective</b>		<b>Semester</b>	
M.Sc. Agricultural Science and Resource Management in the Tropics and Subtropics (ARTS)					E		2.	
M.Sc. Crop Sciences					E Focus PERC		2.	
<b>4. Teaching and learning methodes</b>								
<b>Type of course</b>	<b>Interval</b>	<b>Topic</b>		<b>Language of instruction</b>	<b>Group size</b>	<b>SWS</b>	<b>Workload [h]</b>	
							<b>Contact time</b>	<b>Self-study</b>
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
<b>5. Course cycle</b>				<b>6. Workload [h]</b>		<b>7. Duration</b>		<b>8. Credits (ECTS)</b>
SS				180		1		6,0
<b>9. Requirements for the rewarding of credits (ECTS)</b>								
<b>Types of Assessment</b>		<b>Prerequisites for admission to the Assessment</b>			<b>Graded yes/no</b>	<b>Language (exam)</b>	<b>Weighting factor</b>	
Project work [780800239]					not graded	English	0%	
Report [780800238]		Project work complete, so that a report on it can be composed			graded	English	100%	
<b>Academic Achievements</b>								

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

<b>Module Title: Agricultural Entomology</b>							
<b>Module ID/Code:</b> ARTS-BC06 [780800080]							
<b>1. Content and intended learning outcomes</b>							
<b>Learning content:</b>	Insects are major pests in agriculture but can provide beneficial effects such as pollination or pest control. This module increases the in-depth understanding of entomological aspects in agriculture and presents examples of beneficial and harmful organisms regarding the following aspects: <ul style="list-style-type: none"><li>- Functional morphology and anatomy</li><li>- Identification of insects</li><li>- Host-parasite interactions</li><li>- Development of symptoms</li><li>- Case studies from major crop types</li><li>- Antagonists of insect pests</li><li>- Use of insects in IPM approaches</li><li>- Options for insect control</li><li>- Insecticide resistance</li></ul>						
<b>Learning outcomes</b>							
After a successful completion of the course, the students... <ul style="list-style-type: none"><li>- have obtained specific entomological knowledge.</li><li>- are able to comprehend and explain complex biological interactions.</li><li>- can explain specific problem issues related to biocontrol or the use of insecticides.</li></ul>							
<b>2. Prerequisites</b>							
<b>obligatory</b>							
<b>recommended</b>							
<b>Maximum number of students</b>	20 students						
<b>3. Study program allocation</b>							
<b>Study program</b>					<b>Compulsory/ Elective</b>		<b>Semester</b>
M.Sc. Agricultural Science and Resource Management in the Tropics and Subtropics (ARTS)					E		2.
M.Sc. Crop Sciences					E Focus PERC		2.
<b>4. Teaching and learning methods</b>							
<b>Type of course</b>	<b>Interval</b>	<b>Topic</b>	<b>Language of instruction</b>	<b>Group size</b>	<b>SWS</b>	<b>Workload [h]</b>	
						<b>Contact time</b>	<b>Self-study</b>
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
<b>5. Course cycle</b>			<b>6. Workload [h]</b>		<b>7. Duration</b>		<b>8. Credits (ECTS)</b>
SS			180		1		6,0
<b>9. Requirements for the rewarding of credits (ECTS)</b>							
<b>Types of Assessment</b>	<b>Prerequisites for admission to the Assessment</b>			<b>Graded yes/no</b>	<b>Language (exam)</b>	<b>Weighting factor</b>	
Report (presentation) [780800089]				graded	English	80%	
Assignment [780800088]				graded	English	20%	
<b>Academic Achievements</b>							

<b>Module Title: Agricultural Entomology</b>
<b>Module ID/Code:</b> ARTS-BC06 [780800080]
<b>10. Module coordination</b>
<b>Module coordinator</b>
Prof. Dr. Florian Grundler
<b>Teaching person</b>
The teaching persons in the current semester can be found in basis: <a href="https://basis.uni-bonn.de/">https://basis.uni-bonn.de/</a>
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<b>11. Further information</b>

<b>Module Title: Agricultural Nematology</b>							
<b>Module ID/Code:</b> ARTS-BC07 [780800090]							
<b>1. Content and intended learning outcomes</b>							
<b>Learning content:</b>	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: -functional morphology and anatomy -identification of nematodes -host-parasite interactions and their mechanisms -development of plant symptoms -case studies in important crop plants -nematode antagonists -application and mode of action of entomopathogenic nematode -options for nematode control						
<b>Learning outcomes</b>							
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.							
<b>2. Prerequisites</b>							
<b>obligatory</b>							
<b>recommended</b>							
<b>Maximum number of students</b>	25 students						
<b>3. Study program allocation</b>							
<b>Study program</b>					<b>Compulsory/ Elective</b>		<b>Semester</b>
M.Sc. Agricultural Science and Resource Management in the Tropics and Subtropics (ARTS)					E		3.
M.Sc. Crop Sciences					E Focus PERC		3.
<b>4. Teaching and learning methodes</b>							
<b>Type of course</b>	<b>Interval</b>	<b>Topic</b>	<b>Language of instruction</b>	<b>Group size</b>	<b>SWS</b>	<b>Workload [h]</b>	
						<b>Contact time</b>	<b>Self-study</b>
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
<b>5. Course cycle</b>			<b>6. Workload [h]</b>		<b>7. Duration</b>		<b>8. Credits (ECTS)</b>
WS			180		1		6,0
<b>9. Requirements for the rewarding of credits (ECTS)</b>							
<b>Types of Assessment</b>	<b>Prerequisites for admission to the Assessment</b>			<b>Graded yes/no</b>	<b>Language (exam)</b>	<b>Weighting factor</b>	
Report (presentation) [780800099]				graded	English	80%	
Assignment [780800098]				graded	English	20%	
<b>Academic Achievements</b>							

<b>Module Title: Agricultural Nematology</b>
<b>Module ID/Code:</b> ARTS-BC07 [780800090]
<b>10. Module coordination</b>
<b>Module coordinator</b>
Prof. Dr. Florian Grundler
<b>Teaching person</b>
The teaching persons in the current semester can be found in basis: <a href="https://basis.uni-bonn.de/">https://basis.uni-bonn.de/</a>
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<b>11. Further information</b>

## Module Title: Sustainable Entrepreneurship & Venturing

Module ID/Code: ARTS-BC08 [780750100]

### 1. Content and intended learning outcomes

<b>Learning content:</b>	<p>The module "Sustainable Entrepreneurship &amp; 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.</p> <p>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.</p>
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### Learning outcomes

After a successful completion of the course, the students...

- understand the specifics 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

<b>obligatory</b>	none
<b>recommended</b>	none
<b>Maximum number of students</b>	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	E	2.
M.Sc. Molecular Food Technology	E	2.

### 4. Teaching and learning methods

Type of course	Interval	Topic	Language of instruction	Group size	SWS	Workload [h]	
						Contact time	Self-study
L (blocked)	full-day block		English	25	2,0	30,0	60,0
pT (blocked)	full-day block		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
Project work [780750109]	Regular participation	graded	English	

### Academic Achievements

<b>Module Title: Sustainable Entrepreneurship &amp; Venturing</b>
<b>Module ID/Code:</b> ARTS-BC08 [780750100]
<b>10. Module coordination</b>
<b>Module coordinator</b>
Prof. Dr. Denise Fischer-Kreer
<b>Teaching person</b>
The teaching persons in the current semester can be found in basis: <a href="https://basis.uni-bonn.de/">https://basis.uni-bonn.de/</a>
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<b>11. Further information</b>

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

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

<b>Module Title: Current issues of research management</b>							
<b>Module ID/Code:</b> ARTS-C01 [780750070]							
<b>1. Content and intended learning outcomes</b>							
<b>Learning content:</b>	New trends in resource management (presentations by invited guest speakers) Participation at international conference (Tropentag)						
<b>Learning outcomes</b>							
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.							
<b>2. Prerequisites</b>							
<b>obligatory</b>							
<b>recommended</b>							
<b>Maximum number of students</b>		60 students					
<b>3. Study program allocation</b>							
<b>Study program</b>					<b>Compulsory/ Elective</b>		<b>Semester</b>
M.Sc. Agricultural Science and Resource Management in the Tropics and Subtropics (ARTS)					C		2.+3.
<b>4. Teaching and learning methodes</b>							
<b>Type of course</b>	<b>Interval</b>	<b>Topic</b>	<b>Language of instruction</b>	<b>Group size</b>	<b>SWS</b>	<b>Workload [h]</b>	
						<b>Contact time</b>	<b>Self-study</b>
L	during the semester		English	60	3,0	50,0	50,0
S*	during the semester		English	60	1,0	20,0	60,0
<b>5. Course cycle</b>			<b>6. Workload [h]</b>		<b>7. Duration</b>		<b>8. Credits (ECTS)</b>
WS+SS			180		2		6,0
<b>9. Requirements for the rewarding of credits (ECTS)</b>							
<b>Types of Assessment</b>		<b>Prerequisites for admission to the Assessment</b>			<b>Graded yes/no</b>	<b>Language (exam)</b>	<b>Weighting factor</b>
Presentation [780750079]		Participation (presence) at >20 lectures/seminars			not graded	English	
<b>Academic Achievements</b>							
<b>10. Module coordination</b>							
<b>Module coordinator</b>							
Prof. Dr. Mathias Becker							
<b>Teaching person</b>							
The teaching persons in the current semester can be found in basis: <a href="https://basis.uni-bonn.de/">https://basis.uni-bonn.de/</a>							
<b>Institute/ Department</b>							
Agrar-, Forst- und Ernährungswissenschaften							
<b>11. Further information</b>							

<b>Module Title: Scientific communication</b>							
<b>Module ID/Code:</b> ARTS-C02 [780800190]							
<b>1. Content and intended learning outcomes</b>							
<b>Learning content:</b>	Students aquire technical skills to effectively communicate with other scientists (writing of research papers and theses, preparing posters, oral presentations)						
<b>Learning outcomes</b>							
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.							
<b>2. Prerequisites</b>							
<b>obligatory</b>							
<b>recommended</b>		all compulsory modules ARTS A					
<b>Maximum number of students</b>		50 students					
<b>3. Study program allocation</b>							
<b>Study program</b>					<b>Compulsory/ Elective</b>		<b>Semester</b>
M.Sc. Agricultural Science and Resource Management in the Tropics and Subtropics (ARTS)					C		3.
M.Sc. Crop Sciences					E Focus PERC		3.
<b>4. Teaching and learning methodes</b>							
<b>Type of course</b>	<b>Interval</b>	<b>Topic</b>	<b>Language of instruction</b>	<b>Group size</b>	<b>SWS</b>	<b>Workload [h]</b>	
						<b>Contact time</b>	<b>Self-study</b>
L (blocked)	afternoon block		English	50	2,0	30,0	70,0
P (blocked)	afternoon block		English	50	2,0	20,0	60,0
<b>5. Course cycle</b>			<b>6. Workload [h]</b>		<b>7. Duration</b>		<b>8. Credits (ECTS)</b>
WS			180		1		6,0
<b>9. Requirements for the rewarding of credits (ECTS)</b>							
<b>Types of Assessment</b>		<b>Prerequisites for admission to the Assessment</b>			<b>Graded yes/no</b>	<b>Language (exam)</b>	<b>Weighting factor</b>
none							
<b>Academic Achievements</b>							
at least 3 group exercises must be submitted							
<b>10. Module coordination</b>							
<b>Module coordinator</b>							
Prof. Dr. Mathias Becker							
<b>Teaching person</b>							
The teaching persons in the current semester can be found in basis: <a href="https://basis.uni-bonn.de/">https://basis.uni-bonn.de/</a>							
<b>Institute/ Department</b>							
Agrar-, Forst- und Ernährungswissenschaften							
<b>11. Further information</b>							

<b>Module Title: Sustainability and Risk</b>								
<b>Module ID/Code:</b> ARTS-C03 [780764260]								
<b>1. Content and intended learning outcomes</b>								
<b>Learning content:</b>	Knowledge about sustainability and risk is key to understanding the societal challenges of global change and to considering them in one's own field of action. Starting from the current state of global sustainability problems, this interdisciplinary and multi-perspective course first illustrates the fundamentals of the terms ‘sustainability’ and ‘risk’. Building on this, 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). As the course has thus focused on the political perspective, pertinent economic concepts as well as the role of businesses are subsequently examined. In addition to imparting knowledge about the basics and critical aspects of economic growth, various economic systems towards sustainability (e.g. bio-based economy, circular economy) are introduced and differentiated from each other. When looking at the sustainability management of businesses, the focus is on implementation strategies and sustainable business models. The course finally discusses on the role of the individual in the sustainability and risk debate. This is done by providing insights into the field of sustainable consumption, such as on types, motives and barriers of sustainable consumption, as well as on measures to promote sustainable consumer behaviour.							
	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), guest lectures are also integral components of the curriculum.							
<b>Learning outcomes</b>								
After a successful completion of the course, the students...								
- are able to understand and evaluate the relevant details, their interrelationships as well as the overall interdisciplinary picture with regard to the concepts of sustainability and risk.								
- are able to identify and assess the drivers of, and barriers to, sustainable development.								
- are able to analyse concrete (or local) issues of sustainability and risk from the perspective of various societal actors and to find solutions by applying established generic (or global) tools.								
- are able to critically reflect on all the models, instruments etc. discussed during the course.								
<b>2. Prerequisites</b>								
<b>obligatory</b>								
<b>recommended</b>								
<b>Maximum number of students</b>								
<b>3. Study program allocation</b>								
<b>Study program</b>					<b>Compulsory/ Elective</b>		<b>Semester</b>	
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.	
<b>4. Teaching and learning methodes</b>								
<b>Type of course</b>	<b>Interval</b>	<b>Topic</b>	<b>Language of instruction</b>	<b>Group size</b>	<b>SWS</b>	<b>Workload [h]</b>		
						<b>Contact time</b>	<b>Self-study</b>	
PS	during the semester		English	80	4,0	45,0	135,0	
<b>5. Course cycle</b>			<b>6. Workload [h]</b>		<b>7. Duration</b>		<b>8. Credits (ECTS)</b>	
WS			180		1		6,0	

<b>Module Title: Sustainability and Risk</b>				
<b>Module ID/Code:</b> ARTS-C03 [780764260]				
<b>9. Requirements for the rewarding of credits (ECTS)</b>				
Types of Assessment	Prerequisites for admission to the Assessment	Graded yes/no	Language (exam)	Weighting factor
Written exam [90 min] [780764269]		graded	English	
<b>Academic Achievements</b>				
<b>10. Module coordination</b>				
<b>Module coordinator</b>				
Jun.-Prof. Dr. Lisa Biber-Freudenberger				
<b>Teaching person</b>				
The teaching persons in the current semester can be found in basis: <a href="https://basis.uni-bonn.de/">https://basis.uni-bonn.de/</a>				
<b>Institute/ Department</b>				
Agrar-, Forst- und Ernährungswissenschaften				
<b>11. Further information</b>				
Additional guest lecturers from the UNU and other organisations				

<b>Module Title: International research management and proposal writing</b>							
<b>Module ID/Code:</b> ARTS-C04 [780750080]							
<b>1. Content and intended learning outcomes</b>							
<b>Learning content:</b>	International organizations for technical, scientific and financial support Donors for international reserach and development projects (aims, scope, requirements) Discussion strategies for reserach planning Technical aspects of proposal planning and development (budget, time plan, break-down structure, Log Frame) Do's and don't's in proposal writing basic understanding of team work and research ethics Principles of peer-reviewing Proposal writing, presentation and defense						
<b>Learning outcomes</b>							
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.							
<b>2. Prerequisites</b>							
<b>obligatory</b>							
<b>recommended</b>	ARTS A modules (knowledge and comprehension of resources for agricultural production)						
<b>Maximum number of students</b>	25 students						
<b>3. Study program allocation</b>							
<b>Study program</b>					<b>Compulsory/ Elective</b>	<b>Semester</b>	
M.Sc. Agricultural Science and Resource Management in the Tropics and Subtropics (ARTS)					C	3.	
<b>4. Teaching and learning methodes</b>							
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
<b>5. Course cycle</b>			<b>6. Workload [h]</b>		<b>7. Duration</b>		<b>8. Credits (ECTS)</b>
WS			180		1		6,0

<b>Module Title: International research management and proposal writing</b>				
<b>Module ID/Code:</b> ARTS-C04 [780750080]				
<b>9. Requirements for the rewarding of credits (ECTS)</b>				
<b>Types of Assessment</b>	<b>Prerequisites for admission to the Assessment</b>	<b>Graded yes/no</b>	<b>Language (exam)</b>	<b>Weighting factor</b>
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%
<b>Academic Achievements</b>				
<b>10. Module coordination</b>				
<b>Module coordinator</b>				
Prof. Dr. Mathias Becker				
<b>Teaching person</b>				
The teaching persons in the current semester can be found in basis: <a href="https://basis.uni-bonn.de/">https://basis.uni-bonn.de/</a>				
<b>Institute/ Department</b>				
Agrar-, Forst- und Ernährungswissenschaften				
<b>11. Further information</b>				

<b>Module Title: Data Analysis and Visualization</b>							
<b>Module ID/Code:</b> ARTS-C05 [780800010]							
<b>1. Content and intended learning outcomes</b>							
<b>Learning content:</b>	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.						
<b>Learning outcomes</b>							
After a successful completion of the course, the students...							
- can generate and interpret box plots, histograms, scatter plots.							
- can perform and interpret basic hypothesis tests, ANOVA and linear regression.							
<b>2. Prerequisites</b>							
<b>obligatory</b>							
<b>recommended</b>		at least 5 successfully completed modules in ARTS-A					
<b>Maximum number of students</b>							
<b>3. Study program allocation</b>							
<b>Study program</b>					<b>Compulsory/ Elective</b>		<b>Semester</b>
M.Sc. Agricultural Science and Resource Management in the Tropics and Subtropics (ARTS)					C		3.
M.Sc. Crop Sciences					C		1.
<b>4. Teaching and learning methodes</b>							
<b>Type of course</b>	<b>Interval</b>	<b>Topic</b>	<b>Language of instruction</b>	<b>Group size</b>	<b>SWS</b>	<b>Workload [h]</b>	
						<b>Contact time</b>	<b>Self-study</b>
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
<b>5. Course cycle</b>			<b>6. Workload [h]</b>		<b>7. Duration</b>		<b>8. Credits (ECTS)</b>
WS			180		1		6,0
<b>9. Requirements for the rewarding of credits (ECTS)</b>							
<b>Types of Assessment</b>		<b>Prerequisites for admission to the Assessment</b>			<b>Graded yes/no</b>	<b>Language (exam)</b>	<b>Weighting factor</b>
Assignment [780800019]					graded	English	
<b>Academic Achievements</b>							
<b>10. Module coordination</b>							
<b>Module coordinator</b>							
Prof. Dr. Heiko Schoof							
<b>Teaching person</b>							
The teaching persons in the current semester can be found in basis: <a href="https://basis.uni-bonn.de/">https://basis.uni-bonn.de/</a>							
<b>Institute/ Department</b>							
Agrar-, Forst- und Ernährungswissenschaften, Mathematik							
<b>11. Further information</b>							

## **Free elective module**

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

<b>Module Title: Technology and Sensors in Precision Crop Production</b>							
<b>Module ID/Code:</b> NPW-002 [780800020]							
<b>1. Content and intended learning outcomes</b>							
<b>Learning content:</b>	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).						
<b>Learning outcomes</b>							
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.							
<b>2. Prerequisites</b>							
<b>obligatory</b>							
<b>recommended</b>	Module "Precision Farming" (B.Sc. Agrarwissenschaften)						
<b>Maximum number of students</b>							
<b>3. Study program allocation</b>							
<b>Study program</b>					<b>Compulsory/ Elective</b>		<b>Semester</b>
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.
<b>4. Teaching and learning methodes</b>							
<b>Type of course</b>	<b>Interval</b>	<b>Topic</b>	<b>Language of instruction</b>	<b>Group size</b>	<b>SWS</b>	<b>Workload [h]</b>	
						<b>Contact time</b>	<b>Self-study</b>
L	during the semester		English	120	2,0	30,0	60,0
S	during the semester		English	30	2,0	30,0	60,0
<b>5. Course cycle</b>			<b>6. Workload [h]</b>		<b>7. Duration</b>		<b>8. Credits (ECTS)</b>
WS			180		1		6,0
<b>9. Requirements for the rewarding of credits (ECTS)</b>							
<b>Types of Assessment</b>		<b>Prerequisites for admission to the Assessment</b>			<b>Graded yes/no</b>	<b>Language (exam)</b>	<b>Weighting factor</b>
Written exam [780800029]					graded	English	
<b>Academic Achievements</b>							
<b>10. Module coordination</b>							
<b>Module coordinator</b>							
Prof. Dr. Christopher McCool							
<b>Teaching person</b>							
The teaching persons in the current semester can be found in basis: <a href="https://basis.uni-bonn.de/">https://basis.uni-bonn.de/</a>							
<b>Institute/ Department</b>							
Agrar-, Forst- und Ernährungswissenschaften, Vermessungswesen							
<b>11. Further information</b>							

## Module Title: Tree phenology analysis in R

Module ID/Code: NPW-034 [780800340]

### 1. Content and intended learning outcomes

<b>Learning content:</b>	<p>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:</p> <ul style="list-style-type: none"> <li>- Efficiently compute common chill and heat metrics</li> <li>- Illustrate and evaluate temporal trends in thermal metrics</li> <li>- Design functions for additional metrics</li> <li>- Relate phenology data to temperature records using multivariate statistics</li> <li>- Identify temperature response phases of temperate tree crops</li> <li>- Generate past and future temperature scenarios using a weather generator</li> <li>- Evaluate past and prospective future impacts of climate change on thermal metrics</li> <li>- Participate in a phenology monitoring experiment under semi-controlled conditions</li> <li>- Analyze a phenology dataset and compile a report about their findings</li> <li>- Use git and github for version control and collaboration and R-Markdown for report writing</li> </ul>
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### 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

<b>obligatory</b>	
<b>recommended</b>	
<b>Maximum number of students</b>	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 methods

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 Luedeling

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

<b>Module Title:</b> Lecture Series on Future Competent Agricultural and Food Systems
<b>Module ID/Code:</b> NPW-053 [780800530]
<b>10. Module coordination</b>
<b>Module coordinator</b>
Dr. Thorsten Kraska
<b>Teaching person</b>
The teaching persons in the current semester can be found in basis: <a href="https://basis.uni-bonn.de/">https://basis.uni-bonn.de/</a>
<b>Institute/ Department</b>
<b>11. Further information</b>
<p>The „Fakultätentag“ is the official organization 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.</p> <p>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.</p> <p>While the examination is limited to 25 students of the M.Sc. programs, the lecture series open for guests.</p>

## **Masterthesis and Colloquium**

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

<b>Module Title: Masterthesis</b>							
<b>Module ID/Code:</b> ARTS-D1 [8900]							
<b>1. Content and intended learning outcomes</b>							
<b>Learning content:</b>	Formulate a relevant research question Elaborate a research proposal Present the proposal at a department seminar Conduct independently thesis reserach activity Summerize and write-up reserach findings Discuss own results in relation to the state of knowledge Present key findings and defend thesis during a reserach colloquium						
<b>Learning outcomes</b>							
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.							
<b>2. Prerequisites</b>							
<b>obligatory</b>	All compulsory modules of the first and third semester are completed (54 ECTS credit points) At least 24 credit points have been achieved in the elective course modules						
<b>recommended</b>	Reserach concept has been presented during a departmet seminar						
<b>Maximum number of students</b>							
<b>3. Study program allocation</b>							
<b>Study program</b>					<b>Compulsory/ Elective</b>	<b>Semester</b>	
M.Sc. Agricultural Science and Resource Management in the Tropics and Subtropics (ARTS)					C	4.	
<b>4. Teaching and learning methodes</b>							
<b>Type of course</b>	<b>Interval</b>	<b>Topic</b>	<b>Language of instruction</b>	<b>Group size</b>	<b>SWS</b>	<b>Workload [h]</b>	
						<b>Contact time</b>	<b>Self-study</b>
Proj	during the semester	individually agreed upon with supervisor	English	1		0,0	900,0
<b>5. Course cycle</b>			<b>6. Workload [h]</b>		<b>7. Duration</b>		<b>8. Credits (ECTS)</b>
SS			600		1		20,0
<b>9. Requirements for the rewarding of credits (ECTS)</b>							
<b>Types of Assessment</b>	<b>Prerequisites for admission to the Assessment</b>			<b>Graded yes/no</b>	<b>Language (exam)</b>	<b>Weighting factor</b>	
Masterthesis [8900]				graded	English		
<b>Academic Achievements</b>							
<b>10. Module coordination</b>							
<b>Module coordinator</b>							
All independent teaching staff							
<b>Teaching person</b>							
The teaching persons in the current semester can be found in basis: <a href="https://basis.uni-bonn.de/">https://basis.uni-bonn.de/</a>							
<b>Institute/ Department</b>							
Agrar-, Forst- und Ernährungswissenschaften							
<b>11. Further information</b>							

<b>Module Title: Colloquium</b>							
<b>Module ID/Code:</b> ARTS-D2 [8901]							
<b>1. Content and intended learning outcomes</b>							
<b>Learning content:</b>							
<b>Learning outcomes</b>							
After a successful completion of the course, the students...							
-							
<b>2. Prerequisites</b>							
<b>obligatory</b>							
<b>recommended</b>							
<b>Maximum number of students</b>							
<b>3. Study program allocation</b>							
<b>Study program</b>						<b>Compulsory/ Elective</b>	<b>Semester</b>
M.Sc. Agricultural Science and Resource Management in the Tropics and Subtropics (ARTS)						C	4.
<b>4. Teaching and learning methodes</b>							
Type of course	Interval	Topic	Language of instruction	Group size	SWS	Workload [h]	
						Contact time	Self-study
<b>5. Course cycle</b>			<b>6. Workload [h]</b>		<b>7. Duration</b>		<b>8. Credits (ECTS)</b>
SS			300		1		10,0
<b>9. Requirements for the rewarding of credits (ECTS)</b>							
<b>Types of Assessment</b>	<b>Prerequisites for admission to the Assessment</b>				<b>Graded yes/no</b>	<b>Language (exam)</b>	<b>Weighting factor</b>
[8901]							
<b>Academic Achievements</b>							
<b>10. Module coordination</b>							
<b>Module coordinator</b>							
All independent teaching staff							
<b>Teaching person</b>							
The teaching persons in the current semester can be found in basis: <a href="https://basis.uni-bonn.de/">https://basis.uni-bonn.de/</a>							
<b>Institute/ Department</b>							
<b>11. Further information</b>							