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Deliverable: 1.3 Joint analysis of the partners PhD study programs

Work Package 1: Review of the partners PhD programs study

Work package leaders: Ivana Majić and Sava Vrbničanin

Date: 19 May 2019

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Executive summary

The changing and diverse nature of our society is a challenge for individuals, employers and Higher Education Institutions throughout the European countries. The partners of this consortium support the fact that diversity of study programs is a hallmark of a great universities. Diversity of educational disciplines and teaching methods enriches the environment and experiences of students and all stakeholders' at all academic levels.

Our task is to review the existing PhD study programs at 12 HEI in southeastern part of Europe. Partners of this consortium reported partial or full compliance of the existing PhD programs with Bologna process and national and EU qualification framework. By comparing the aims and learning outcomes of disciplines related to Plant health we identified core competences that PhD students will gain upon completing the program.

Comparison of study programs reveled partner's strengths and missing knowledge, skills and competences. In order to improve education against common agreed standards of excellence, we indicated the disciplines or the structure of program that should be harmonized. However, due diligence reveal that partners are very successful in specific disciplines, offering cutting edge knowledge, skills and competences. This enables consortium to increase networking and interrelation, to share good practices and knowledge and achieve a strategic alliance in the region while treasuring the diversity.

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Partner 1 FAZ University of Zagreb, Faculty of Agriculture, Croatia

1. COMPLIANCE OF THE PARTNERS INSTITUTIONS HIGHER EDUCATIONAL SYSTEM WITH BOLOGNA PROCESS

FAZ performs undergraduate, graduate and postgraduate education in all fields of agriculture. Undergraduate and graduate study programs offered cover all fields from plant to animal science: agricultural economy, agricultural engineering, organic agriculture, plant health, landscape architecture, environment and resource management). Postgraduate study program named Agricultural sciences covers all fields in agriculture. The degree structure of FAZ study programs is three-cycle system (bachelor, master and doctoral) in a 3+2+3 year period. The study system enables students to attend classes at other universities abroad and also enable international students to attend the classes at FAZ through different exchange programs (ERASMUS+, CEEPUS, Erasmus Mundus etc…). Study programs are based on scientific, basic, applied and development studies, aimed at creating new knowledge and ideas and at fostering critical thinking and creativity, and knowledge and innovation transfer towards the economy. The first generation of students enrolled into the study programs developed according to the Bologna declaration at FAZ in 2005. The enrollment rate is approximately 400 undergraduate students per academic year.

A set of learning outcomes as defined by the European Qualifications Framework and Croatian Qualification Framework has been established for each study program and for each course at all degree levels.

Evaluation of undergraduate, graduate, postgraduate and specialist study programs of the University of Zagreb is subject to **formal process established by the University of Zagreb** and it is carried out in accordance with the Regulations on Evaluation of University Study Programs of Undergraduate, Graduate and Integrated Undergraduate and Graduate Studies, and Vocational Studies of the University of Zagreb, the Act on Quality Assurance in Science and Higher Education and the Ordinance on the Content of a License and Conditions for Issuing a License for Performing Higher Education Activity, Carrying out a Study Program and Re-Accreditation of Higher Education Institutions (in Croatian http://www.unizg.hr/studiji-i-studiranje/studiji/kvaliteta/vrjednovanje-studijskih-programa/). External evaluation was conducted internationally by Croatian Quality Assurance Agency by external evaluators. Re-accreditation procedure is carried out every five years. FAZ completed institutional re-accreditation in 2013 and in 2018 and the re-accreditation procedure of postgraduate doctoral studies in 2016 all with positive accreditation recommendation and some suggestions for improvement.

Doctoral studies at University of Zagreb are governed by national regulatory acts which identify the education, scholarships, granting and conditions that must be fulfilled by universities and research units leading doctoral studies.

The Diploma Supplement has been automatically issued to completed students with all credentials containing a description of the nature, level, context, content and status of the studies completed by the individual noted on the diploma.

2. REVIEW OF THE EXISTING PhD STUDY PROGRAMS

Title: Postgraduate doctoral studies Agricultural Sciences

Duration: 3 years (maximum period up to 6 years)

Credits or hours required in order to successfully complete the Program: 180 ECTS

Structured* or individual**: Both

*(*the mentor has predefined research objectives on specific research topics that are built into different projects;**no predefined objectives, the mentor helps a PhD candidate to choose a research topic on which the PhD candidate works either independently or in a research team)*

Language: Croatian

Tuition fee: 60 000 HRK (8 100 €)

Funding support: Structured program offer paid PhD positions, while individual program is self-funded (or employer pays, scholarship granted by research institutions or industry etc.)

Enrollment and admission requirements: *completed graduate studies in biotechnical or other sciences (bologna 3+2 degree structure or equivalent with min 300 ECTS, according to the previous system). The applicants that completed their studies at faculties outside the biotechnical sciences may be asked to complete additional differential modules, which will be defined by the council of postgraduate doctoral studies of agricultural sciences upon reviewing each individual case.*

The average study grade is 3.5 (according to the 1-5 grading system, or equivalent acc. To other grading systems). Exceptionally, the council may consider applications with a lower average grade, but only if they include sufficiently elaborated written recommendations provided by three university teachers.

A written recommendation by the prospective mentor, giving his/her consent to accept the applicant to the project with the doctoral thesis, and the principal researcher, if the mentor is not the principal researcher. Knowledge of the English language at the level that enables the applicant to communicate and use technical literature (certificate issued by an authorized school of foreign languages). Students that do not have this level of knowledge of the English language may also enroll, but they need to fulfill this obligation before their enrolment in the third year.

Basic computer knowledge (windows, web, e-mail). This knowledge will be checked by the prospective mentor, and he/she will record the result in the recommendation.

Enrolment is also granted to students, who acquired their m.sc. Degree before the taking effect of the new law on scientific work and higher education (official gazette narodne novine 123/2003). They enroll the third year of the program with the obligation of public defense of the thesis topic at least 6 months before the defense of the thesis. The same conditions apply to the students currently attending programs for m.sc. Degree, if they have successfully completed all their exams.

Foreign students with a validated graduation certificate can also enroll this doctoral program if they meet the above mentioned criteria. Conditions for admission to the studies are publicly announced in media.

Capacity: not defined

Table 1 List of the key activities to accumulate the credits

	Activity	Number of credits (ECTS)	
		min	max
	Compulsory group of activities	180	-
1.	Compulsory courses (2)	12	
2.	Elective courses (min 3)	18	
3.	Research work	150	
		Minimum of 180	

Minimum 30 ECTS credits are acquired through direct teaching while the remaining credits are obtained through scientific work that is primarily directly related to the thesis topic. These credits are obtained by guided experimental work in laboratories, practicums, and /or field experiments, by publicly defending the reported dissertation topic, and by proven scientific activities.Confirmation of scientific activities is adjusted to the conditions for the appointment to the scientific degrees within the biotechnological sciences, so the applicant must meet the following criteria:

- to publish at least one paper that refers to the topic of the thesis in a journal indexed as group a1 (CC, SCI),
- to publish two papers (at least one directly related to the dissertation topic) in journals indexed in the specialized databases of a2 group (CAB, ASFA and others, as specified in the Regulations on the Requirements for the Appointment to the Scientific Titles of the National Science Council, in Official Gazette, Narodne novine 84/2005, 11th July, 2005),
- to elaborate and present, orally or by poster, one study on a national and one on an international scientific conference (at least one related to the dissertation topic).

Table 2 The learning outcomes of the Program

After completing the PhD study program student will be able to:
1. Critically analyse and evaluate the results of its own scientific research, interpret and argue against larger and more complex social groups and present the latest technical, technological and socio-economic knowledge in the field of agriculture and related activities.
2. Publish research results in high-ranking journals with the aim of disseminating new knowledge and to apply new knowledge and skills in production and economic practices in the field of agriculture and related activities.
3. Actively participate in the preparation of studies, project proposals, strategic and operational documents in the field of agriculture and rural development.
4. Guide and/or monitor the implementation of projects and business activities in more complex production and socio-economic systems in the field of agriculture, food processing and food production, environmental protection and rural development with the highest level of social responsibility.
5. Create new proposals (individually and/or in teams) to solve the problem of agricultural production and rural development in changing and unknown natural, productive, economic and socio-political conditions and circumstances.

6. Apply the latest scientific knowledge, cognitions and technologies to improve production and organizational processes in the field of agriculture, food processing and food production, environmental protection and rural development (through the field, laboratory and social research etc.).
7. Individually suggest and take part in the adoption of measures for agricultural, environmental and rural development policies.
8. Develop research and learning skills necessary for lifelong learning and continuous improvement and development of the acquired knowledge (formal, unformal and informal).
9. Follow, synthesize and evaluate national and international scientific and professional literature and to evaluate the scientific and professional work in the field of agriculture.

Compliance of the Program with European Qualification Framework (EQF)

FAZ adopted and implemented all central tools of Bologna process, and learning outcomes are aligned with 8.2 of Croatian Qualification Framework or 8 of EQF.

2.1. Program disciplines and courses

Table 3 Number of compulsory and elective courses grouped by disciplines offered by the Program

Compulsory courses	**Number**
Scientific and Research System	1
Course of the mentor (1 out of 7)	8
Zoology	2
Plant Pathology	3
Weed Science	1
Interdisciplinary	2

Table 4 Courses of general importance of the Program

Courses	**Credits (ECTS)**
Scientific and Research System	6
Total 2	**6**

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Table 5 Courses that focus on various disciplines related to Plant health

Courses	Credits (ECTS)
ZOOLOGY	
Research Methods in Agricultural Entomology	6
Agricultural Zoology	6
Total 2	**12**
WEED SCIENCE	
Advanced Weed Management	6
Total 1	**6**
PLANT PATHOLOGY	
Plant Bacteriology	6
Plant Mycology	6
Plant Virology	6
Total 3	**18**
INTERDISCIPLINARY	
Methods for Ecological Quality Evaluation in the Integrated Plant Protection System	6
Phytopharmacy with Ecotoxicology	6
Total 2	**12**

Table 6 The objectives and learning outcomes of courses of general importance

COURSE	THE OBJECTIVES*	THE LEARNING OUTCOMES OR CORE COMPETENCES**
Scientific and Research System	• The aim of this module is to introduce students to the basic tenets of scientific research and the acquisition of basic knowledge of the rules of planning, organizing and presenting scientific research. • The practical aim of the module is to prepare postgraduate students for the work on dissertation.	• Describe and explain the terms – science, scientific research and work; critically judge the unethical conduct in science and scientific community. • Collect the scientific literature by searching databases. • Distinguish and classify scientific publications; carry out the procedure of publication in the scientific journals. • Devise, organize and prepare a presentation of scientific research and present it. • To discuss, create and set up hypotheses in accordance with the purposes and self-assess them and recognize the need and role of statistical analysis in the scientific work. • Formulate and design application and the defense of the doctoral thesis
Course of the mentor	Is selected from one of the courses related to discipline	

*****To provide students with knowledge about...*

***When students successfully complete their programs they will be able to…; Use descriptors (active verbs) as defined by EQF*

Table 7 The key objectives and the learning outcomes of all other courses grouped by disciplines that are related to the Plant health

DISCIPLINE	THE OBJECTIVES*	THE LEARNING OUTCOMES OR CORE COMPETENCES**
Zoology	To acquire the theoretical and factual knowledge necessary to identify pests. To understand the consequences caused by their attack in crop production and to apply measures for their control. To acquire skills of proper sampling of plant material and soil and the use of appropriate methods of sample analysis and identification of these harmful organisms. To acquire skills for organization and implementation of measures in order to protect agricultural crops. To make the doctoral students familiar with the new cognitions of the methods used in entomological researches and to train them for the selection of the most acceptable method for independent assessment and the implementation of researches, particularly those related to the dissertation topic.	• Identify and appoint animal pests organisms in crop production • Distinquish and describe types of damage caused by plant pests in crop production • Select the appropriate methodes of sampling of plant material and soil so as identification methodes in order to determine the level of pest population • Calculate and predict the attack intensity of harmful organisms • Analyze and identify the reasons for the appearance of certain pests • To develop recommendations for the suppression or protection plantations of harmful nematodes, mites, slug and snails, rodents and birds in specific conditions and different types of agricultural production • Research planning and selection of the research methods in concrete conditions • Analysis and assessment of the possibility to use parcticular method in the implementation of selected entomological researches • Elaboration, evaluation and selection of the methods for insect breeding in laboratory conditions • Assessment of the impact of the selected method on biological diversity and composition of the fauna in ecosystems • Selection of the research method within the doctoral dissertation topic, explanation and evaluation of justifiability of that selection
Weed Science	To acquire skills and competences in the field of sustainable use of herbicides, the principles of weed classification; keys to weed determination, the significance of plant	• To define the fundamental terms of weed science and to explain their importance and interaction • To distinct and to argument the advantages and disadvantages of chemical weed control methods

	competition, methods of weed management and control, environmentally friendly weed control, rational use of herbicides, methods of scientific research in weed science in laboratory and field conditions, methods for weed seed bank evaluation, the introduction of the biology and ecology of weeds in weed management, forecasting weed emergence models for arable crops;	• To analyse and evaluate the global development and trends in weed control • To lead or to participate in creating strategies, studies or documents in the field of sustainable use of herbicides
Plant Pathology	Scientific training in the field of phytopathology of pathogens (viruses, phytoplasma, bacterial and fungal pathogens). Knowledge of the basic facts in phytobacteriology, phytovirology and phytomycology and the parasitic relationship between pathogen and plant, biology and ecology of plant pathogens. Study of the plant pathogens through their morphology, taxonomy, ecology, nomenclature, chorology, pathogenesis and symptomatology of diseases. Obtain skills in diagnostic possibilities by modern diagnostic methodology.	• Integrate theoretical knowledge and practical skills in the selection and application of diagnostic tools to identify plant pathogenic bacteria, funghi and plant viruses and recognize the symptoms of viral diseases • Analyze and evaluate the collected facts about the diseased plant with the aim of describing the basic biology of fungal, bacterial and viral pathogens • Analyze and evaluate information, to discuss the importance of funghi, phytobacteria and plant viruses in natural and cultivated ecosystems • Create/design and conduct research in the area of plant bacteriology in order to confirm the presence of bacterial species or even in finding new species, diagnose mycosis and advice for futher tests necessary for full identification of an isolated fungus, conduct futher tests necessary for full identification of an new non identified fungus • Plant laboratory investigation for the diagnosis of mycotic disease and interpret results of culture on fungal isolation media • Describe the parasitic and mutualistic interactions between fungi and plants as a demonstration of a broad and coherent knowledge of the subject • Analyze and evaluate information in order to discuss the role of pathogenes in natural and managed ecosystems • Create and conduct antifungal susceptibility testing

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		• Recognize the importance and role of plant virology in agricultural plant production Explain the characteristics of plant viruses an (morphology, taxonomy, ecology, chorlogy and pathogenesis) • Use of Web databases and other Internet resources about plant viruses
Interdisciplinary	To inform students about the new scientific results and gaining knowledge about the plant protection methods against plant pests and enable them for critical evaluation of plant protection products (PPs), independent research activities and creation of the new, knowledge in the area of phytopharmacy. To introduce the advantages and disadvantages of certain elements in integrated production in order to create new agricultural habitats. The value of the following elements will be evaluated: natural regulations, biodiversity, biological control measures, ecological infrastructure and other regulatory mechanisms.	• To analyze and understanding the historic development of the pesticides and to criticaly elaborate each group of pesticides within the context of the time when it was developed and applied • Critically evaluate toxicological and ecotoxical propertis of PPs • Describe and elaborate potential impacts and consequences of application of different group of PPs on agro-ecosystem and effectively react if the unprofessional application of PPs occurred and causes negative implications on agro-ecosystem • Chose and apply adequate methods for the evaluation of the PPs • Select and apply the most appropriate method and PPs in order to control various pests • Plan and carry out investigations with PPs, analyze, discuss and present obtained results • Independently create scientific research from the field phytopharmacy • Identify the factors that causes of biological balance • Design a sustainable model in landscape arhitecture with ecological infrastructure

*****To provide students with knowledge about...*

***When students successfully complete their programs they will be able to…; Please use descriptors (active verbs) as defined by EQF*

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3. THE SWOT ANALYSIS OF THE PROGRAM

Strengths	**Weakness**
• Large number of students enrolled; • Very diverse selection of courses; • Excellent choice of supervisors and other external experts; • High level of satisfaction and harmony between students and supervisors; • Plant health courses that are offered are usually shaping the content according to the specific needs of each student; • Good skills of scientists to apply for funds; • Good skills of some scientists to implement scientific project (based on previous experiences); • Involvement of scientists in international scientific projects; • Some scientists are engaged in *CUTTING EDGE RESEARCH*	• Scientists are not motivated to apply for EU and domestic projects (the system of promotion on the job position is not very competitive); • Students from the real sector are not ready (or not able due to their regular engagements) to carry out all the activities related to completing PhD studies (conferences, mobility etc.); • Learning outcomes of the program are not focused on plant health; • The choice of the plant health courses is limited and courses are designed to "cover" very broad area from specific discipline; • Poor research infrastructure (lack of the space and equipment); • Lack of the institutional support (particularly with administrative procedures: the administrative procedures and financial rules are very complicated and sometimes scientists and PhD candidates waste their time with solving administrative and financial issues); • Institutional rules and description of working positions doesn't recognize the status of PhD candidate who is devoted to research only;
Opportunities	**Threats**
• Excellent collaboration with the national agricultural and food processing industry; • National policy declarative support to scientists to strengthen international co-operation with other HEIs; • Available EU funds for scientific projects; • Possibility to attract PhD students from abroad; • The importance of plant health issues at EU level is increasing: the need for educated professionals in plant health topics is increasing;	• Poor national financing of the scientific research; • Persons holding PhD degree are not recognized by job market (they are often considered as overeducated); • Low level of financing PhD students at national level; • Low acceptance rate of scientific projects; • Real sector doesn't recognize that not all professionals who completed study in agriculture are capable to work on the positions that requires specifically knowledge in plant health;

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Partner 2 **FAZOS - Josip Juraj Strossmayer University of Osijek, Faculty of Agrobiotechnical Sciences Osijek, Croatia**

1. COMPLIANCE OF THE PARTNERS INSTITUTIONS HIGHER EDUCATIONAL SYSTEM WITH BOLOGNA PROCESS

The Faculty of Agrobiotechnical Sciences Osijek (**FAZOS**) enrolled the first generation of students into the study programs developed according to the Bologna declaration in 2005 with an enrollment rate of approximately 300 undergraduate students per academic year. FAZOS offer degree structures on a comparable three-cycle (bachelor, master and doctoral) system in a 3+2+3 years period. This reformed studies enable students to attend classes at other universities in Croatia as well as partner universities abroad.

A set of learning outcomes as defined by the European Qualifications Framework and Croatian Qualification Framework has been established, and ECTS for each module at all degree levels in order to provide more quality assessments of students against a competency-based, rather than workload-based.

In order to ensure sustainability of the programs of the Faculty and promote European cooperation, the Quality Assurance Committee has been assembled and standards are developed to provide high quality as work model. The Committee recognizes roles and responsibilities of teachers, students and stakeholders concerning quality assurance and monitor and deliver all of the expected and achieved results. The Committee conducts internal or self-evaluation analysis. External evaluation was conducted internationally by Croatian Quality Assurance Agency by external evaluators. Re-accreditation procedure is carried out every five years. FAZOS completed its re-accreditation procedure of doctoral studies in 2016 with positive accreditation recommendation.

The Diploma Supplement has been automatically issued to completed students with all credentials containing a description of the nature, level, context, content and status of the studies completed by the individual noted on the diploma.

Doctoral studies at University of Osijek are governed by national regulatory acts which identifies the education, scholarships, granting and conditions that must be fulfilled by universities and research units leading doctoral studies.

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2. REVIEW OF THE EXISTING PhD STUDY PROGRAMS

Title: Postgraduate doctoral studies Agricultural Sciences major Plant Protection

Duration: 3 years (maximum period up to 6 years)

Credits or hours required in order to successfully complete the Program: 180 ECTS

Language: Croatian

Structured* or individual**: Both

Tuition fee: 60 000 HRK (8 100 €)

Funding support: Structured program offer paid PhD positions, while individual program is self-funded (or employer pays, scholarship granted by research institutions or industry etc.)

Enrollment and admission requirements: *MASTER'S* degree in Biotechnical Sciences or other relevant to the field of study with at least a 3,5 grade (on a scale from 1 to 5 (the best)) in average. Certificate of proficiency in spoken and written English.

Capacity: not defined

Compliance of the Program with European Qualification Framework (EQF):
FAZOS adopted and implemented all central tools of Bologna process, and learning outcomes are aligned with 8.2 of Croatian Qualification Framework or 8 of EQF.

Table 1 List of the key activities to accumulate the credits

	Activity	Number of credits (ECTS)	
		min	**max**
	Compulsory group of activities	140	-
1.	Compulsory courses (2)	12	12
2.	Elective courses (min 5)	18	60
3.	Research work	60	100
4.	Presentation of scientific work	10	30
5.	Dissertation	40	40
	Additional group of activities		40
6.	Professional activities	-	10
7.	Teaching activities	-	30
	Minimum of 180		

Table 2 The learning outcomes of the Program

After completing the PhD study program student will be able to:
1. Demonstrate the mastery of skills to critically apply range of existing theories, methods and tools in plant protection
2. Create a plan for protection of agricultural crops based on the principles of integrated and ecological pest management
3. Identify and evaluate the key environmental factors important for management of weeds, diseases and pests
4. Select and develop the most appropriate methods for monitoring of weeds, pathogens and pests
5. Recognize and identify allergenic plants, quarantine organisms, and beneficial invertebrates
6. Recognize and explain the risks of pesticides for humans, animals, and impact on environment
7. Demonstrate the ability to conceive, design and conduct research work with scholarly integrity
8. Demonstrate the intellectual indipendence to publish and present results of the research work related to plant protection

2.1. Program disciplines and courses

Table 3 Number of compulsory and elective courses grouped by disciplines offered by the Program

Courses	**Number**
Compulsory	2
Elective	35
Zoology	14
Plant Pathology	8
Weed Science	11
Interdisciplinary	2

Table 4 Courses of general importance of the Program

Courses	**Credits (ECTS)**
Principles of Scientific Work in Plant Protection	6
Ecology in Plant Protection	6
Total 2	**12**

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Table 5 Courses that focus on various disciplines in Plant health

Courses	Credits (ECTS)
ZOOLOGY	
Morphology and Physiology of Insects	2
Systematic Entomology	2
Entomology in Crop Science	4
Entomology in Horticulture	4
Insect Pests of Orchards and Vineyards	4
Stored Product Pests	3
Control Methods of Stored Product Pests	2
Plant Resistance to Pests	2
Urban Entomology	2
Quarantine Pests	1
Acarology	2
Ecology of Nematodes	2
Nematology	4
Zoocides	4
Total 14	**38**
WEED SCIENCE	
Weed Science	4
Special Weed Science	4
Weed Science in Crop Production	4
Herbicides	2
Herbicide-Soil-Plant Interaction	1
Application and Legislation of Pesticides	2
GMO in Plant Protection	2
Weed Science in Orchards and Vineyards	4
Weed Science in Horticulture	4
Weed Communities in Crop Production	2
Allergenic Weeds	2
Total 11	**31**
PLANT PATHOLOGY	
Laboratory Methods in Mycology	2
Quarantine Diseases	1
Seed Diseases	2
Phytopatology in Horticulture	4
Phytopatology in Crop Production	4
Toxic Fungi and Mycotoxins	2
Diseses of Orchards and Vineyards	4
Soil Microbiology	4
Total 8	**23**

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INTERDISCIPLINARY	
Plant Protection in Ecological Agriculture	4
Toxicology and ecotoxicology	2
Total 2	**6**

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Table 6 The objectives and learning outcomes of courses of general importance

COURSE	THE OBJECTIVES*	THE LEARNING OUTCOMES OR CORE COMPETENCES**
Principles of Scientific Work in Plant Protection	The experimental methodology and scientific analysis of data, modes of presentation and publication of research results, application of the most modern ICT technologies and statistical computer programs.	• Plan and organize the experimental method • Set up a scientific hypothesis and choose the methodology • Make the proper selection of design of experiment and apply the appropriate statistical tests for the data analysis in statistical computer programs • Interpret the result of statistical analysis and bring correct scientific conclusions summarized in a research report.
Ecology in Plant Protection	The key ecological mechanisms in plants that confer plant protection against root herbivores.	• Predict the impact of environmental factors on the development of pests • Identify plant mutualist (beneficial invertebrates, fungi and bacteria), and insects vectors of plant diseases • Explain the concepts of pesticide residues in the environment and food, waiting period, tolerance • Critically evaluate the toxicity of pesticides to humans, animals and the environment

*****To provide students with knowledge about...*

***When students successfully complete their programs they will be able to…; Use descriptors (active verbs) as defined by EQF*

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Table 7 The key objectives and the learning outcomes of all other courses grouped by disciplines that are related to the Plant health

DISCIPLINE	THE OBJECTIVES*	THE LEARNING OUTCOMES OR CORE COMPETENCES**
Zoology	• The insects and mites morphological and physiological characteristics, biology and classification • Methods of conventional identification of insects and mites • Life trait characteristics of the most important insect and nematode pests of agricultural crops and stored grain products, symptoms and thresholds of damage, monitoring and management • Effect of environmental factors on the most important insect pests and natural enemies • Invasive insect pest species and quarantine lists • Importance of development of different ecological mechanisms in plants as a tool of host plant resistance • Diversity and control measures of insects specific for urban areas • Nematode morphology, life cycle, trophic diversity, classification, distribution, parasitism, and nematodes as virus vectors • Ecology of nematodes, reaction to soil disturbation, role of nematodes in nutrient cycle • Zoocides (modes of action, resistance management, toxicity) and methods of application in agriculture	• Explain the importance and describe morphological and physiological characteristics of insects, monitor, collect, prepare, classify and identify economically important insects and mites in agricultural production and stored grain products • Recognize the symptoms of damage, predict population dynamics and damage thresholds of the most important insect and mite pests of agricultural crops and stored grain products • Develop a management plan to protect agricultural crops against insect pests • Explain the importance of biotechnology and describe methods of breeding plants for resistance against pests • Rank and compare indicators of the possible occurrence of resistant populations of the most important insect pests • Identify nematodes and symptoms of damage, and develope a management plan • Explain the ecological indicators of namatode community • Explain the mode of action of zoocides, IRAC groups and select the most promising formulation posing the smallest environental risk
Weed Science	• Biological and ecological characteristics of weeds, damages and control measures in conventional, integrated and ecological crop production • Significance of phytosociology in agriculture, sintaxonomic units of vegetation, sinecology of habitats, reproduction and weed dispersal	• Describe and identify biological and ecological characteristics of weeds in agricultural crops, and genetic diversity • Apply current methods of monitoring of weed communites, mapping, prevention and eradication • Explain the interaction between crops and weeds in agroecosystem

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	• Relationships of weed flora and crops in agroecosystems, weed mapping and monitoring of changes in weed comminities and their habitats • Herbicides classification, residual effect of herbicides, way of accession into plant, biochemical mechanism of action, and ecological consequences of implementation, the fate and behavior of herbicides in soil • Pesticides selection and application methods, with respect to the pesticide legislative in EU countries and Croatia • Research dillema, advantages and disadvantages of genetically modified cultivars in plant protection against pests, weeds and diseases • The most important allergenic plants, research methods and forecast models in aerobiology, present effective strategies of their control	• Identify and interpret phenology of allergenic and invasive plants • Distinguish and compare influence of abiotic factors on pollen presence in the air • Create, estimate and elaborate cost-effectiveness of weed control in various crops • Elaborate the advantages and disadvantages of available weed control methods • Classifiy and explain absorption and translocation of herbicides in the plants, mechanism of selective activity, resistant principles and herbicides residues, persistence and degradation, and waiting period • Explain the current efforts in research and development of pesticide resistant crops and genetically modified plants resistant to pests, and principles of registration and regulation rules of pesticides and GMOs
Planth Pathology	• Laboratory methods in phytopathology • Biology, ecology and epidemiology of the most important pathogens (pseudofungi, fungi, bacteria and viruses) of agricultural crops and seeds, seed health testing methods, study of morphological, cultural and biometric characteristics • Conventional and molecular identification of pathogens • Quarantine service legislative, overview of quarantine diseases • Management of plant pathogens • Toxicogenic fungi and micotoxins, as human disease agents and other secondary metabolites of fungi important in production of agricultural crops	• Use laboratory methods in pathology • Identify plant diseases based on symptomatology, morphology and molecular characteristics of pathogens • Evaluate the impact of environmental factors on infection and disease incidence • Predict the occurrence of diseases (plant diseases forecasting) and damage thresholds • Design, propose and compare the plant disease management • Predict the spread of quarantine pathogens. • Assess the risk of contamination of agricultural products with mycotoxins with regard to environmental factors • Compare the impact of different groups of mycotoxins on human and animal health.

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	• Influence of physicochemical factors on biology and ecology of soil microorganisms • Multitrophic interactions in soil between soil microorganism, diseases agent and higher plants, diversity of soil microbial communities	• Suggest preventive and curative measures against toxigenic fungi. • Classify and assess microorganisms in different agroecosystems, their importance, interaction and role in soil
Interdisciplinary	• The toxic effects of pesticides on living organisms, the behavior of pesticides in the environment, degradation, methods of determining pesticide residues • The basic principles and standards in organic agriculture, methods, measures and plant protection products in accordance with Croatian and international standards	• Classify and compare physiochemical properties and toxicology of plant protection products and sources of toxic agents • Define the principles, direct and indirect measures of environmentally acceptable plant protection • Recognize and evaluate safety of pesticides application, efficacy, phytotoxicity and environmental impact • Develop and apply the risk assesment plan with regard to toxicological and ecotoxicological properties of pesticides • Compare the efficiency of plant protection measures in conventional, integrated and organic agricultural production with regard to environmental impact • Assess and argument possibilities of developement of pesticides resistance

*****To provide students with knowledge about...*

***When students successfully complete their programs they will be able to…; Please use descriptors (active verbs) as defined by EQF*

3. SWOT ANALYSIS OF THE PROGRAM

Strengths	**Weakness**
• Long tradition and agricultural environment, the program covers all relevant disciplines • The program is harmonized according to EU standards, and aligned with European Qualification Framework • The optimal number of relatively young and internationally recognized professors • Equipped infrastructure (laboratories and lecture halls) and research farm (approximately 63 ha of land) • Publications in top ranking scientific and professional journals • International collaboration and experienced staff in organization of international scientific and professional meetings • Strong collaboration and interdisciplinary research with Agricultural Institute Osijek and other Faculties of Uni. Osijek • Involvement of doctoral students in teaching, research and study program organization	• Small number of competitive scientific projects, and a great number of professional projects • Small number of external teaching and scientific staff involved in the program • Lack of textbooks and teaching materials in Croatian language for several courses • Lack of courses in English language and distance learning • Insufficient budget for research analysis that are not available at Institution, and for supporting students participation at conferences and publication fees • Inbalance between the disciplines (publications in top ranking journals) • Overlap of the scientific content between several courses • Insufficient transfer of knowledge in real sector, lack of patents and innovations • Small number of doctoral candidates per cycle • No foreign PhD candidates
Opportunities	**Threats**
• To harmonize the research topics and content of courses with the cutting edge knowledge, actual needs at the labor market and society in general • To define qualification standards through CQF program • To offer courses in English language and distance learning for certain courses • Development of web page with active links to teaching material • Involve external professors in study program with the aim of raising the quality • Raised mobility of mentors and students • Create interdisciplinary research teams with strong tracking records • More international competitive research projects (Horizon etc) • Laboratory accreditation and stronger market positioning	• Difficult employment after completing PhD thesis • Very few doctoral candidates per cycle • Low prospect to obtain high quality and perspective candidates • Similar and competitive programs offered in neighboring and EU countries • Low investments of government in higher education institutions • Reduced interest of graduates for enrollment in agricultural studies • Lack of resources and financial support to upgrade laboratory equipment • Migration of rural population to urban areas and exodus of graduates to EU countries

Partner 3 **UNIBA**

Università degli Studi di Bari Aldo Moro – Dipartimento di Scienze del Suolo, della Pianta e degli Alimenti – Bari, Italy

1. COMPLIANCE OF THE PARTNERS INSTITUTIONS HIGHER EDUCATIONAL SYSTEM WITH BOLOGNA PROCESS

The former Agricultural Faculty of Bari (currently, Department of Scienze del Suolo della Pianta e degli Alimenti) (acronym DISSPA-**UNIBA**) enrolled the first generation of students into the study programs developed according to the Bologna declaration in 2001. Approximately 350 students in average have been enrolling per academic year since then. DISSPA-UNIBA offers the degree framework on a comparable three-cycle (bachelor, master and doctoral) system in a 3+2+3 years period. This reformed framework enables students to attend classes at other universities in Italy as well as partner universities abroad. Moving to other Italian universities the career of each student is evaluated by a specific Commission for validation of exams already passed.

A set of learning outcomes as defined by the European Qualifications Framework (EQF) has been established for each course (some courses are made by modules) at bachelor and master levels in order to provide more quality assessments of students against a competency-based, rather than workload-based. Learning outcomes at doctoral level have not been set up till now.

In order to ensure sustainability of the programs of each course at first and second level (Bachelor, Master), the Quality Assurance Committees and other sub-Committees have been set up at the University of Bari per each course and quality requirement standards have been developed to provide high quality as work model. Each Committee recognizes roles and responsibilities of teachers, students and stakeholders concerning quality assurance, monitors and delivers all expected and achieved results in term of quality of education and student qualification. Each Committee conducts a self-evaluation analysis submitted to an annual revision by the UNIBA. External evaluation is conducted by the National Agency for the Evaluation of the University system and Research (ANVUR) by external evaluators. Re-accreditation procedure is carried out every five years. DISSPA-UNIBA completed successfully its re-accreditation procedure of Bachelor and Master courses in November 2018.

Concerning Doctorate, re-accreditation is made every five years by Ministry of Education, University and Research (MIUR) in collaboration with ANVUR. Re-accreditation is made also in case of changing of the Coordinator of the doctorate of in case of a annual change in the members of the Academic Board by over 20% of its composition. MIUR-ANVUR assesses the quality of the members of the Academic Board every year based on their publications, funds, laboratories available for research, etc.

Doctoral courses at DISSPA-UNIBA are governed by National and Athenaeum regulatory acts which identify the education, scholarships, granting and conditions that must be fulfilled by universities and research units leading doctoral studies.

2. REVIEW OF THE EXISTING PhD STUDY PROGRAMS AT DISSPA-UNIBA

Title: PhD (doctorate) in Biodiversity, Agriculture and Environment

Duration: 3 years (there is no possibility to extend the period over three years to gain the title)

Number of Curricula **=** 5: 1) Genetics and molecular and structural evolution; 2) Plant genetics and biotechnology; 3) Agroforestry engineering and crop production; 4) Environmental sciences; 5) Crop protection.

Organization (in brief): The course is organized in three years. The start of the course (cycle) is November of each year and they are numbered progressively; since the beginning in 1984, 35 cycles have been run. PhD students are obliged to attend the program and to carry out continuous study and research activities at the sites designated for this purpose in accordance with the procedures set out by the Academic Board, with an exclusive full-time commitment equivalent to 1,500 hours per year. Within three months from the beginning of the course, the PhD student has to present a research project outlining the planning of his activities, which is approved by the Academic Board. At the end of the first semester of each year of the course, the PhD student is required to present a short written report on the activities carried out; at the end of each year of the course the student is required to present a detailed written report and a brief oral presentation concerning the activity carried out. The positive assessment by the Academic Board allows the admission to the successive year of the program, or, at the third year, to the final exam. Mandatory lessons (for 14 ECTS), common to the five *curricula*, are planned during the first semester of the first year. In the second semester of the first year, more specific and also mandatory lessons are planned for each *curriculum* (for 6 ECTS). No other courses are foreseen during the second and the third year, even though the Tutor can suggest specific additional (elective) courses for each PhD student.

Credits or hours required in order to successfully complete the Program: 21 ECTS. Research and teaching (attended lessons) activity in Italy and abroad, congress attending, seminars as attendant, seminars as speaker, etc.) are not codified in ECTS.

Structured* or individual**: Both

*(*the mentor has predefined research objectives on specific research topics that are built into different projects;**no predefined objectives, the mentor helps a PhD candidate to choose a research topic on which the PhD candidate works either independently or in a research team)*

Language: Italian/English

Tuition fee**: around** 200 € depending on the income

Funding support: Scholarships are covered by sources coming from the Ministry of Education University and Research (MIUR) (through UNIBA), from EU programs (through Ministerial PON FSE-FESR “Research and Innovation 2014-2020” - Action I.1 “Innovative Research PhDs with Industrial Profiles”), from other public and/or private bodies and also from funds within approved national and international research projects.

Enrolment and admission requirements: Eligible candidates have to possess one of the following qualifications irrespective of their gender, age, nationality, religion, ethnicity and social class: master degree; master degree awarded abroad, declared equivalent to an Italian degree, recognised as such solely for the purpose of the admission to the competition

Capacity: not defined

Compliance of the Program with European Qualification Framework (EQF):

The process of adoption and implementation of Bologna process is still in progress and not completely adopted for PhD course at the DISSPA-UNIBA, although it was carried out for Bachelor and Master degre. However learning outcomes of the PhD courses are aligned with point 8 of EQF.

Table 1 List of the key activities to accumulate the credits

	Activity	**Number of credits (ECTS)**	
		Min	**max**
	Compulsory group of activities	-	-
1.	Compulsory courses (9/11)	20	22
2.	Elective courses	not defined	not defined
3.	Research work	not defined	not defined
4.	Presentation of scientific work	not defined	not defined
5.	Dissertation	not defined	not defined
	Additional group of activities		40
6.	Professional activities	not defined	not defined
7.	Teaching activities (during 3 yrs)	0	4
			Minimum (not defined)

2.1. Program disciplines and courses

Table 2 Interdisciplinary courses common to the 5 curricula (crop protection included)

Courses	Credits
Safety and management of research lab hazards	1
Bioinformatic applications for the characterization of beneficial and harmful entities	2
Applied statistics in biosciences	2
Project management	1
Communication of science and scientific writings	2
Valorisation of research results	1
English language (B2)	4
Series of seminars held by Italian and foreign teachers	-
Total 8	**13**
Courses specific for the curriculum in Crop Protection	
• Methods to assess plant reactions to diseases	1
• Laboratory on plant disease symptom studies	2
• Advanced diagnostic techniques in Plant Pathology	3
Total 8	**6**

Table 3 The learning outcomes of the Program

After completing the PhD study program the student will be able to:
1. Demonstrate the mastery of skills to critically apply range of existing theories, methods and tools in plant protection
2. Demonstrate the ability to conceive, design, conduct and create reports on research work
3. Recognise risks related to the activities conducted in a laboratory working in crop protection
4. Demonstrate indipendence and initiative in tackling research activity, publishing and presenting results of the research work related to plant protection
5. Demonstrate the ability to elaborate raw data for statistical significance
6. Exploitation of results to start patent procedures
7. Demonstrate to have specific and deep competence in the subject of crop protection developed during PhD course.

Table 4 The key objectives and the learning outcomes of the courses

DISCIPLINE	THE OBJECTIVES*	THE LEARNING OUTCOMES OR CORE COMPETENCES**
	Courses common to the 5 curricula (interdisciplinary)	
Safety and management of research lab hazards	• Occupational safety according to the Italian and European regulations: from D.Lgs. 626/94 to D.Lgs. 81/2008 and their modifications; prevention, protection, hazards and damage • Hazards in the research laboratories: chemical, biological, physical, ergonomic, accident and emergency • Chemical hazards: Italian and European regulation (DSP 548/67; Dir. CE 59/2001; D.Lgs. 65/2003; CLP and Dir CE 1272/2008); Reach analysis; Symbols and pictograms; risk phrases and “hazard statements”. Individual and collective protection devices; storage of chemicals; behavioral rules in the laboratory • Biological hazards: definition, classification and management practices; biosecurity cabinet: characteristics and functioning • Physical hazards: noise, radiation and illumination: definition, classification and management criteria • Management of hazardous waste produced in the laboratory: definition and classification. Italian regulations (D.lgs. 152/2006). Obligations and responsibilities of the manufacturer; storage and disposal procedures according to the Italian regulations	• Recognize the critical point to ensure occupational safety according the national and international rules • Describe the main risks for human health associated with the research activities • Explain how to prevent and manage the risks associated with the research activities • Explain how to manage waste produced in the laboratory
Bioinformatics applications	• Primary, secondary, archival and curated databases (Refseq, GenBank, protein database) • BLAST searching of biological sequence data via website (NCBI) or in local (LINUX)	• Apply bioinformatic tools on line and in local systems (Windows and Linux operating systems) for data analyses • Interpret biological information (gene, genomes, transcripts, etc.) using leading public repositories

	• Introduction to Linux (Ubuntu GUI and command shell) and basic commands of shell • Sequence format (description and construction of fasta and GBF files) and managing different file formats -NGS sequencing technologies and pre-processing of relative sequence data (filtering, quality control) • Whole Genome Sequencing and assembling (reference guided, *de novo* assembly) • Transcriptome genome assembling and RNAseq data analysis of differential gene expression in biological systems (pathosystem) • Functional annotation, Gene Ontology and gene enrichment functions • Bioinformatic tool for metagenomic data analysis in different environment (human gut, soil, infected plants)	• Analyse by means of bioinformatic tools data for phylogenetic analysis of microorganisms (entities) • Assess genomic, transcriptomics, metagenomics data across different plant species and biological conditions
Applied statistics in Biosciences	• programming in R and how to use R for effective data analysis • installation and configuration of the software necessary for statistical programming mainly in biosciences • How to face practical issues in statistical computing which includes programming in R, reading data into R, accessing R packages and how and when to use specifics statistical tests for data analysis	• Configure statistical programming software • Become more familiar with the R interface and language • Read existing datasets into R or create new ones • Summarise and graphically display data • Perform all conventional statistical analysis tests
Project management	• theory and practice of the project management cycle, from the search of financing opportunities to the implementation of activities, including the phases of quality control, risk management and final evaluation • budget preparation and financial administration • preparation of projects as devoted to produce a unique product, service or result with a defined beginning and end to meet objectives. In terms of contents, the project	• Improve personal and collective capacities of designing, realizing and concluding high quality projects, ensuring the attainment of the objectives, the respect of time and costs, the reduction of risks of failure • Improve the group capacities of facing the different phases of a project from different point of view and with a multidisciplinary approach

	management includes the development of both technical and management skills	
Communication of science and scientific writing	• How to write a research paper: title, abstract, keywords, highlights, introduction, materials and methods, results and discussion, conclusions, acknowledgements • The use of reference management software for scientific writing. References, citations and bibliographic research. Non-peer-referee and peer-referee journals. Objective evaluation indices for the scientific publications • Presentations at conferences • Use of PowerPoint	• Write scientific articles in referenced journals • Use tools for bibliographic researches • Give presentations in congresses and other contexts • Describe in oral and written form various aspects characterizing the research job
Valorisation of research results produced by research activities	• Methodologies concerning the dissemination and exploitation of the results produced by research activities • Transfer knowledge and results to the stakeholders	• To maximize the impact of research, enabling the effect of results to be potentially wider than the original focus • To develop plans for using results for scientific, social, or economic purposes
English language	• Speaking and writing in the field of agriculture • Communications by using a worldwide language	• develop a formal style used in scientific and academic English
Seminars by Italian and foreign researchers	• Specific topic in the field of crop protection and also in a wider range connected with agriculture	• Understand issues related to different field of application of crop protection and then have an holistic approach to solve problems
Methods to assess plant reactions to diseases	• Development of methods of control based on genetic resistance • Measurements of development of symptoms • Physio-chemical reactions • Inocula preparation and experimental protocols • Influence of inoculation methods on the reaction of plants	• Find the best inoculation method in relation to the disease, to the host and to the pathogen • Assess symptoms • To exploit plant reaction to measure resistance
Laboratory on plant disease	• Methodologies to identify specific or a specific symptoms exhibited by a plant specimen	• identify correctly symptoms exhibited by a diseased plant, caused by an infective/non infective agent • recognize diseases based on unmistakable symptoms

symptom studies	• Progression of symptoms caused by infective/non infective diseases • Identification of variations in symptoms expressed by diseased plants	
Advanced diagnostic techniques in Plant Pathology	• Updated methods for the identification of diseases in agriculture • Laboratory- or field-based techniques such as innovative formats of molecular and serological tests based on the use of portable device, fluorescence imaging and hyper spectral techniques • Biosensors based on highly selective bio-recognition elements such as enzyme, antibody, DNA/RNA and bacteriophage as a new tool for the early identification of crop diseases	• Select the most appropriate method of identification of plant pathogens • Apply various advanced diagnostic methods in plant disease detection in relation to their reliability, cost and ease use

*****_To provide students with knowledge about..._

**When students successfully complete their programs they will be able to…; Please use descriptors (active verbs) as defined by EQF

3. THE SWOT ANALYSIS OF THE PROGRAM

Strengths	Weakness
• The PhD course in “crop protection“ is one of the oldest at the university of Bari since it started in 1984. Program changed over the years but still covers relevant aspects in crop protection. • Teaching staff of high quality (as ascertained by didactic evaluation questionnaire). • Equipped infrastructure (libraries, laboratories, green houses, etc.) didactic-experimental centres (approximately 160 ha of land), updated instruments. • Publications in highly impacted journals and also in professional journals • Collaboration with renowned national and international working groups in which PhD students spend their period of research abroad. • Involvement of PhD students in teaching support activities. • Starting from the second year, students have a minimum budget (1/10 of the total amount of annual fellowship) for participation at conferences, publication fees, etc. • Teaching courses held only in the first year of doctorate. Second and third year dedicated only to research activity in Italy and abroad. • Presence each year of a minimum number of foreign candidates.	• The program is not completely harmonized and aligned with European Qualification Framework. • Small number of doctoral positions and candidates per cycle. • Difficulty in finding financial support for basic research and additional positions. • No funds for supporting expensed of scientists of other institutions for teaching or for research collaboration. • No specific budget for conducting research of PhD students. The research of the PhD student is financed through research group projects. • Insufficient transfer of knowledge in practical sector, lack or few patents. • PhD students are ready mainly for the academic career and less for other specialized tasks (i.e. industries). • Very low possibilities to continue an academic career.
Opportunities	**Threats**
• To harmonize the doctoral course according to European rules with the cutting edge knowledge and actual needs at the labour market, not only for the academic career. • Higher interest of EU in financing the third level of education. In Italy, for some Southern regions, the call PON FSE-FESR “Research and Innovation 2014-2020”-Action I.1 “Innovative Research PhDs with Industrial Profiles” gave the opportunity of financing additional competitive fellowships to prepare PhD ready to work in industries. • Define qualification standards following the European Qualification Framework. • Offer distance learning courses for interdisciplinary subjects. • Involvement of renowned international scientists for teaching courses and/or seminars. • Increase mobility of mentors and students. • Create new relationship among research teams for complementary researches. • Participation to international competitive research projects (Horizon, Life, etc.)	• Difficult employment after completing PhD thesis (too high specialization). The specialization of PhD is suitable for academic career. • Low number of candidates per cycle (no interest in PhD courses because of difficulties in employments) • Lower prospective in the time to obtain high quality candidates • Brain drain abroad because the doctorate offers greater prospects in other countries • Low investments of government in funding fellowships and doctoral research. • Reduced interest of agriculture in investing in so high specialized figure of PhDs

Partner 4 AU - Agricultural University Plovdiv,
Faculty of Plant Protection and Agroecology, Bulgaria

1. COMPLIANCE OF THE PARTNERS INSTITUTIONS HIGHER EDUCATIONAL SYSTEM WITH BOLOGNA PROCESS

At the end of 1995, the Higher Education Act (HEA) was passed; with it Bulgaria was one of the first countries in Europe to introduce the 3-tier system of higher education – Bachelor, Master and Doctor. Teaching for earning each degree is in line with the Classificatory of areas of higher education and professional directions, the implemented European system of ECTS. HEA contains provisions related to external and internal system of quality assurance of higher schools, system of credits and European diploma supplement. In keeping with the European Qualifications Framework as an instrument of recognizing qualifications of students and employees, a National Qualifications Framework of Republic of Bulgaria was adopted in 2012. It stipulates 9 qualifications levels; the degrees of higher education are situated in the last 3 levels of the framework.

The Faculty of Plant Protection and Agroecology enrolled the first generation of students into the study program Plant protection developed according to the Bologna declaration in 2000 with an enrollment rate of approximately 120 undergraduate students per academic year. The Agricultural University - Plovdiv offers degree (bachelor, master and doctoral) in a three-cycle system (4 + 1 or 2 + 3 years). This reformed studies enable students to attend classes at other universities in Bulgaria as well as partner universities abroad.

A set of learning outcomes as defined by the European Qualifications Framework and Bulgarian Qualification Framework has been established for each module at all degree levels in order to provide more quality assessments of students against a competency-based, rather than workload-based.

In order to ensure sustainability of the programs of the Faculty and promote European cooperation, the Central Commission of Quality Assurance (CCQA) has been assembled and standards are developed to provide high quality as work model. The Commission recognizes roles and responsibilities of teachers, students and stakeholders concerning quality assurance and monitor and deliver all of the expected and achieved results. The Commission conducts internal or self-evaluation analysis. External evaluation is conducted by National Evaluation and Accreditation Agency (NEAA) by external evaluators. Re-accreditation procedure is carried out every 3 to 6 years depending on the previous evaluation (grade in accreditation of 4.00-4.99, 5.00-6.99, 7.00- 8.99, 9.00-10.00). The Faculty of Plant Protection and Agroecology (FPPA) completed its re-accreditation procedure of doctoral studies in 2013 with positive accreditation recommendation and grade 9,61. Next accreditation is due on April 2019. **https://www.neaa.government.bg/en/**

The Diploma Supplement has been automatically issued to completed students with all credentials containing a description of the nature, level, context, content and status of the studies completed by the individual noted on the diploma.

Doctoral studies at the Agricultural university - Plovdiv are governed by national regulatory acts which identifies the education, scholarships, granting and conditions that must be fulfilled by universities and research units leading doctoral studies.

2. REVIEW OF THE EXISTING PhD STUDY PROGRAMS

Title: Postgraduate doctoral studies Agricultural Sciences major Plant Protection

Duration: 3 years (with 1 year prolongation) for full time; 4 years for part time

Credits or hours required in order to successfully complete the Program: 180 ECTS

Structured* or individual**: Both

Language: Bulgarian, English

Tuition fee: government paid PhD position: 1000 BGN (511 €) only once for the whole period self-funded: each year 8 000 BGN (4 090 €) for full time PhD position; each year 5 000 BGN (2556 €) for part time

Funding support: Structured program offer paid PhD positions, while individual program is self-funded (or employer pays, scholarship granted by research institutions or industry etc.)

Enrollment and admission requirements: *MASTER'S* degree in Plant protection or other Agricultural sciences with at least a 3.5 grade (on a scale from 1 to 6 (the best)) in average. Certificate of proficiency in spoken and written English.

Capacity: not defined

Table 1 List of the key activities to accumulate the credits

	Activity	Number of credits (ECTS)	
		min	max
	Compulsory group of activities		-
1.	Compulsory exam*	20	20
2.	Research work	50	50
3.	Annual reports 3x10 credits	30	30
4.	Publications in scientific journals	30	-
5.	Participation in a conference/seminar	-	5
6.	Pre- Defense at the department	50	50
	Additional group of activities		40
7.	Teaching activities	-	7
		Minimum of 180	

*Compulsory exam – the student is not obliged to attend any course, but have to prepare by himself/herself and pass an exam, called “candidate’s minimum”, which depending on the specific topic of the PhD thesis could be in Entomology, Plant pathology, Weed science, etc. The student may attend any course running at bachelor or master programs in Plant protection but will get no credits for this.

After successfully passing this exam, the PhD student may be involved in teaching.

There are available elective courses, which may coplement PhD students'competence in statistical analysis, teaching methods, using computer databasis, English, etc., but it is above the needed 180 credits.

Table 2 The learning outcomes of the Program

After completing the PhD study program the student will be able to:
1. demonstrate knowledge and understanding at the highest possible degree not only in Plant protection but also in related scientific areas
2. to broaden and improve current knowledge in the field of Plant protection as well as its interaction with close scientific areas
3. proficiently employ the methods of scientific research in the field of Plant protection
4. use specialized and systematic knowledge to make a critical analysis and synthesize new ideas
5. demonstrate the mastery of skills to critically apply range of existing theories, methods and tools in plant protection
6. to find solutions to complicated problems by employing new technological methods and instruments and develop innovative solutions by combining a variety of original strategies and technologies
7. to make up, design, implement and adapt a contemporary research process in conformity with scholarly norms
8. present one's own ideas and conclusions clearly and effectively
9. demostrate the intellectual independence to publish and present results of the reseach work related to Plant protection

Compliance of the Program with European Qualification Framework (EQF):

AU adopted and implemented all central tools of Bologna process, and learning outcomes are aligned with level 8 of Bulgarian Qualification Framework and of EQF.

2.1. Program disciplines and courses

Table 3 Number of compulsory and elective courses grouped by disciplines offered by the Program

Courses	**Number**
Compulsory	0
Elective	0
Interdisciplinary	0

3. SWOT ANALYSIS OF THE PROGRAM

Strengths	Weakness
• 78 year-long traditions in agricultural education and science, including 35 in Plant protection. • Traditionally strong contacts in the area of Plant protection with leading scientists and experts worldwide. • Close contacts and good communication with leading national research institutions. • Experimental fields and glasshouses, certified laboratory complex. • Facilitated and fast communication among researchers in solving interdisciplinary scientific tasks. • Well-stocked university library serving teaching/training/learning activities. Access to international online databases. • Significant financial resources for research activities attracted by international scientific and operational programs through bilateral agreements with EU countries, China, etc. and the National Science Fund. • Stimulating the scientific work of young scientists.	• Insufficient or outdated research equipment and laboratory appliances and resources at some departments (research units). • Outdated infrastructure of insufficient capacity to meet present-day demands. • Insufficient funding for research activity strongly dependent on government funding. • Still low scientific capacity to participate in European scientific networks and applied research projects. • Demographic crisis and low remuneration for young people are a barrier to academic and scientific careers. • Self-confidence deficit of academic staff to break out of routine research and search for innovative solutions.
Opportunities	**Threats**
• Opportunities for developing Plant protection projects related to State priorities. • Opportunities for training more undergraduate, post-graduate and doctoral students as well as young researchers in the field of Plant protection. • Possibilities for international knowledge exchange within joint projects. • Growing interest in training foreign students from countries outside the European Union. • Contacts, mobility and exchange of researchers and students in frame of bi- and multilateral co-operations. • Enhanced opportunities for the education-science-business relationship and practical contacts. • Upgrading existing communication and educational networks. • Membership in the EU - facilitated contacts, mobility and exchange of scientists, joint projects.	• Expensive maintenance of the material and technical base. • Deterioration of the economic situation and insufficient funding for both research, education and the renovation of the existing infrastructure and equipment. • Low remuneration, lack of incentives and difficulties in attracting young people into the higher education and research sector. • Possible demotivation in terms of research, particularly strong in young scientists due to legal and organizational difficulties, slow career development and low payment. • The frequent changes in the Regulations and Rules lead to reorganizations and reforms. Incompetent interference of politics with science and education. Increased competition.

Partner 5 AUA - Agricultural University of Athens, Department of Plant Science, Greece

1. COMPLIANCE OF THE PARTNERS INSTITUTIONS HIGHER EDUCATIONAL SYSTEM WITH BOLOGNA PROCESS

The AUA's Crop Science PhD program is in strong alignment with the directives and objectives of the Bologna process since its establishment. It represents the third cycle of education as it was formally introduced to the Bologna Process (bachelor, master and doctoral) system and its being regulated by the legislation (4485/2017, ΦΕΚ τ.Α΄114/4-8-2017) of the Greek state.

Regarding mobility, the PhD candidate is permitted to execute part of his research in other than the hosting, national or international research institutions, in the context of programs such as the ERASMUS+ or similar.Modern topics and advanced technologies provide the necessary ammunition to the PhD students to achieve their future endeavors in regarding employment and their carreers as researchers within the European Higher Education Area (EHRA). The progmam has a strong social dimension, since it is a no-fee PhD program, ensuring the reflection of the diversity of the total population.

The program outcome, according to the European Qualification Framework (EQF), corresponds to the Level 8, ensuring the acquisition of advanced interdisciplinary knowledge, skills and techniques, necessary for the development of problem-solving skills, independency, and innovation.

Additionally, highly skilled senior researchers and supporting staff, and advanced research facilities are strategically positioned to attract talents and HQP from third countries advancing its international dimension.

2. REVIEW OF THE EXISTING PhD STUDY PROGRAMS

Title: PhD program in Crop Science

Duration: 3 years (maximum period up to 6 years)
The **minimum duration** for the PhD nomination is three (3) years from the date of the assignment of the three-member advisory committee (paragraph 2, article 39 of the legislation N. 4485/2017 (ΦΕΚ τ.Α΄114/4-8-2017). An exception is for students that do not hold a diploma according to the legislation (article 46 of the legislation 4485/2017, ΦΕΚ τ.Α΄114/4-8-2017). In this case the minimum duration is determined to four (4) years. The **maximum duration** is 6 years following the date of the assignment of the three-member advisory committee. It can be expended for up to one more year following justified request and its acceptance by the Department's General Assembly. In s**pecial cases:** *e.g.*, military service, health issues, pregnancy; a maximum extension of two (2) years following justified request by the advisory committee in collaboration with the PhD student. In case where the maximum allowed duration of studies is being reached, the PhD student status will be suspended and the student removed from the list of PhD candidates of the Department and all its privileges will be revoked.

Credits or hours required in order to successfully complete the Program: Currently, the AUA's PhD program has no assigned credits–ECTS

Structured* or individual**: Both

Tuition fee: No tuition fees apply

Language: Greek, English

Funding support: Funding provided by the principal investigators grants and fellowships of the Greek state or the private sector

Capacity: not applicable

Requirments for complletion of the PhD thesis: Three publications in international journals with impact factor is a prerequisite and successful public defence of the PhD thesis.

Compliance of the Program with European Qualification Framework (EQF): The AUA's PhD program is in the process of fully adapting and implementing the EQF (external and internal evaluations)

The learning outcomes of the Program: The program outcome, according to the European Qualification Framework (EQF), corresponds to the Level 8, ensuring the acquisition of advanced interdisciplinary knowledge, skills and techniques, necessary for the development of problem-solving skills, independency, and innovation. Following the completion of the PhD Program, the student will be able to:

Knowledge	Skills	Responsibility and autonomy
Knowledge at the most advanced frontier of crop science and at the interface between fields (e.g., phytopathology, entomology, pesticide science)	The most advanced and specialised skills and techniques in crop science, including synthesis and evaluation, required to solve critical problems in research and/or innovation and to extend and redefine existing knowledge or professional practice	Demonstrate substantial authority, innovation, autonomy and professional integrity and sustained commitment to the development of new ideas or processes at the forefront of crop science (e.g., phytopathology, entomology, pesticide science)

2.1. Program disciplines and courses*:* Presently, no obligatory or optional courses are projected for the PhD candidates of the AUA's Crop Science Department. The Advisory Committee may request from the PhD candidate to **attend courses** in cases that they do not hold a MSc degree or hold a degree in a discipline not relevant to Crop Science.
The program includes, but it is not limited to, the disciplines of:

- Entomology and zoology
- Pesticide science
- Phytopathology
- Enironmental science

3. SWOT ANALYSIS OF THE PROGRAM

Strengths • Advancement of knowledge through original advanced research • The doctoral training meets the needs of a job market that is wider than academia • Arrangements for supervision and assessment is based on a transparent contractual framework of shared responsibilities between doctoral candidates, supervisors and the institution • The seven-member committee for the PhD defence consists of experts from and outside the University • Graduates are successful in acquiring postdoc and other high level jobs in Greece and abroad in the private and public sectors • Solid, world-wide recognized researchers in their respective fields • AUA's doctoral program and research training are designed to meet new challenges and include appropriate professional career development opportunities • Multiple projects are funded by the state's funding agencies, which can support the PhD students • The interest of graduates to pursue higher education towards the PhD degree is currently continuously increasing • PhD students should usually have published at least 2 papers from their thesis in current contents journals (or indexed in other international databases) along with other outputs	**Weaknesses** • The doctoral program usually exceeds an acceptable time duration (> 3-4 years full-time) • Lacks significant interdisciplinarity. Doctoral programs should seek to offer geographical as well as interdisciplinary and intersectoral mobility and international collaboration within an integrated framework of cooperation between universities and other partners • The development of high quality doctoral program and the successful completion by doctoral candidates requires appropriate and sustainable funding • No ECTS in the doctoral program
Opportunities • Research training is designed to meet new challenges and includes appropriate professional career development opportunities • Acquisition of international experience by participating in the EU research and educational mobility programs • Several fellowships are available to the students from research state funds and foundations • Expansion of international footprint represents a great opportunity for the AUA	**Threats** The budget that comes from the government does not provide sufficient support to cover expenses for doctoral students´ work. Therefore, this problem lies fully on supervisors who have to secure money from grant agencies for the PhD-related expenses, in order to provide updated research tools and smart technologies to PhD candidates

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Partner 6 AUT - Agricultural University of Tirana, Faculty of Agriculture and Environment, Albania

1. COMPLIANCE OF THE PARTNERS INSTITUTIONS HIGHER EDUCATIONAL SYSTEM WITH BOLOGNA PROCESS

The Agricultural University of Tirana is the oldest university in Albania. It was established on 1 November 1951 as the State High Agricultural Institute, and was further accorded the status of the Agricultural University of Tirana. AUT is the only center of higher education in Albania focusing on agriculture, forestry, biotechnology and food as well as veterinary, with the mission of education, research and transfer of knowledge.

AUT has for years been transformed into one of the most important institutions in its unique fields. AUT is organized in 5 Faculties: Faculty of Agriculture and Environment, Faculty of Economics and Agribusiness, Faculty of Biotechnology and Food, Faculty of Forestry and Faculty of Veterinary Medicine.

AUT offers contemporary academic programs:

- Undergraduate studies, which provide students with respective professional knowledge for all degree directions (EQF level 6, **Bachelor**, 6 semesters, 180 ECTS);
- Post graduate education, which offers a deeper professional knowledge through advanced programs (EQF level 7, **Master of Sciences,** 4 semesters, 120 ECTS);
- **PhD studies** proffer the students with a deep familiarity of their own branch of science (EQF level 8, PhD studies, 6-8 semesters, 60 ECTS, majors Agriculture & Environment, Plant Protection Sciences, Environmental Sciences, Agronomic Sciences, Horticulture Sciences and Animal Production Sciences).

2. REVIEW OF THE EXISTING PhD STUDY PROGRAMS

Title: Doctoral study Agriculture and Environment, Profile Plant Protection Sciences

Duration: *3 – 5 years*

Credits or hours required in order to successfully complete the Program: 60 ECTS

Language: Albanian

Tuition fee: 200 000 ALL (about 1600 euro)

Funding support: -

Enrollment and admission requirements: *MASTER'S* degree in Plant Medicine, Plant Production, Horticulture, Biotechnology, Chemistry, Biochemistry or other relevant to the field of study with at least a 180 ECTS and estimation above 8 (5-10) in average. Certificate (C1) in spoken and written English.

Capacity: 5 – 6 students per academic year

PhD is open with CM Decision in 2009:

- ✓ At the beginning it was just with scientific work
- ✓ The first Academic year was 2011-2012
- ✓ Academic year 2012-2013 was the the last year of registrations
- ✓ 40 ECTS with obligated + 20 ECTS from election modules
- ✓ In total it lasted for the 3 academic years
- ✓ PhD school is CLOSED from 2013 – 2018.

Table 1 List of the key activities to accumulate the credits

	Activity	Number of credits (ECTS)
	Compulsory group of activities	-
1.	Compulsory courses (5)	40
2.	Elective courses (4)	20
3.	Research work	50
4.	Presentation of scientific work	30
5.	Dissertation	40
Total		**180**

Doctoral students who have successfully completed the theoretical course as well as the final exam qualify for PhD candidate status and are allowed to select the supervisor and continue

with the thesis. The research area is determined by the student in collaboration with the Supervisor and Head of Department.

The "Doctor" degree is awarded on the basis of the dissertation and after publishing at least three scientific articles, three presentations (posters or referrals) at scientific conferences. The thesis defense is realized through an oral exam, in front of a jury of 5 field-related professors.

Table 2 The learning outcomes of the Program

After completing the PhD study program students will be able to:
1. During the theoretical course students are provided with knowledge about the methodology of scientific research and how they accomplish their dissertation thesis
2. Knowledge on statistics on scientific research in the field of plant protection
3. During the theoretical course of the doctoral school students are provided with deep professional knowledge in the field of plant protection.
4. Recognize and explain the risks of pesticides for humans, animals, and impact on environment
5. Recognize and identify allergenic plants, quarantine organisms, and beneficial invertebrates
6. Biotechnology Knowledge in Molecular Diagnosis
7. Knowledge on Analytical methods and instrumental analysis in plant medicine laboratories and demonstrate the ability to conceive, design and conduct research work.
8. Demonstrate the intellectual indipendence to publish and present results of the research work related to plant protection.

Compliance of the Program with European Qualification Framework (EQF):

AUT adopted and implemented all central tools of Bologna process. PhD studies proffer the students with a deep familiarity of their own branch of science (EQF level 8)

2.1. Program disciplines and courses

Table 3 Number of compulsory and elective courses grouped by disciplines offered by the Program:

Compulsory Courses	**Credits (ECTS)**
1. Methodology of scientific research	(10 ECTS)
2. Biotechnology	(10 ECTS)
3. Biochemistry and Physiology of Plants	(8 ECTS)
4. Environment and Plant Cultivation	(8 ECTS)
5. Analytical methods and instrumental analysis	(4 ECTS)
total	**40 ECTS**
Elective courses	
Module 1 = (5 ECTS credits)	
- Pro and parasitic Eucariotes of Agricultural Plants or	
- Damage Insects of Agricultural Systems	
Module 2 = (5 ECTS credits)	
- Plant infectious units of crops or	
- Non-insect pests in agro-organisms.	
Module 3 = (4 ECTS credits)	
- Integrated control of disease, sanitation and quarantine of planting material or	
- Integrated Pest Management and implementation of EU protocols or	
- Phytotoxicology and food protection according EU standards.	
Module 4 = (6 ECTS credits)	
Theoretical Ph.D. examination	

Table 4 Courses of general importance of the Program

Courses	Credits (ECTS)
1.Methodology of scientific research	10 ECTS
2.Biotechnology	10 ECTS
3. Biochemistry and Physiology of Plants	8 ECTS
4. Environment and Plant Cultivation	8 ECTS
5. Analytical methods and instrumental analysis	4 ECTS
Total	40 ECTS

Table 5 Courses that focus on various disciplines in Plant health

Courses	Credits (ECTS)
Module 1	5 ECTS
- Pro and parasitic Eucariotes of Agricultural Plants or	
- Pest Insects of Agricultural Systems	
Module 2	5 ECTS
- Plant infectious units of crops or	
- Non-insect pests in agro-organisms.	
Module 3	4 ECTS
- Integrated control of disease, sanitation and quarantine of planting material or	
- Integrated Pest Management and implementation of EU protocols or	
- Phytotoxicology and food protection according EU standards.	
Module 4	6 ECTS
- Theoretical Ph.D. examination	
Total	20 ECTS

Table 6 The objectives and learning outcomes of courses of general importance

COURSE	THE OBJECTIVES*	THE LEARNING OUTCOMES OR CORE COMPETENCES**
Methodology of scientific research	To prepare students with the necessary knowledge to understand the research process and the skills to begin devising and planning their own small scale research project. Provide knowledge on the techniques of raising and pursuing field experiments	Having successfully completed this module you will be able to: 1. To demonstrate understanding of how quantitative and qualitative methods describe to research and the differing requirements associated with these approaches. 2.To express an understanding of the ethical considerations involved in the planning of health services research. 3.To demonstrate an ability to priorities workload to meet module deadlines. 4.Constract an ability to plan a small scale research project. 5. To depicit a systematic approach to gathering evidence and an awareness of levels of evidence and their applications.
Biotechnology	Demonstrate knowledge of essential facts of the history of biotechnology and description of key scientific events in the development of biotechnology Demonstrate knowledge of the definitions and principles of ancient, classical, and modern biotechnologies. Describe the theory, practice and potential of current and future biotechnology. Describe and begin to evaluate aspects of current and future research and applications in biotechnology.	1. Explain what is meant by biotechnology, both traditional and modern 2. Describe how the development of modern biotechnology was driven by advances in the fundamental disciplines in biology 3. Outline different examples and case studies in biotechnology.

Environment and Plant Cultivation	Interpret the basic principles of agricultural systems and sustainable agriculture and how to improve the economic conditions of farmers Recognize the principles of sustainable development and sustainable agriculture Explain the basic scientific information about the various systems of sustainable production in agriculture.	1. Analyse critical success factors of systems for protected cultivation of crops 2. Define and understand the most relevant processes in protected cultivation ranging from plant physiology to economics and use this knowledge in their management, crop cultivation, research and/or decision making
Analytical methods and instrumental analysis	The aim of the module is to describe the selected analytical methods and instrumentation of general importance for analytical methods which are also related to and used within the research projects of the lecturers' teams.	After completion of the module; 1. Students will be able to independently apply or transfer the chosen set of protocol of determination of pathogens 2. Practice in instrumentation and other scientific contexts 3. Research projects even beyond phytopathology and will be skilled enough to perform the relevant analytical experiments including data interpretation at a medium level of complexity.

*****To provide students with knowledge about...*

***When students successfully complete their programs they will be able to…; Use descriptors (active verbs) as defined by EQF*

Table 7 The key objectives and the learning outcomes of all other courses grouped by disciplines that are related to the Plant health:

DISCIPLINE	THE OBJECTIVES*	THE LEARNING OUTCOMES OR CORE COMPETENCES**
Pro and parasitic Eucariotes of Agricultural Plants	1. Define plant disease and identify the conditions necessary for a plant disease to develop. 2. Describe the classification of plant diseases. 3. Explain the scouting, identification, and diagnosis of plant diseases. 4. Explain the control of plant diseases. 5. Identify strategies used in disease management.	1. Students will be able to discuss the advance concepts of plant pathology and plant-pathogen interactions. 2. Students will be able to assess the role of host, pathogen, environment, time and human in plant diseases occurrence and outbreaks. 3. Students will be able to apply the concepts of plant pathology to formulate integrated disease management strategies based on the sustainable agriculture practices in Albania and region. 4. Students will be able to diagnose the most economical plant diseases of Albania and region. 5. Students will be able to scout the fields and inspect the seedlings and adult plants to identify plant diseases at early and late stages
Pest Insects of Agricultural Systems	1.Identify the advance concepts of the pest Insects 2. Define the important and contemporary information on insects, other arthropods and vector nematodes of plant pathogens, the role and management of these vectors in agricultural crops. 3. Describe the populations dynamics and monitoring and sampling methods of these vectors	1. Student will demonstrate proficiency/understanding of basic principles, processes and patterns in student's area of expertise (insect organism biology, pest management and/or molecular biology). 2. Student will exhibit breadth of understanding of a diversity of subjects in entomology. 3. Student will demonstrate proficiency in concepts and applications of mathematics and/or statistics for analysis and problem solving. 4. Student will demonstrate research skills (e.g., hypothesis testing, collection, analysis and discussion

		of data), effective communication skills, including proficiency in technical and/or scientific writing and an ability to prepare and deliver effective oral presentations.
Non-insect pests in agro-organisms	1.Identify the non- insect pest species and quarantine lists 2.Explain of development of different ecological mechanisms in plants as a tool of host plant resistance 3. Rodenticides,etc.; activity and modes of action, resistance management, toxicity 4.Application methods in agriculture	1.Develop the management plan to protect agricultural crops against non insect pests 2. Explain the mode of action of rodenticides RRAC groups and select the most promising formulation posing the smallest environental risk
Integrated control of disease, sanitation and quarantine of planting material - according EU standards	1.Through this course students are given the key concepts of Integrated Management of Diseases and Pests. 2.Monitoring, forecasting and critical threshold. Agronomic practices to control insects and pathogens. 3.Resistance to diseases and pests of host plants. Biological Control of Organisms. Biological Control Strategies. 4.Implementation of Integrated Management of Diseases, Pests and Transfer / Exchange of Knowledge. Agronomic practices to control insects and pathogens. 5.Resistance of host plants to diseases and pests. Organic Control of Organisms. Biological Control Strategies. 6.Identify and principles of quarantine; the implementation of quarantine control rules in international trade in goods of plant origin and mandatory phytosanitary control at border crossing points.	1.The integrated management will be recognized: general principles of integrated control, resistant or tolerant cultivars, propagation material. 2. The application of agricultural practices which express conditions unsuitable to pathogens and insects. 3.Define and use of physical-mechanical methods, the use of biological tools, the use of substances of natural origin 3. Explain the phytosanitary products on the basis of economic threshold. 4.Implementation integrated protection protocols based on EU standards.

Integrated Pest Management and implementation of EU protocols	1. Integrated Pest Management implementation, Pests and Transfer / Exchange of Knowledge. 2. Agronomic practices to control insects and pathogens. 3.Resistance of host plants to diseases and pests. Organic Control of Organisms. Biological Control Strategies. 4.Identify and principles of quarantine; the implementation of quarantine control rules in international trade in goods of plant origin. and mandatory phytosanitary control at border crossing points.	1.Define and use of physical-mechanical methods, the use of biological tools, the use of substances of natural origin 2. Explain the phytosanitary products on the basis of economic threshold. 3.Implementation integrated protection protocols based on EU standards.
Phytotoxicology and food protection and safety	1.Application and demonstration of phytotoxicology and food protection and safety processes related to plant protection 2.Explanation and illustration of phenomena that accompany food safety 3.Identify the chemical and biological characteristics of plant mycotoxins. 4. Pollution and destruction of human and animal food and prevention and neutralization of mycotoxins	1.Explain the concepts of pesticide residues in the product with plant origin and environment , Pre Harvest Interval, Maximum Residue Level, etc 2. Data collection and mapping out the agricultural hazards: this involves identifying the hazards and determining their dimension in terms of frequency, duration.

*****To provide students with knowledge about...*

***When students successfully complete their programs they will be able to…; Please use descriptors (active verbs) as defined by EQF*

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3. SWOT ANALYSIS OF THE PROGRAM

Strengths	Weakness
• University policies for PhD development • Academic Staff interested in PhD thesis supervision • Teaching methodology in plant protection • Students interested in doctoral studies	• Limited collaboration of professors with other Universities • Financial resources • Termination of study cycle due to plagiarism findings • Academic staff needs contemporary training in the field of plant protection diagnosis
Opportunities	**Threats**
• More specific and deeper PhD programs • Conducting research at other institutions • ERASMUS collaborative programs • Initiatives to raise international profile	• Problems in the political life of our country and in higher education • Problems in the specification of sub-legal acts for the post-university qualification framework

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1. COMPLIANCE OF THE PARTNERS INSTITUTIONS HIGHER EDUCATIONAL SYSTEM WITH BOLOGNA PROCESS

The University of Korça [UNKO] was created on 7 January 1992, on the basis of the Higher Agricultural Institute of Korça (1971-1992). In 1994 it was given the name "Fan S. Noli". Bologna Agreement was launched in 1998-1999, as a Process established goals for reform in the participating countries, such as the three-cycle degree structure (bachelor, master's, doctorate), and adopted shared instruments, such as the European Credits Transfer and Accumulation System ECT(A)S. In these terms Agriculture faculty has adapted its structure in three cycle degree. UNKO performs undergraduate, graduate and postgraduate education in some fields of agronomy from plant science, agricultural economy, agricultural engineering.

Faculty of Agriculture offers these academic programs:

- Undergraduate studies, which provide students with respective professional knowledge for all degree directions (EQF level 6), **Bachelor** (6 semesters) 180 ECTS
- Post graduate education, which offers a deeper professional knowledge through advanced programs (EQF level 7), **Master studies,** 1 year study program (2 semesters) 60 ECTS
- PhD studies proffer the students with a deep familiarity of their own branch of science (EQF level 8), **PhD studies** (6-8 semesters) 60 [out 180] ECTS
- Sustainable horticulture

Since 2018 all master studies were transformed from 1.5 year with 90 credits in 1 academic year with 60 credits in all respective fields

2. REVIEW OF THE EXISTING PhD STUDY PROGRAMS

Title: Sustainable horticulture Joint PhD study program with Agriculture University of Tirana

***Duration*:** min 3 up to 5 years

Credits or hours required in order to successfully complete the Program: 60 ECTS

Language: Albanian

Tuition fee: 200 000 ALL (about 1600 euro)

Funding support: -

Enrollment and admission requirements: *MASTER'S* degree in Plant Medicine, Plant Production, Horticulture, Chemistry, Biochemistry or other relevant to the field of study with at least a 180 ECTS and evaluation above 8 out of 10 in average. Certificate (C1) in spoken and written English.

Capacity: 5 – 6 students per academic year

PhD is open with CM Decision in 2011

- ✓ The first Academic year was 2012-2013
- ✓ 3 academic years lasted
- ✓ PhD school is CLOSED from 2013 – 2018. From 2013 UNKO had no new students because the Ministry did not awarded quotes, and the last students enrolled finished their theses till 2018!

Table 1 List of the key activities to accumulate the credits

	Activity	Number of credits (ECTS)
	Compulsory group of activities	
1.	Compulsory courses (6)	51
2.	Compulsury modules (12)	
3.	Elective courses (2)	9
4.	Research work	60
5.	Presentation of scientific work	
6.	Dissertation	60
	Total	**180**

Doctoral studies are part of the program in "Engineer agronomy". Doctoral students who have successfully completed the theoretical course as well as the final exam qualify for PhD candidate status and are allowed to select the supervisor and continue with the thesis. The research area is determined by the student in collaboration with the Supervisor and Head of Department.

The "Doctor" degree is awarded on the basis of the dissertation and after publishing at least three scientific articles, three presentations (posters or referrals) at scientific conferences. The thesis defense is realized through an oral exam, in front of a jury of 5 field-related professors.

Table 2 The learning outcomes of the Program

After completing the PhD study program students will be able to:
1. Prepare methodology of scientific research and how they should accomplish their dissertation thesis
2. Procces on statistics on scientific research in the field of sustainable horticulture
3. During the theoretical course of the doctoral school students were provided with deep professional knowledge in the field of sustainable horticulture.
4. Know sustainability of production systems, sustainability indicators and their management.
5. Know sustainable production systems in horticulture.
6. Deep knowledge on Ecology of Natural Resources, and the resources and Sustainable use of natural resources in horticulture
7. Deep knowledge on Integrated control of diseases and pests in horticulture
8. Demonstrate the intellectual indipendence to publish and present results of the research work related to plant protection.

Compliance of the Program with European Qualification Framework (EQF):

AUT adopted and implemented all central tools of Bologna process. PhD studies proffer the students with a deep familiarity of their own branch of science (EQF level 8)

2.1. Program disciplines and courses

Table 3 Number of compulsory and elective courses grouped by disciplines offered by the Program

Nr.	Modules	Credits
1	Methodology of scientific research	4
2	Physiology and advanced biochemistry of plants	8
	The applied biochemistry and physiology of garden plants	5
	Physiology and post-harvest technology ofhorticultue crops	3
3	Sustainable production systems in horticulture.	13
	Ecology of Natural Resources	3
	Sustainability of production systems, sustainability indicators and soil fertility management.	3
	Microbiological activity and soil fertility.	4
	Fertility of the soil and nutrition of plants.	3
4	Integrated control of diseases and pests in horticulture.	8
	Integrated control of plant diseases	4
	Integrated control of pests	4
5	Alternative production of garden plants.	10
	Organic production of garden plants.	6
	Quality and certification systems in horticulture.	4
6	Integrated management of protected environments.	8
	Integrated production in protected environments.	4
	Plant cultivation systems soilless cultivation	4
7	Sustainable use of natural resources in horticulture. {Optional subjects}	9
	National genetic resources of fruits and vegetables.	5
	Multiplication Methods of endangered genetic resources.	4
	Plant pathology	4
	Entomology	4
	Weeds scince	3

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Table 4 Courses of general importance of the Program

Courses	Credits (ECTS)
Methodology of scientific research	4
Physiology and advanced biochemistry of plants	8
Sustainable production systems in horticulture.	13
Integrated control of diseases and pests in horticulture.	8
Alternative production of garden plants.	10
Integrated management of protected environments.	8

Table 5 Courses that focus on various disciplines in Plant health

Courses	Credits (ECTS)
Integrated control of plant diseases	4
Integrated control of pests	4
Plant pathology	4
Entomology	4
Weeds	3
Total	19

Table 6 The objectives and learning outcomes of courses of general importance

COURSE	THE OBJECTIVES*	THE LEARNING OUTCOMES OR CORE COMPETENCES**
Methodology of scientific research	To prepare students with the necessary knowledge to understand the research process and the skills to begin devising and planning their own small scale research project. Setting up and tracking experimental evidence. Field experiment processing methods. Statistical knowledge and statistical indicators. Experimental schemes, General Principles of Drawing Methods and Scientific Reports. Provide knowledge on the techniques of raising and pursuing field experiments. To provide enough knowledge to students about statistical indicators and methods of field statistics field data processing. To provide general principles for the development of methodologies and scientific reports on field experiments, etc.	• To demonstrate understanding of how quantitative and qualitative methods contribute to research and the differing requirements associated with these approaches. • To demonstrate an ability to priorities workload to meet module deadlines. • To demonstrate an ability to plan a small scale research project. • To demonstrate a systematic approach to gathering evidence and an awareness of levels of evidence and their applications. • Recognize and implement in practice the establishment of experimental schemes. • To carry out the elaboration of experimental field data statistics and to provide the appropriate recommendations for the practical implementation of the best variant provision. • Recognizing the General Principles of Designing Methods and Scientific Reports on Field Experiments
Physiology and advanced biochemistry of plants	The course deals with the study of compounds found in every living substance cell in general and in plants in particular. It aims to familiarize students with the main biochemical reactions, mechanisms of their development, control of biochemical processes and accelerating reactions. Also, a special role is devoted to the photosynthesis	The student should know • To argue the metabolic reactions occurring in living beings, and especially the plants. • To explain the mechanisms of reactions occurring in living beings and

	process, as a key mechanism in capturing and conserving the light energy and transforming it into the energy of biochemical substances. Plant Physiology is the science that relates to the recognition of plant functions, ranging from germ to reproduction, the way it transports the substances and the physiological functions of the constituent parts of the plant. Discipline is aimed at recognizing students and equipping them with knowledge about how the plants function, as they take water and mineral matter from the ground as they transport it to higher parts, as well as synthesize organic matter, energy sources for the plant , the ways of plant movement, their growth, etc.	• Describe and identify the three dimensional structures and the changes that they bring to biological properties are formed. • To describe how the plant functions as a living organism, • To recognize and understand the vital functions of the plant and the factors that influence their normal growth and development.
Sustainable production systems in horticulture	The main purpose of the course is to form students who should: – Learn the concepts of cultivation systems, farms and agricultural production systems – Learn the general features of agricultural systems – Teach the principles of sustainable development and sustainable agriculture – Learn the basic scientific information about the various systems of sustainable production in agriculture. – Implement the basic principles of agricultural systems and sustainable agriculture and how to improve the economic conditions of farmers	The student at the end of the course should be able to • distinguish and determine the types of sustainable production systems applied in Albanian agriculture; • To argue and explain whether the principles of sustainable production systems have been applied and which practices are developed according to these principles. • To identify and forecast the possible changes that need to be made in the current production systems to guide them towards sustainable ones, especially towards the steady growth of agricultural production.
Alternative production of garden plants.	The "Alternative production of garden Plants" course provides the main concepts on Growth and Production Systems of Ground Vegetable, Physical	At the end of the course the students will

	Elements and Microclimate Composition in Cultivation Crops in Crop Solution, Irrigation and Fertilizer Management for Vegetable Crops, and Treats aspects of non-soil cultivation of tomatoes, cucumber and alternative vegetable crops. It provides basic knowledge on the cultivation of vegetables in the bag culture, perlite, rock wool, peat bags, fertilization, automatic control, financial and structural considerations, optical materials, substrate security, isolation environmental, and energy exchange. The wet buffer system. Water relations with the amount of fruit, irrigation control, the main plant nutrition, the role of plant growth elements, nutrient solutions and ingredients, nutritional programs, disease and pest management, harvesting, packing and storage.	• Identify and compare scientific information and basic theoretical knowledge of Alternative Science, • Describe and explain of the physical and chemical characteristics of the substrates used, • Design and propose the composition of the microclimate in accordance with the culture requirements, nutritional solving features, and contemporary techniques of cultivating vegetables in these environments.
Integrated management of protected environments.	Students are provided with theoretical and practical knowledge about the agro-ecosystem, its properties and the hierarchy of systems in agriculture as well as the general characteristics of agricultural systems. Covered areas include agro-biodiversity in support of sustainable agro-ecosystems and sustainability analysis of an agricultural holding. Also included are various systems of agricultural production; traditional agriculture, conservation farming (blue), biological agriculture, high-value agriculture, legacy-derived farming systems of global importance, conventional and integrated agriculture, precious agriculture, community-supported agriculture, urban agriculture (sub-urban) and basic knowledge of agro-forest systems.	• To describe and interpret the hierarchy of systems in agriculture as well as the general characteristics of agricultural systems. • To distinguish covered areas, include agro-biodiversity in support of sustainable agro-ecosystems and sustainability analysis of an agricultural holding • To elaborate and compare traditional agriculture, conservation farming (blue), biological agriculture, high-value agriculture, legacy-derived farming systems of global importance, conventional and integrated agriculture, precious agriculture, community-supported agriculture, urban agriculture (sub-urban) and basic knowledge of agro-forest systems.

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Table 7 The key objectives and the learning outcomes of all other courses grouped by disciplines that are related to the Plant health

DISCIPLINE	THE OBJECTIVES*	THE LEARNING OUTCOMES OR CORE COMPETENCES**
Entomology	The core concepts of the General Entomology on Morphology, Anatomy, Biology, Physiology, ecology and systematics of pests: Arthropods, plant pathogens, snails and rodents. special Entomology, the main pests in cultures: fruit trees, vineyards, olive, citrus and field crops. Propagation, description, biology, prognosis and masses to control them.	• To describe the concepts of on Morphology, Anatomy, Biology, Physiology, ecology and systematics of pests: Arthropods, plant pathogens, snails and rodents. • to be able to recognize the special Entomology, the main pests in cultures: fruit trees, vineyards, olive, citrus and field crops • To identify and classify the main pests in cultures: fruit trees, vineyards, olive, citrus and field crops. • To collect and classify different species • to predict prognosis and propose masses to control them.
Phytopathology	The main concepts of Phytopathology's, General on plant-pathogens: Viruses, bacteria, mushrooms, as causes of diseases in crops of fruit trees, vine, olive, citrus, vegetables and arable plants. The ways on contamination, Symptoms, Biology, and Prognosis on major viral, bacterial and fungal diseases in agricultural crops as well as methods of control over them.	• describe the main plant-pathogens: Viruses, bacteria, mushrooms, as causes of diseases in crops • to recognize the ways of contamination, Symptoms and Biology, • To predict and identify prognosis on major viral, bacterial and fungal diseases in agricultural crops • To predict and propose methods of control over plant disease.
Integrated control of diseases and pests in horticulture.	Through this course students are given the key concepts of Integrated Management of Diseases and Pests. Monitoring, forecasting and critical threshold. Control of pests in plants. Agronomic practices to control insects and pathogens.	• Define the principles, direct and indirect measures of environmentally acceptable plant protection • to recognize and describe the basic concepts of IPM. • To propose an IPM technical guide, implement it and compare it with conventional methods • To develop and estimate the effect of agronomic practices to control insects and pathogens.

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	Resistance to diseases and pests of host plants. Biological Control of Organisms. Biological Control Strategies. Implementation of Integrated Management of Diseases, Pests and Transfer / Exchange of Knowledge. Agronomic practices to control insects and pathogens. Resistance of host plants to diseases and pests. Organic Control of Organisms. Biological Control Strategies. Modification of pesticides. Resistance to pesticides and resistance management	• To explain the resistance of host plants to diseases and pests. • To critically explain Biological Control Strategies, Modification of pesticides, Resistance to pesticides and resistance management • To estimate the critical threshold forecast for some of the major diseases and pests of agricultural crops. • To Compare the efficiency of plant protection measures in conventional, integrated and organic agricultural production with regard to environmental impact
Weed science	Morphological and biophysical characteristics of the most prevalent weeds in Albania. Annual weeds, perennial weeds, as well as parasite weeds. Bio morphological features of weeds, ways of spreading, damages that come up and effective control methods in agricultural crops under the concrete conditions of the area both through lectures, laboratories and through field practices and herbalizations of the weeds.	• Describe the main morphological and biophysical characteristics of the most prevalent weeds in Albania. • Identify and classify annual weeds, perennial weeds, as well as parasite weeds. • Explain and interpret morphological features of weeds, • Distinguish and explain ways of spreading, • Predict damages caused by different weeds in different cultures • Propose effective control methods in agricultural crops under the concrete conditions.

*****To provide students with knowledge about...*

***When students successfully complete their programs they will be able to…; Please use descriptors (active verbs) as defined by EQF*

3. THE SWOT ANALYSIS OF THE PROGRAM

Strengths	**Weaknesses**
• The region has a good tradition in agriculture, • Presence of research institutions of regional character, • Experimental Didactic Economy. EDE • Geographical position favorable in the sense of regional development, • Favorable position of the region in relation to neighboring countries.	• The topics should be part of the development strategy at regional and national level, • Difficulty in tracking field experiments, • Doctoral candidate - geographical distance effects, • The implementation of the study results in regional and national agricultural development strategies, • Lack of cooperation in regional and national projects with the university, which should be regulated by law • Chain link disconnection: specialist adviser-researcher-farmer
Opportunities • Establishment of a Scientific Research Center near EDE. • Return the Faculty to a training center for all agriculture specialists. • The possibility of providing financial support from governmental organizations for the best students in the faculty for doctoral studies. • Improving and standardizing CVs and syllabus. • New curricula's for PhD study programs, Continuous improvement of the qualification of the staff and lecturers	**Threats** • Distance of students, • Lack of funding, • Lack of excellent students • Difficulties in applying scientific methods designated for application to farms, • English level **C1** certificate required

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Partner 8 UNSA – University of Sarajevo, Faculty of Agriculture and Food Sciences Sarajevo, Bosnia and Herzegovina

1. COMPLIANCE OF THE PARTNERS INSTITUTIONS HIGHER EDUCATIONAL SYSTEM WITH BOLOGNA PROCESS

The Bologna system of studying at the Faculty of Agriculture and Food Sciences in Sarajevo was introduced in 2005/2006 and is carried out according to the 3 + 2 + 3 scheme.

The Faculty offers two scientific areas of doctoral studies (Agricultural sciences and Food technology). Doctoral studies programs of the Faculty last for three years (six semesters), and the entire study program is evaluated with 180 ECTS points.

The modernization of the syllabi for each module at all degree is defined according to the “Qualifications Framework for Higher Education in Bosnia and Herzegovina”.

By completing the doctoral study, acquired academic qualification Doctor of Agricultural Sciences, or Doctor of Food Technology.

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2. REVIEW OF THE EXISTING PhD STUDY PROGRAMS

Title: Doctor of Agricultural Sciences

Duration: 3 years

Credits or hours required in order to successfully complete the Program: 180 ECTS

Structured* or individual**: Both

Language: Bosnian, Croatian or Serbian

Tuition fee: 18 000 BAM (9 200 €)

Funding support: Ministry of Education of canton Sarajevo financially support students with special awards from the University of Sarajevo

Enrollment and admission requirements: The Persons that on the basis of previous higher education, have acquired at least 300 ECTS points according to the Bologna process principle with general average grade of at least 8.

Capacity: Not limited

Table 1 List of the key activities to accumulate the credits

Activity	Number of credits (ECTS)
Compulsory group of activities	**180**
1. Compulsory courses (2)	**12** (6+6)
2. Elective courses	**30**
3. Research work (5)	**48** (9+9+18+8+4)
4. Doctoral dissertation (3)	**90** (18+60+12)

Table 2 The learning outcomes of the Program

1.	analysis, evaluation and synthesis in problem solving and resolution,
2.	scientifically based assessment of requirements and application of scientific knowledge in practice,
3.	governance and communication of profound knowledge from the domain of agricultural science,
4.	team work, judgment and decision making.

Compliance of the Program with European Qualification Framework (EQF)

UNSA implemented almost all central tools of Bologna process. The modernization of the syllabi for module at the Program idefined according to the “Qualifications Framework for Higher Education in Bosnia and Herzegovina”. The learning outcomes of disciplines and courses are to be defined.

2.1. Program disciplines and courses

Table 3 Number of compulsory and elective courses grouped by disciplines offered by the Program

Courses	Number
Compulsory	**2**
Elective (which are closely linked to the Phytomedicine module)	**8**
Zoology	3
Phytopathology	4
Weed Science	1
Electives which are closely linked with other modules	59

Table 4 Courses of general importance of the Program

Courses	Credits (ECTS)
Experimental Statistics in Agriculture	6
Ethics and Methodology of Scientific Work	6
Total 2	**12**

Table 5 Courses that focus on various disciplines in Plant health

Courses	Credits (ECTS)
ZOOLOGY	
Agricultural Entomology	6
Phytoacarology	3
Nematology	3
Total 3	
PHYTOPATHOLOGY	
Agricultural Bacteriology	3
Agricultural Mycology	6
Agricultural Virology	3
Microorganisms and Soil Fertility	6
Total 4	
WEED SCIENCE	
Herbology	6
Total 1	

Table 6 The objectives and learning outcomes of courses of general importance

COURSE	THE OBJECTIVES*	THE LEARNING OUTCOMES OR CORE COMPETENCES**
Experimental Statistics in Agriculture	Acquire knowledge bout statistical methods and their application in agriculture and food technology	Not defined
Ethics and Methodology of Scientific Work	To introduce students with: basic epistemological aspects of science; methodological particularities of natural sciences on one side and social, humanistic and spiritual sciences, on the other; give an analytical view of the basis methodology of scientific work both in the aspect of the research process and in the aspect of the design of research results in the form of scientific papers.	Not defined

*****To provide students with knowledge about...*

***When students successfully complete their programs they will be able to…; Use descriptors (active verbs) as defined by EQF*

Table 7 The key objectives and the learning outcomes of all other courses grouped by disciplines that are related to the Plant health

DISCIPLINE	THE OBJECTIVES*	THE LEARNING OUTCOMES OR CORE COMPETENCES**
Zoology	The subject should enable the student to acquire new and wider knowledge of morphology, anatomy and physiology of insects, nematodes and mites, independent work in species identification, monitoring of economically significant species, estimation of harmfulness, prognosis of species and determination of thresholds of harmfulness.	Not defined
Phytopathology	Introducing students with the methods of identification of phytopathogenic organisms. Acquisition of knowledge about their morphology, ecology and biology. Based on a detailed study of the morphology, the development cycle of these organisms and their relationship with host plants to devise measures to effectively control. Introducing students with the new approaches and methods of studying factors that affect biodiversity of microorgansms in soil, water and air, creating and maintaining fertility and remediation of the soil as well as the spread of certain systemic and physiological groups of microorganisms in different ecosystems.	Not defined
Weed Science	Acquisition of knowledge on the biological, morphological and ecological characteristics of the most important weeds plants and taking integral measures against the weeds. Another not less important goal is gaining skills in determining the floral composition of weed sinuses and accordingly apply adequate measures to control weeds in modern farming systems.	Not defined

***When students successfully complete their programs they will be able to…; Please use descriptors (active verbs) as defined by EQF*

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3. THE SWOT ANALYSIS OF THE PROGRAM

Strengths	**Weakness**
• the University location is in the capital city of the Bosnia and Herzegovina • long tradition of the Faculty in the teaching process at all levels of academic study • affordability of studying in a financial perspective • there is a good interaction between students and teaching staff	• extremely small number of elective courses • small number of teaching staff • course do not offer learning outcomes • a small number of students that enroll in the PhD study program • laboratories are not sufficiently equipped to carry out of the PhD study program
Opportunities	**Threats**
• improve scientific cooperation with with business entities • employment of young staff according with needs • increase the mobility of students and teachers through different exchange programs	• growing competition from other universities with similar teaching programs • reducing the quality of teaching because of workload small number of teaching staff • there is some weaker job market openness for highly educated staff •

Partner 9 APTF - University of Mostar, Faculty of Agriculture and Food Technology, Bosnia and Herzegovina

1. COMPLIANCE OF THE PARTNERS INSTITUTIONS HIGHER EDUCATIONAL SYSTEM WITH BOLOGNA PROCESS

The Faculty of Agriculture and Food Technology, University of Mostar enrolled the first generation of students into the study programs developed according to the Bologna declaration in 2005 with an enrollment rate of approximately 65 undergraduate students per academic year. **APTF** offer degree structures on a comparable three-cycle (bachelor, master and doctoral) system in a 3+2+3 year's period. This reformed studies enable students to attend classes at other universities in Bosnia and Herzegovina as well as partner universities abroad.

A set of learning outcomes as defined by the European Qualifications Framework and National Qualification Framework (proposed by Ministry Concile B&H) has been established for each module at all degree levels in order to provide more quality assessments of students against a competency-based, rather than workload-based.

In order to ensure sustainability of the programs of the Faculty and promote European cooperation, the Quality Assurance Committee has been assembled and standards are developed to provide high quality as work model. The Committee recognizes roles and responsibilities of teachers, students and stakeholders concerning quality assurance and monitor and deliver all of the expected and achieved results. The Committee conducts internal or self-evaluation analysis.

The University of Mostar is an accredited higher education institution which in June 2015 received an "institutional" accreditation from the Ministry of Education, Science, Culture and Sport of Herzegovina-Neretva Canton and in July of that same year it was registered in the State Register of Accredited Higher Education Institutions. Latest external evaluation was conducted internationally by Croatian Quality Assurance Agency by external evaluators. Re-accreditation procedure is carried out in 2017 with positive accreditation recommendation.

The Diploma Supplement has been automatically issued to completed students with all credentials containing a description of the nature, level, context, content and status of the studies completed by the individual noted on the diploma.

Doctoral studies at University of Mostar are governed by national regulatory acts which identifies the education, scholarships, granting and conditions that must be fulfilled by universities and research units leading doctoral studies.

2. REVIEW OF THE EXISTING PhD STUDY PROGRAMS

Title: Postgraduate doctoral studies Agricultural Sciences and Enviromental Protection

Duration: 3 years (maximum period up to 6 years)

Credits or hours required in order to successfully complete the Program: 180 ECTS

Structured* or individual**: Both

*(*the mentor has a predefined research objectives on specific research topics that are built into different projects;*
***no predefined objectives, the mentor helps a PhD candidate to choose a research topic on which the PhD candidate works either independently or in a research team)*

Language: Croatian

Tuition fee: 13800 KM (7 055 €)

Funding support: Structured program offer paid PhD positions, while individual program is self-funded (or employer pays, scholarship granted by research institutions or industry etc.)

Enrollment and admission requirements: *MASTER'S* degree in Biotechnical Sciences or other relevant to the field of study could be enrolled at PhD program. Average grade of undergraduated and graduated study (300 ECTS) program should be <3.5 (on a scale from 1 to 5 (the best) , but not less than 3 with recommendation of two professor related to the research field of PhD candidates. Certificate of proficiency in spoken and written English.

Capacity: 15

Table 1 List of the key activities to accumulate the credits

	Activity	**Number of credits (ECTS)**
	Compulsory group of activities	-
1.	Compulsory courses (3)	18
2.	Elective courses (min 7)	42
3.	Research work	40
4.	Scientific activities	20
5.	Dissertation	60
		Minimum of 180

Table 2 The learning outcomes of the Program

After completing the program student will abe able to:	
1.	Acquire the knowledge needed to perform complex tasks aimed at developing agriculture and environmental protection and will be trained to work on: scientific-research and development projects (employment at faculties, scientific institutes and other public institutions).
2.	Develop and improve the agriculture through bioregional use, increase fertility, remediation and land protection; raising the productivity of agricultural production and processing, taking into account the "field to table" quality assurance and food safety throughout the chain (institution development, entry into the register, advisory services, new labor.
3.	Work on environmental quality control and inspection work (employment in control laboratories, and offices and districts of towns and counties).
4.	Create a plan for protection of agricultural crops based on the principles of integrated and ecological pest management.
5.	Identify and evaluate the key environmental factors important for ecology management.
6.	Develop a new Technologies in agricultural production based on traditional products.
7.	Process and produce a foodstuffs in an environmentally friendly way (employment in different manufacturing companies).
8.	Design and develop of environmentally friendly technologies, research that supports rural development, innovation in agriculture and the creation of additional income on farms and rural communities.
9.	Improve the traditional technologies that do not meet today's criteria in agricultural production and environmental protection.
10.	Demonstrate the intellectual indipendence to publish and present results of the research work related to evnviromenatal protection.

Compliance of the Program with European Qualification Framework (EQF):

APTF adopted and implemented all central tools of Bologna process, and learning outcomes are aligned with 8.2 of Croatian Qualification Framework or 8 of EQF.

2.1. Program disciplines and courses

Table 3 Number of compulsory and elective courses grouped by disciplines offered by the Program

Courses	Number
Compulsory	3
Elective	
Zoology	1
Phytopathology	0
Weed Science	2
Interdisciplinary	6

Table 4 Courses of general importance of the Program

Courses	Credits (ECTS)
Principles of Scientific Work	6
Statistic methods in Plant Protection	6
Princeples of Ecology and Plant Protection	6
Total 3	**18**

Table 5 Courses that focus on various disciplines in Plant health

Courses	Credits (ECTS)
ZOOLOGY	
Biological and landscape diversity	6
Total 1	**6**
WEED SCIENCE	
Seed Science	6
Herbology	6
Total 2	**12**
PLANT PATHOLOGY	
Total 0	**0**
INTERDISCIPLINARY	
Plant Protection	6
Toxicology and ecotoxicology of pesticides	6
Technical system in plant production	6
Horticulture (selected chapter)	6
Vegetable crop (selected chapter)	6
Pomology (selected chapter)	6
Total 6	**36**

Table 6 The objectives and learning outcomes of courses of general importance

COURSE	THE OBJECTIVES*	THE LEARNING OUTCOMES OR CORE COMPETENCES**
Principles of Scientific Work	The experimental methodology and scientific analysis of data, modes of presentation and publication of research results, application of the most modern ICT technologies and statistical computer programs.	Plan and organize the experimental method Set up a scientific hypothesis and choose the methodology Make the proper selection of design of experiment and apply the appropriate statistical tests for the data analysis in statistical computer programs Interpret the result of statistical analysis and bring correct scientific conclusions summarized in a research report.
Statistic Methods in Plant Protection	The module should enable the student to understand and acquire necessary knowledge to set up experiments in their research, provide statistical analysis of obtained results and to have independent interpretation of qualitative and quantitative data by advanced methods and adequate software tools for analysis.	Apply the statistical methods, computer processing of statistical data, interpreted and make conclusion based on the obtained results.
Principles of Ecology and Enviromenatal Protection	Introduction to the general ecological principles and to the expansion of global knowledge of the environmental challenges and theoretical basics of environmental policy and strategy. Recognize the complexity of the environment and the economy, which will provide the necessary theoretical and Empirical knowledge for understanding and implementation of the concept of sustainable development in practice.	Understand the interdisciplinary of ecology and environmental protection, identification of aspects of environmental management, basic policies, mechanisms and instruments of the environment protection. Independently assess the meaning and role of the environment in economic development based on the concept of sustainable development. Understand the basics of international and national policies, instruments and institutions of nature protection and environmental management.

*****To provide students with knowledge about...; **When students successfully complete their programs they will be able to…; Use descriptors (active verbs) as defined by EQF*

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Table 7 The key objectives and the learning outcomes of all other courses grouped by disciplines that are related to the Plant health

DISCIPLINE	THE OBJECTIVES*	THE LEARNING OUTCOMES OR CORE COMPETENCES**
As defined in the existing Program (Zoology)	demonstrate knowledge and understand the biodiversity Introduction with the latest technical systems in the field and their most effective with the aim of obtaining the highest possible supply with the smallest investment	Able to have critical evaluation of biodiversity in human society and to perform a range of experimental procedures, develop an awareness of the environment as a finite resource Acquire the knowledge about new machines for harvesting agricultural crops. Compare the features of some systems at different manufacturers, and choose the most convenient system for our field of work. Acquaint them with the basic laws on the distribution of fertilizers and pesticides, new machines and technical solutions in fertilization, care and plant protection.
(Weed Science)	Introducment to production of seed of self-fertilized species, production semen seed species, introduce legislation in the seed sector, legislation in Europe (EC, UPOV and OECD), performing field exercises, seed production and practically performing the aprobeation in seed production. Aquire a knowlge on basic biological characteristics of weed, weed growth, weed relation according to abiotic and biotic factors, direct and indirect measures in the control of weeds, some crops and untreated surfaces with suggestive measures for their suppression.	Develop a practical application of production seeds methods on self-fertilized and pollinated herbs; installation, inspection and processing of field experiments. Able to develope a critical and creative opinion and presentation of acquired knowledge
(Interdisciplinary)	provide basic principles and standards of agriculture plant protection, acquainted with economically damaging organisms in plant production and the	Acquire the knowledge of the importance of economically important harmful organisms in different branches of

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	ways of their control, quarantine organisms and novel harmful organisms	agricultural production, methods of their control, and special knowledge about quarantine harmful organisms.
	introduce students with toxic effects of pesticides on living organisms, behavior of pesticides in the environment, methods for the determination of pesticide residues and their action on a living organism.	critically analyse the basic concepts of toxicology and ecotoxicology of pesticides; Discuss the relevance and importance of the effects of chemical on ecological systems; Explain how effects of chemicals on biological systems are measured and quantified in toxicology and ecotoxicology; Contrast the view of ecotoxicology from industry and environment protection groups; Explain the wider social and environmental implications of the area of study
	provide specialized knowledge for the needs of the study aspect of production and application of horticultural plants	Acquired the skills in the production and application of horticultural herbs
	Acquire a specialist knowledge on economically sustainable production of vegetable crops	Self-creation and management of economically viable vegetable production models while respecting high standards of environmental protection.
	Emphase every segments of active action by pomological and agrotechnical measures with their analysis on environmental impact. Sustainable development of the area with performance fruit production through the use of natural and traditional potentials, and alignment with the strategic development plan and use of modern technologies and similar experience.	Acquire the concept of sustainable development, sustainable management of natural resources within the framework fruit production, which should be regional specificity and provide good products, preserve biodiversity, reduce the environmental burden of plant protection and limit rinsing of nutrients into groundwater. Trained participants who can perform activities with the application of all professional and scientific knowledge and experiences.

**To provide students with knowledge about...*

***When students successfully complete their programs they will be able to…; Please use descriptors (active verbs) as defined by EQF*

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3. THE SWOT ANALYSIS OF THE PROGRAM

Strengths	**Weakness**
• Introduced III cycles of studying; • Work in teaching and research positions in the field of Agriculture; • To strengthen the research potential and to overcome the gap between the existing state and actual needs; • Diverse selection of modules in offer courses;	• Not enough student motivated to go to; • Not enough number of elective modules; • Not enough scientific project found by the local government; • PhD diploma is not required/recognized in public sector or job market; • Poor national financing;
Opportunities	**Threats**
• Possibilities to make scientific research in agro-Mediterranean filed; • More scholarship for PhD students; • Specialize research and skills on a specialized agricultural topic; • To provide courses for foreign students; • Possibility to apply to EU or other project funds;	• PhD diploma is mostly required for student involved in HEI or scientific research institutes; • PhD study program is cost demanding;

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Partner 10 UB – University of Belgrade, Faculty of Agriculture, Belgrade, Serbia

1. COMPLIANCE OF THE PARTNERS INSTITUTIONS HIGHER EDUCATIONAL SYSTEM WITH BOLOGNA PROCESS

The University of Belgrade – The Faculty of Agriculture enrolled the first generation of students into the study programs developed according to the Bologna declaration in 2006/07. Eight study programs of PhD studies (Field & Vegetable Crop Science, Fruit Science & Viticulture, Zootechnics, Soil & Water Management, Phytomedicine, Agricultural Engineering, Food Technology, Agroeconomics) were have been first conducted. From 2008/09, the study programs of PhD studies: Field & Vegetable Crop Science, Fruit Science & Viticulture, Zootechnics, Soil & Water Management, Phytomedicine and Agricultural Engineering have been integrated into the study program Agricultural Sciences (with six modules). Approximately 960 undergraduate students enroll each academic year. UB offer degree structures on a comparable three-cycle (BSc, MSc, PhD) system in a 4+1+3 years period.

The first year of PhD studies serves as an academic base for all modules, while in the second year the subjects are connected to one of the six modules. In the third year, work on the PhD thesis is envisaged. The number of ECTS credits for each semester is 30 (a total of 180 ECTS). The study program contains 1 compulsory course and elective courses in 7 positions. For each elective course item, students are offered a list of subjects they can choose. The PhD thesis is completed during three years of study program. After completing the PhD studies, the student acquires the title "Doctor of Biotechnical Sciences", while in addition to the diploma, the passed elective subjects and narrow field of research are listed.

A set of learning outcomes as defined by the European Qualifications Framework and Serbian Qualification Framework has been established for each module at all degree levels in order to provide more quality assessments of students against a competency-based, rather than workload-based.

Quality control of the study program of doctoral academic studies involves regular and systematic monitoring, quality control as well as undertaking measures for improving quality including: curriculum, teaching, teachers and associates, student evaluation, textbooks and literature. Quality control of the program is carried out in advance for specified periods of time in accordance with the law. With the aim of providing quality control of the curriculum, the active role of students and their assessment of the quality of the program is ensured. All initiatives and decisions related to the implementation of the study program of PhD studies in Agricultural Science start with the Departments of the Institute participating in this study program. Suggestions are considered by the Teaching-Scientific Board of the Institute, and then by the Commission for Quality Control. This Commission submits its recommendation to the Teaching-Scientific Board of the Faculty of Agriculture

PhD studies at UB are governed by national regulatory acts which identify the education, scholarships, granting and conditions that must be fulfilled by universities and research units leading PhD studies.

The Diploma Supplement has been automatically issued to completed students with all credentials containing a description of the nature, level, context, content and status of the studies completed by the individual noted on the diploma.

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2. REVIEW OF THE EXISTING PhD STUDY PROGRAMS

Title: Doctor of Biotechnical Sciences

Duration: 3 years (with the possibility of extension up to 8 years)

Credits or hours required in order to successfully complete the Program: 180 ECTS

Structured* or individual**: Both

Language: Serbian

Tuition fee: 150 000 RSD (1250 €) per year, for foreign students 3300 €/year.

Funding support: For all Study programs 40 students fund government and 107 self-funded students.

Enrollment and admission requirements: Persons who have completed MSc, ie integrated studies with at least 300 ECTSs, ie completed at least four years of studies according to regulations that were valid until the entry into force of the Law, and a general average grade of at least 8 (eight) basic academic and master academic studies, or integrated studies, are eligible for enrollment into the program of doctoral academic studies.

***Capacity*:** Not limited, but every year the Government determines the number of students.

Table 1 List of the key activities to accumulate the credits

	Activity	Number of credits (ECTS)	
	Compulsory group of activities	**180**	
1.	Compulsory courses (1)		**7**
2.	Elective courses (min 7)	**58**	(10+10+8+8+10+6+6)
3.	Research work (6)	**40**	(3+4+4+9+10+10)
4.	Doctoral dissertation (5)	**75**	(10+10+15+20+20)

Table 2 The learning outcomes of the Program

After completing the PhD study program student will be able to:
Analyze and predict the solution and the consequences of specific problems in Agricultural area (e.g. Phytomedicine: disease, pest, weeds, pesticides);
Can use and demonstrate modern research methods in some agricultural sciences area (e.g . Phytomedicine);
Independently explore theoretical and practical problems in some specific Agricultural sciences area (e.g . Phytomedicine) or improved some solutions and application;
Design of experiment, describe procedure of measuring, process, analyze and discuss expected results;
Critical thinking, creative and independent work, be able for work in team and for professional communication;
Communicate and cooperate with relevant social and international subjects;
Present of scientific research at meetings, and publish obtained data in referent scientific journals;
Engage in national and international research projects;
Knowledge and respect of the principles of the ethical code of good scientific practice;

Compliance of the Program with European Qualification Framework (EQF):

UB adopted and implemented all central tools of Bologna process, and learning outcomes are aligned with 8.2 of Serbian Qualification Framework or 8 of EQF.

2.1. Program disciplines and courses

Table 3 Number of compulsory and elective courses grouped by disciplines offered by the Program

Courses	**Number**
Compulsory	**1**
Electives (which are closely linked to the Phytomedicine module)	**44**
Entomology and Agricultural Zoology	14
Phytopathology	18
Weed Science	6
Phytopharmacy	6
Electives which are closely linked with other modules	48

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Table 4 Courses of general importance of the Program

Courses	Credits (ECTS)
Experomental statistics	7
Total 1	**7**

Table 5 Courses that focus on various disciplines in Plant health

Courses	Credits (ECTS)
ENTOMOLOGY AND AGRICULTURAL ZOOLOGY	
Methods in entomology	10
Methods in acarology	10
Methods in nematology	10
Methods in malacology	10
Principles in zoosystematics	10
Entomology	7
Morphology and anatomy of insects	10
Physiology of insects	8
General phytoacarology	10
Applied phytoacarology	6
Nematology	10
Small rodents	8
Malacology	6
Anatomy of infested plants	6
Total 14	
WEED SCIENCE	
Methods in weed science	10
Weed science	10
Population ecology of weeds	6
Diversity of weed flora and vegetation	8
Weed anatomy	6
Software packages in weed and pesticide research	10
Total 6	
PHYTOPATHOLOGY	
Research methods in plant mycology	10
Methods in phytobacteriology	10
Methods in plant virus research	10
Phytopathology	10
Phytopathogenic fungi and fungi-like species	8
Phytopathogenic prokaryotes	8

Phytopathogenic viruses and viroides	8
Population genetics of fungi and fungi-like species	8
Population genetic of plant viruses	8
Molecular characterization of phytopathogenic fungi	6
Molecular characterization of plant patogenic bacteria	6
Molecular characterization of plant viruses	6
Bioinformatics in research of fungi and fungi-like species	10
Bioinformatics in plant virus research	10
Diseases of stored plant produce	8
Plant patophysiology	10
Ecology of plant pathogens and epidemiology of disease	8
Mycotoxins	8
Total 18	
PHYTOPHARMACY	
Methods in phytopharmacy	10
Phytopharmacy	8
Pesticie mode of action	8
Pesticide analysis	10
Pesticide – risk and exposure	6
Food toxicology	6
Total 6	

Table 6 The objectives and learning outcomes of courses of general importance

COURSE	THE OBJECTIVES*	THE LEARNING OUTCOMES OR CORE COMPETENCES**
Experimental statistics	The course should enable the student to acquire and understand the knowledge necessary to set up experiments in agricultural research and statistical analysis of the results obtained.	Skills in the application of statistical methods and computer processing of statistical data, explain and interpret obtained results, compare own results with relevant literature results and make final conclusion concerning all experiment.

***To provide students with knowledge about...*

***When students successfully complete their programs they will be able to…; Use descriptors (active verbs) as defined by EQF*

Table 7 The key objectives and the learning outcomes of all other courses grouped by disciplines that are related to the Plant health:

DISCIPLINE	THE OBJECTIVES*	THE LEARNING OUTCOMES OR CORE COMPETENCES**
Entomology and Agricultural Zoology	• different methods, designing and setting up the experiments for identification and characterization of insects, nematods, maits, snails, rodents, birds, as well as interpretation of obtained results and anticipating future research steps; • basic concepts and principles of taxonomy, fundamentals of taxonomy, micro and macrotaxonomy, systematic position of insects/mites/nematodes in animal kingdom, relationships of these animals with related taxa; • crucial characteristics of economic harmful insects, their life cycles, harmfulness and natural enemies; as well as identification of species and damage symptoms, monitoring, prognosis of their emergence and estimation of harmful thresholds; • external and internal structure of insects,morphological characteristics that are specific for certain groups of insects, and also recognizing of morphological characteristics relevant for identification of insects; • function of insect organs as well as to understand all life processes that occur in certain organs of the insect body and in the organism in general; • structure and function, ontogenetic development, genetics, ecology and phylogeny of main phytophagous groups of mites; as well as the role of mites in different ecosystems, their pest status, control and resistance to acaricides;	• demonstrate the different methods of detection, identification and characterization of pests; combine different methods and experiments and explain the results; • integrate the knowledge in zoosystematics and be capable to identify already known taxa, recognise crucial characters and use them in description and diagnose of taxa, as well as successfully engage in scientific and professional work; • explain of bioecological traits of the harmful insect species and their natural enemies, emergence prognosis, monitoring and control, solved problems coused by insects, as well as be capable for professional work, critical and creative thinking; • recognise and summarize of morphological and anatomical characteristics of insects, and using the insect identification keys; • distinguish and explain of physiological processes in digestive and respiratory system of insects, bloodstream, nervous system, muscles, sensory and reproductive organs, as well as to understand the significance of physiological processes in the insect life; • recognise and interpret of morphology, anatomy, physiology, ontogenesis, ecology, evolution and phylogeny of phytophagous mites, and their natural enemies; as well as recognise specific symptoms,

	• major terrestrial groups of nematodes, their place and significance *per se* and in agroecosystems; • systematics, structure, function, ontogenetic development, physiology, genetics, ethology and bioecology, phylogeny, monitoring, forecast and control of main groups of snails and small rodents; • structures of vegetative and reproductive organs of infested plants, as well as modern methods in plant microscopy.	pest diagnosis and prognosis, pest assessment and control; • determine and explain of basic nematode properties, specific symptoms and invertebrate parasitic nematodes, in particular of insect parazites; be able to recognize nematode damages; and also collect sample for nematological expertise and independently recommend integrated nematode management; • to identify of snails and small rodents, diversity, structure, physiology, genetic, ecology, evolution and phylogeny, behavioral and bioecological characteristics; to summarize of developmental stages and population dynamic of snails and small rodents, their natural enemies, monitoring, prediction, management and control; • recognise of plant organs infested by pests; the complexity of specific anatomical injuries; as well as be capable of critical apply different microscopic techniques, analyse and interpretate of the anatomical injuries caused by pests.
Weed Science	• different methods of: plant interaction, soil weed seed bank, weed seed germination, weed/crop resistance/tolerance to herbicides, weed flora and vegetastion, weed management; • weed classification, biological and ecological characteristics of weed species, economically harmful weed species, weed–crop interactions, parasitic weeds, invasive weed species, application of diagnostic methods and the impact of climatic change on weed spread, and integrated weed management; • diversity of weed populations, population diversity caused by environmental factors, growth / reduction dynamics of weed populations; and the skill to evaluate and prediction further movement of the weed	• design and organize experiments and demonstrate skils concerning the particular methods for testing: weed-crop interactions, soil seed bank, effect of abiotic factors on seed germination, weed resistance to herbicides, weed vegetation, weed management; as well as analyze and explain the obtained results; • predict and diagnose of weed emergence, as well as recommend of IWM strategy; • identify and describe of weeds taxon and symptoms caused by herbicides and different abiotic factors, predict the appearance and abundance of weeds, explain weed-crop interaction, weed response to herbicides, as well as successfully engage in scientific and professional work;

	population in the context of changes in environmental conditions; • biodiversity, factors that influence on biodiversity, weed flora and vegetation of Serbia, principles of classification of plant communities and mapping; as well as determination of weed species, sampling and processing of phytosociological relevés, making phytosociologica tables and mapping weed flora and communities; • structure of vegetative and reproductive organs of weed plants, as well as with modern methods in different plant microscopy; • software packages for processing, analysis and interpretation of data in the field of: weed-crop and weed-abiotic / biotic factors interactions, weed flora and vegetation, weed/crop response to herbicides, and pesticide efficiency.	• summarize and explain genetic diversity of weed populations, factors that induce variability, dynamics of increasing or decreasing of populations abundance in certain environmental conditions; as well as predict the abundance, density and coverage weed populations in different crops and different environmental conditions; • recognize factors that influence on diversity of weed flora and vegetation, use keys for weed determination, principles of weed communities classification and mapping of weed flora and vegetation; • to distinguish structure of vegetative and reproductive organs of weed species, the effect of stress factors (herbicides, temperature..) to weed anatomy and consequences on crop yield, and demonstrates the skill of using different microscopic techniques, recognize and explain of the anatomical changes caused by herbicides or other abiotic factors; • critical apply of different software packages for data processing obtained in all scientific research of weeds and pesticides.
Phytopathology	• different methods, designing and setting up the experiments for identification and characterization of phytopathogenic organisms; interpretation of obtained results and anticipating future research steps; • general characteristics, variability, pathogenesis, epidemiology, predicting, resistance, profilaxis and therapy of phytopathogenic organisms, as well as successfully engage in scientific and professional work; • biology and ecology of various phytopathogenic organisms; and also determination, epidemiology, detection and study of races which is crucial for further scientific development of phytopathology;	• critical apply the different methods for detection, identification and characterization of phytopathogenic organisms; also ready to derive and combine different methods, create experiments and explain the obtained results; • demonstrate knowledge of plant pathogens characteristics, new pathogens, changes in diseased plants, epidemiology, resistance, prophylaxis and therapy; and also capable to professional work in phytopathology; • explain and categorize mechanisms of infection, pathogen - host plant interactions, pathogen

	• processes leading to genetic and evolutional changes in the population of phytopathogenic organisms; • molecular detection, identification and characterization of different group of phytopatogenic organisms and their populations, as well as phylogenetic and phylogegraphic research; • informatin technologies in molecular research of phytopathogenic organisms and using software packages for data analyses of nucleotide and amino acid sequences different group of phytopathogenic organisms and clarify obtained data; • diseases induced by biotic agents during storage on harvested plants and postharvest disease control; • changes in primary and secondary metabolism in diseased plants during pathogenesis, specific plant-pathogen interactions and plant defence; • intra/interspecific relationships between plant pathogens and environmental factors, as well as of population dynamics of plant pathogens in different environment; • definition of mycotoxins, their chemical and biological characteristics, toxicity, prevention and measures of preventing toxin presence in the food, detection of common toxins in the plant products.	interactions with other biotic and abiotic factors, specialization of phytopathogenic organisms, principles of classification and nomenclature, symptomatology and control; • synthesis and evaluation the processes leading to genetic and evolutionary changes in population of different species of phytopathogenic organisms; • diagnose and solve scientific and practical problems in molecular characterization of different type phytopathogenic organisms due to prevalent isolate-based selection and development of resistance in host plants and controlling the risk of the introduction of new genotypes; and also compute of biological data, obtain, store, organise, archive, analyse and visualise biological data; • explain of changes on stored products, identify postharvest pathogens, explain the relationship between the pathogen and host in storage conditions, and propose postharvest disease control; • critical apply the knowledge of changes in primary and secondary plant metabolite in diseased plants, effect of phytohormones and other metabolites in plant defence and on quality of plant products; • predict and diagnose the occurrence of plant diseases; • control risks of mycotoxins and toxigenic fungi, their accumulation in the food, improves food safety, as well as recognize risks, debate and solve the practical problems.
Phytopharmacy	• basic and special methods for research of pesticides, toxicological and ecotoxicological studies, as well as	• mastering and critical apply general knowledge and skills in research work with pesticides and specificities in research in PhD thesis; as well as for critical and creative thinking.

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designing and setting up the experiments for pesticide application and interpretation of obtained results;
- mode of action, spectrum of application, selectivity, phytotoxicity, resistance etc., and effects achieved by their application to harmful organisms, crops and non-target organisms, as well as successfully engage in scientific and professional work;
- basic pesticide mechanisms of action from the point of view of their rational and sustainable application in the crop protection;
- principles of analytical measurements of pesticides based on the national and international regulations, recommendations and analytical methods, also understand similarities and differences between certain types of control tests, testing the quality of the active substances and formulations, residues monitoring;
- toxicological assessment and food contaminants due to the effects they have on human health;
- risk assessment of pesticides for the environment and human health, internationally recommended parameters for the exposure assessment, effect assessment, hazard identifications, principles, steps and methodologies in decision making process in risk management.

- appraise and compare the most important pesticide properties, efficiency, safety of application, phytotoxicity, resistance, and environmental impact;
- identify and explain the basic biochemical and physiological processes and cellular structures, that is, site / pesticide mechanism of action, in order to be properly applied in plant protection;
- predict of pests and disease appearance and assess of their harmfulness , as well as recommend of IPM strategy;
- describe and summarize the most important elements of physical and chemical analysis of pesticides, use of databases for retrieval and selection procedures for testing, and implementation of simple methods of analysis;
- demonstrate knowledge of sources of toxic substances in food and procedures/principles that are used for their analysis;
- demonstrate knowledge in toxicology and ecotoxicology at basic steps in the risk assessment process, know how to use available data for hazard identification, exposure assessment, hazards and risks to organisms and the environment based on dose response;
- evaluation and development of new ideas or tactics in system of sustainable use of pesticides.

*****To provide students with knowledge about...*

***When students successfully complete their programs they will be able to…; Please use descriptors (active verbs) as defined by EQF*

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3. THE SWOT ANALYSIS OF THE PROGRAM

Strengths	**Weakness**
• High renown and tradition of the Faculty in the teaching process with wide range of study programs at all levels of academic study. • Appropriate number of competent and professional teachers. • Founded ECTS system, aims of course, learning outcomes, student competence acquisition and evaluation of student achievements. • Course contents and study programs are comparable to similar ones in Serbia, the region and Europe. • There is a wide range of quality general-educational, theoretical-methodological, scientific-professional and professional-applicative courses. • There is a system for evaluating extra-curricular activities. • There is a student support system (mentors, tutors, student support center at the UB). • There is own teaching literature (textbooks, practicums) in the most important areas. • There is a platform for e-learning that enables the introduction of modern forms and methods of teaching and learning in the teaching process.	• Relatively high teaching load of individual teachers. • A system of support for the development of educational and didactic competences of teachers have not been developed. • The existence of content overlap between individual courses and study programs. • Existence of a number of courses with too narrow content, insufficiently specific learning outcomes and unclear acquisition of competences. • Lack of study programs in English language. • Extremely large number of elective courses. • Lack of relevant data on job market needs for the some qualifications coming out from study programs. • Some classrooms, laboratories and practice rooms are not sufficiently equipped to carry out of the PhD study program. • There is not teaching literature for some courses. • Relatively poor use of the e-learning platform that should facilitate communication with students.
Opportunities	**Threats**
• Redefining learning outcomes and competencies that will take into account the needs of the expanded job market. • Determination and defining teachers' capacity in certain narrow scientific fields, as well as employment of young staff in accordance with needs. • Defining and implementing national and international projects related to the teaching process. • Establishing cooperation with business entities in order to improve scientific research. • Improving student and teacher mobility through various exchange programs. • Up-grate of the level of proficiency in teaching using international experience. • Improvement of pedagogical competencies of teaching staff. • Involving external experts in the process of improving study programs.	• Existence of other HEIs with similar teaching programs. • Non-evaluation of teaching activity sufficiently by the competent Ministry. • Mismatch of some learning outcomes and competences in study programs with the needs of the job market. • High teacher load and insufficient employment of young people can negatively affect the quality of the teaching process. • Due to the change in the elective of higher education and employment of young scientist, in the future, a reduction in the number of teachers can be expected; In some study programs, this can contribute to decrease quality of teaching. • Non-interest and non-motivation of teaching staff for quality changes in the teaching process.

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Partner 11 UNS - University of Novi Sad, Faculty of Agriculture, Novi Sad, Serbia

1. COMPLIANCE OF THE PARTNERS INSTITUTIONS HIGHER EDUCATIONAL SYSTEM WITH BOLOGNA PROCESS

The academic studies are organised on three levels:

BSc 4 years, 8 semesters (240 ECTS)

MSc 1 year, 2 semesters (60 ECTS)+3

PhD 3 years, 6 semesters (180 ECTS) **or**

Integrated studies in Veterinary Medicine 5 years, 10 smesters (300 ECTS)

PhD 3 years, 6 semesters (180 ECTS)

2. REVIEW OF THE EXISTING PhD STUDY PROGRAMS

Title: Agronomy

Duration: three years, 6 semesters

Credits or hours required in order to successfully complete the Program: 180 ECTS

Structured* or individual**: both

Language: Serbian/English

Tuition fee: free(supported by the Ministry of Education) or around 400 EUR/semester (2,800 EUR)

Funding support: no official support, mostly from the projects

Enrollment and admission requirements: 300 ECTS, Master's degree in Biotechnical Sciences or other relevant to the field of study, no grade requirements

Capacity: 25

Table 1 List of the key activities to accumulate the credits:

1. 2 obligatory courses, 15 ECTS
2. 6/136 elective courses, 60 ECTS
3. Students preparatory work and research, 70 ECTS
4. Manuscript publishing, 15 ECTS
5. Viva, 20 ECTS

Table 2 The learning outcomes of the Program:

1. profound understanding of science and profession in biotechnology;
2. skills to use modern research methods in biotechnology;
3. ability to perform independent research of theoretical and practical problems in order to find innovative or improved solutions and their application;
4. ability to work in teams and establish professional communication in order to contribute to the development of the knowledge and profession;
5. capacity for critical thinking and analysis and integration of the knowledge to develop new technologies;
6. ability to transfer knowledge and ideas to colleagues, to the international academic/research community, and the society;
7. skills to independently contribute to expanding the limits of knowledge in the scientific fields of Agricultural Production through original research;
8. ability to support technological and social progress in academic and professional environment.

Compliance of the Program with European Qualification Framework (EQF):

UNSFA adopted and implemented all central tools of Bologna process, and the Faculty is accredited for scientific and research work by a National body for the Accreditation of the Scientific and Research Organisations.

2.1. Program disciplines and courses

Table 3 Number of compulsory and elective courses grouped by disciplines offered by the Program

Courses	**Number**
Compulsory	2
Elective	136 (18 Plant Health)
Zoology	2
Entomology	6
Phytopathology	4
Pesticide Science	4
Weed Science	2
Interdisciplinary	2

Table 4 Courses of general importance of the Program

Courses	Credits (ECTS)
Academic (generic, soft) skills	5
Biostatistics	10
Total 2	**15**

Table 5 Courses that focus on various disciplines in Plant health

Courses	Credits (ECTS)
ZOOLOGY	
Special zoology	10
Special parasitology	10
Total 2	**20**
ENTOMOLOGY	
Techniques of Insect Identification	10
Monitoring of Insects	10
Parameters of Insect Populations	10
Advanced entomology 1	10
Advanced entomology 2	10
Neglected vector species and pathogens	10
Total 6	**60**
PESTICIDE SCIENCE	
Chemical methods for pesticide residues analysis	10
Advanced phytopharmacy 1	10
Advanced phytopharmacy 2	10
Biological methods for pesticides residues analyses	10
Total 4	**40**
WEED SCIENCE	
Advanced herbology 1	10
Advanced herbology 2	10
Total 2	**20**
PLANT PATHOLOGY	
Diagnosis of plant pathogenic fungi and fungi-like organisms	10
Diagnosis of plant pathogenic viruses	10
Plant disease resistance	10
Detection and Identification of Phytopathogenic Bacteria	10
Total 4	**40**
INTERDISCIPLINARY	
Integrated Pest Management	10
Methods and machines of pesticide application in plant protection	10
Total 2	**20**

Table 6 The objectives and learning outcomes of courses of general importance

COURSE	THE OBJECTIVES*	THE LEARNING OUTCOMES OR CORE COMPETENCES**
Academic (generic, soft) skills	Searching for the truth: the experimental design and analysis of data, writing a scientific paper, presentation of research results, writing of the project proposal, management, supervision.	To know how to look for good quality in research and to recognize when you have found it To recognize what makes a well-designed research experiment. To understand the importance of identifying all the factors influencing experiments. To appreciate the need to consider different methods for processing and analyzing experimental results. To acquire skills to develop arguments and ideas and present them in a logical manner. To be able to construct a good quality scientific manuscript for publication in English. To acquire and demonstrate skills in presenting scientific research to others at meetings. To know the criteria needed to write successful project proposals. To acquire basic skills for self-management, management of others and career management. To appreciate the qualities needed for effective supervision and mentoring of research students and staff. To improve ability to communicate in English.
Biostatistics	Application of the most modern statistical instruments and statistical computer programs	The doctoral students should be able to use statistical instruments and apply them adequately. The acquired skills can be used for successful solving of problems in their scientific research and further professional work.

***To provide students with knowledge about…;**When students successfully complete their programs they will be able to…; Use descriptors (active verbs) as defined by EQF*

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Table 7 The key objectives and the learning outcomes of all other courses grouped by disciplines that are related to the Plant health

DISCIPLINE	THE OBJECTIVES*	THE LEARNING OUTCOMES OR CORE COMPETENCES**
Zoology	Identification of different animal pest species of importance for agriculture, veterinary and medicine practice. Identification of parasitic species, diagnosis of diseases that occur in humans and animals, symptoms of plant damage and the application of adequate control methods.	Plan and organize research in the field of Special zoology. Plan and organize research in the field of Special parasitology.
Entomology	Approaches and techniques of monitoring beneficial and pest insect species. Morphology and anatomy of selected pest species, stage of development, taxonomic affiliation, and life cycle. Techniques of insect identification. Medical and veterinary importance of insects. Methods for vector monitoring and surveillance, pathogen detection, principles and components of integrated vector management. Insects populations, factors influencing population density/abundance and saesonality.	Extend knowledge of the previous studies of selected specific scientific field in Entomology.. Select and apply adequate monitoring strategies for different insect groups; observe and evaliate species composition and population status; and conserve the beneficial insects. Explain the concept and provide capacities and conditions for safe-food production. Use the adequate identification technique and proper preservation for different insect developmental stages and groups. To prevent vector establishment and dispersal, manage vector populations by choosing the most appropriete strategy for vector control. Characterize the insects population, and predict population density. Create sustainable strategy to prevent damages to crops and control pest insects.

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		Design measures to protect beneficial and endangered insect species.
Phytopathology	Techniques for diagnosis of plant pathogenic fungi and fungi-like organisms. Techniques for diagnosis of plant pathogenic viruses . Nature of plants resistance to main pathogens and basis of selection process in resistance to main diseases. Detection and identification of phytopathogenic bacteria in diseased plants.	Detect and identify phytopathogenic fungi and fungi-like organisms. Detect and identify phytopathogenic viruses by classical methods and molecular tools. Explain the disease cycles of plant pathogenic fungi and reaction of grown plants to pathogens. Determine grown plants resistance to diseases, and tolerance to diseases. Master skills for identification techniques (conventional and fast, contemporary techniques).
Pesticide Science	Methods for the pesticide residues analysis in food of plant and animal origin, soil and water. Pesticides properties, pesticides fate in the environment, assessment of biological effects (phyto-toxicity, efficacy), possibilities of pesticide mixtures application. Innovative methods in phytopharmacy and application of of environmentally accaptable pesticides. Delayed /postponed resistance mechanism to be included in and sustainable agriculture in a view of plant protection practice. Contemporary zoocides and herbicides and their implementation into programs with the reduced risk to the environment. Biological detection of pesticides in soil, water and plant material	Apply techniques of analysis of pesticide residues in order to test food safety, contamination of soil and water. Improve capacities for scientific work in area of modern pesticide applications, in terms of providing safe food and products and environmental protection. Implement innovative methods in accordance with the comprehensive methods in phytopharmacy. Apply biological methods in field of pesticide science.
Weed Science	Weed species, their spread and significance for agricultural, i.e. field, vegetable, orchard-vineyard and non-agricultural (ruderal) areas.	Upgrade the previously gained knowledge from the field of herbology. Explain the concepts necessary for choice of measures for control of resistant weed species.

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Interdisciplinary	Biology of phytopatogenic fungi, insects and other harmful organisms of significance for agricultural production; pesticides properties and application principles; basic and specific principles of integrated plant protection, safe-food production. Optimal pesticide application methods, techniques and machines; Optimal exploitation of mechanization, ecologically acceptable pesticide application, production of residue-free plant products; proper maintenance of machines for pesticide application; work organization, with full exploitation of capacities; integrated plant protection and disease forecasting models.	To master methods on scientific bases; constructive analysis; specific principles and practices in integrated plant protection. Critically evaluate the factors which can affect efficacy of pesticides in rational, economical and ecologically acceptable pesticide application. Use the optimal methods, techniques, and machines for pesticide application in plant production.

*****_To provide students with knowledge about..._

**When students successfully complete their programs they will be able to…; Please use descriptors (active verbs) as defined by EQF

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3. SWOT ANALYSIS OF THE PROGRAM

Strengths	**Weakness**
• High scientific production of staff • Ability to transfer new knowledge to different stakeholders • Multidisciplinary expertise in the field of biotechnology, including plant health • Participation/coordination in many international (TEMPUS, ERASMUS, FP7, HORIZON 2020) and national project	• Weak enrollment requirements • Quality of students lost in ECTS • Lack of funding for PhD research projects/training • Not strong enough nor strategic collaboration between academia and economy • Lack of modern equipment due to insufficient funding • Low chances for employment of the young scientists • Lack of national evaluation sheme for teachers
Opportunities	**Threats**
• Students are willing to learn • Politicians constantly promiss they will do their best to stop the “brain drain” • International cooperation - teachers and students mobilities (training), networking, • Growing needs of economy and agriculture for innovative research • Most of the international projects stimulate involvement of early career researchers	• Low motivation to finish the PhD studies • Founders are expecting decrease of costs – lower financing • Research work not coordinated with country research priorities/ economy/ agriculture/ market needs • Funding for the PhD research projects might be even more difficult to find in the future • Weak capacities in strategic planning • Continuous brain drain

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Partner 12 UoM BTF - University of Montenegro, Biotechnical Faculty, Podgorica, Montenegro

1. COMPLIANCE OF THE PARTNERS INSTITUTIONS HIGHER EDUCATIONAL SYSTEM WITH BOLOGNA PROCESS

The Biotechnical Faculty (**UoM BTF**) enrolled the first generation of students into the study programs developed according to the Bologna declaration in 2005 with an enrolment rate of approximately 160 undergraduate students per academic year. Since 2017/2018 UoM BTF offers degree structures on a three-cycle (bachelor, master and doctoral) system in a 3+2+3 year's period. These reformed studies enable students to attend classes at partner universities abroad.

A set of learning outcomes as defined by the European Qualifications Framework and Montenegrin Qualification Framework has been established for each module at all degree levels in order to provide more quality assessments of students against a competency-based, rather than workload-based.

In order to ensure sustainability of the programs of the University and promote European cooperation, the Quality Assurance Centre has been assembled and standards are developed to provide high quality as work model. The Centre recognizes roles and responsibilities of teachers, students and stakeholders concerning quality assurance and monitor and deliver all of the expected and achieved results. The Centre conducts internal or self-evaluation analysis. External evaluation was conducted internationally by external evaluators of The European University Association (EUA). Re-accreditation procedure is carried out every five years. UoM BTF completed its re-accreditation procedure of bachelor and master studies and accreditation of doctoral studies in 2016 with positive recommendation.

The Diploma Supplement has been automatically issued to completed students with all credentials containing a description of the nature, level, context, content and status of the studies completed by the individual noted on the diploma.

Doctoral studies at University of Montenegro are governed by national regulatory acts which identify the education, scholarships, granting and conditions that must be fulfilled by universities and research units leading doctoral studies.

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2.REVIEW OF THE EXISTING PhD STUDY PROGRAMS

Title: Doctoral studies Biotechnics

Duration: 3 years

Credits or hours required in order to successfully complete the Program: 180 ECTS

Structured* or individual**: Both

Language: Montenegrin

Tuition fee: 6 000 €

Funding support: Self-funded or scholarship granted by Ministry of Science.

Enrolment and admission requirements: *MASTER'S* degree in Biotechnical Sciences or other relevant to the field of study.

Capacity: not defined

Table 1 List of the key activities to accumulate the credits

	Activity	Number of credits (ECTS)	
		min	**max**
	Compulsory group of activities	180	180
1.	Compulsory courses (3)	22	22
2.	Elective courses (2)	16	16
3.	Presentation of scientific work	22	22
4.	Research work	90	90
5.	Dissertation	30	30
			Minimum of 180

Table 2 The learning outcomes of the Program

After completing the programs students will be able to:

1. Demonstrate the ability of independent research work in the field of study, and the independence in the application of skills and methods of work in the studied field;
2. Demonstrate the ability of synthesizing, exploring, designing, applying, implementation and acceptance of science based processes;
3. Identify and perform the original research that contributes to the expansion of existing knowledge by scientific work, which part can be published in national and international peer reviewed journals (indexed in SCI/SCIE list);
4. Critically analyze, evaluate and synthesize new and complex ideas;

5. Promote, in academic and professional context, technological, social or cultural progress in a knowledge-based society.

Compliance of the Program with European Qualification Framework (EQF):

UoM BTF adopted and implemented all central tools of Bologna process, and learning outcomes are aligned with 8 of Montenegrin Qualification Framework or 8 of EQF.

2.1. Program disciplines and courses

Table 3 Number of compulsory and elective courses grouped by disciplines offered by the Program:

Courses	Number
Compulsory	3
Elective	2
Phytopathology*	
Pesticides*	

* Among elective courses, Phytopathology and Pesticides are the only two courses related to Plant Health

Table 4 Courses of general importance of the Program

Courses	Credits (ECTS)
Methodology of scientific research work	8
Sustainable agriculture	7
History of agriculture and sociology of rural development	7
Total	**22**

Table 5 Courses that focus on various disciplines in Plant health

Courses	Credits (ECTS)
Phytopathology	8
Pesticides	8
Total 2	**16**

Table 6 The objectives and learning outcomes of courses of general importance

COURSE	THE OBJECTIVES*	THE LEARNING OUTCOMES OR CORE COMPETENCES**
Methodology of scientific research work	Methodology of scientific work, the method of facts acquiring, the method of research, data processing and analysis.	Analyse the collected facts, analyse the current methodological findings, apply general methods, empirical research methods, approach to project preparation and develop critical awareness.
Sustainable agriculture	The importance of agriculture in the world and in Montenegro; problems recognized in modern food production; the most important areas of agricultural production that are based on the principles of sustainable agriculture, latest trends in agriculture; significance of the development of rural areas.	Explain agricultural production based on the principles of sustainable agriculture; critically evaluate agricultural resources, use of chemical compounds in agriculture in a safe manner, use of proper energy sources related to agriculture; discuss the development of rural areas
History of agriculture and sociology of rural development	History of villages and peasantry; the importance of agriculture for Montenegrin society under the conditions of integration processes.	recognize current social processes as modernization; analyse the consequences of modernization on the life of villages and peasantry; analyse the impact of globalization on the development of agriculture, develop a possible direction of rural development and agriculture in Montenegro

*****_To provide students with knowledge about..._

**When students successfully complete their programs they will be able to…; Use descriptors (active verbs) as defined by EQF

Table 7 The key objectives and the learning outcomes of all other courses grouped by disciplines that are related to the Plant health

COURSE	THE OBJECTIVES*	THE LEARNING OUTCOMES OR CORE COMPETENCES**
Planth Pathology	Importance of plant diseases in agricultural production and food safety, the causes of plant diseases, the characteristics of plant pathogens, pathogenesis, symptomatology and anatomical and physiological changes in diseased plants, epidemiology and ecology of plant diseases, forecasting possibilities of the occurrence and spread of plant diseases, integrated measures to combat plant pathogens.	• Explain the importance and role of plant disease causal agents in plant production and food safety, • Apply standard equipment in laboratory for plant pathology, • Describe methods and procedures in diagnostics in plant pathology, • Distinguish abiotic (non-parasitic) diseases from biotic (parasitic) diseases, • Recognize different groups of symptoms in parasitic plant diseases, and aetiology of the disease, • Describe characteristics of plant pathogens • Analyze environmental factors and their role in the epidemiology and prognosis of plant diseases. • Suggest options for the most beneficial and sustainable control measures.
Pesticides	Pesticides and their use in agriculture and communal hygiene; chemical groups of pesticides and active substances and their effects on human health and the environment; managing the resistance of harmful organisms to pesticides; problems related to pesticide residues in food, legislation related to pesticides.	• Define different groups of pesticides • Recognize physical and chemical properties of pesticides • Describe mode of action and chemical groups of pesticides • Elaborate antiresistant strategy • Explain legal regulations in the European Union and in Montenegro related to pesticides • Recognize the importance of pesticide residues in food and the environment • Formulate measures to avoid negative effects of pesticides application to human health and the environment

*****To provide students with knowledge about; **When students successfully complete their programs they will be able to; Please use descriptors (active verbs) as defined by EQF*

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3. THE SWOT ANALYSIS OF THE PROGRAM

Strengths	**Weakness**
• Introducing European practices • Recognized as very important level of education and research at University • Joint studies of many disciplines • Collaboration with other Universities • Young motivated people	• Not adequate infrastructure (labs, equipment) • Not adequate working – research conditions • Not highly specialized program • Low number of courses related to plant health • Insufficient experience in organization of doctoral studies • New program organized very recently at the Faculty
Opportunities	**Threats**
• Since PhD studies started very recently at the Faculty, the best practices from PIs can be considered for their improvement • Ministry of Science has recently started to finance the research for PhD candidates • Possibility of interdisciplinary approach • Motivation of young people who went abroad to come back to Montenegro • Collaboration with foreign professors and EU financial support	• Not sufficient number of doctoral candidates • Uncertainty for employment of persons with doctoral degree • Insufficient awareness about the need for special program related to plant health during the accreditation process • Not sufficient awareness about the importance of doctoral studies at the Faculty

4. THE COMPARISON OF THE PhD STUDY PROGRAMS

Our task is to review the existing PhD study programs at 12 HEI in southeastern part of Europe. Partners of this consortium reported partial or full compliance of the existing PhD programs with Bologna declaration and national and EU qualification framework. The SWOT analysis are mostly described for the institutions, rather than PhD programs related to the Plant health. All partners indicate harmonization of the study and development of joint PhD program as strategic decisions and opportunity. However, programs at UNKO and AUT are inactive since 2013 and going through the process of revision. Partners mostly indicate funding issues and need for greater teacher and students mobility in order to increase the interdiciplinarity and international experience. This will ensure high quality doctoral program that also meets the needs of a job market.

There are considerable differences between PhD programs in the terms of structure, utilization of tools of Bologna declaration (Table 8) and learning outcomes (Tables 9-16). PhD programs in the most of the countries take three years to complete. While several partners may prolong studying period from 4 up to 8 years. In this period students have to accumulate 60 ECTS (UNKO and AUT) or 180 ECTS (all other partners except DISSPA-UNIBA and AUA, who do not have it clearly defined). PhD students could accumulate credits through compulsory and elective courses, must publish scientific papers, participate in teaching and take other activities before completing the study program. The number of the courses offered by the programs greatly vary between the partners ranging between 5 (UoM BTF) and 138 (UNS) courses. Several partners do not offer courses at PhD level at all (AUA and AU).

The greatest similarity between the PhD study programs and structure was noticed between FAZ, FAZOS, UNSA, UB and UNS. While, the structure of the program at DISSPA-UNIBA, AUA and AU greatly differ comparing to all other partner's programs. UNKO and AUT perform joint doctoral study program, so the structure of the program is the same. The most of the study programs are accredited to be performed in national language, however DISSPA-UNIBA, AU, AUA and UNS offer study program in English language as well.

DISSPA-UNIBA offers three-cycle degree structure (bachelor, master and doctoral) system in a 3+2+3 years periods. However, while the study programs for bachelor and master degree were developed according to the Bologna declaration, doctoral studies at DISSPA-UNIBA are partially in compliance with Bologna process. Similar differences are observed in the structure of PhD program at AUA. Programs at DISSPA-UNIBA did not fully adopt, while AUA did not adopt ECTS. Six partners fully adopted (FAZ, FAZOS, AU, APTF, UB, UoM BTF) all five central tools of Bologna process.

APTF indicated need for harmonization in technical aspects of the program. Critical points of PhD study program at APTF are: students take all compulsory and elective modules in the first year of the study; all modules are awarded by 6 ECTS; students need to accumulate 60 ECTS from teaching activity group.

The courses or activities related to Plant health at several institutions start from the second year of the study. While the first year is often devoted to the disciplines of general interests in

Agronomy. The structure of such program can be recognized from more general title of the degree diploma, compared to the more specialized titles reported by the partners.

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Table 8 The general information about the programs structure

Partner	Duration (years)	*Credits	**Defined LO of the program [1] and courses[2]	Disciplines related to Plant health	Degree title
FAZ	3 (max 6)	180 ECTS	[1]Yes [2]Yes	Zoology, Weed Science, Plant Pathology, Interdisciplinary	Doctor of Science in Biotechnical Sciences, field Agriculture
FAZOS	3 (max 6)	180 ECTS	[1]Yes [2]Yes	Agricultural zoology (Entomology; Acarology; Nematology); Weed Science; Plant Pathology; Interdisciplinary	Doctor of Science in Biotechnical Sciences, field Agriculture, branch Plant Protection
UNIBA	3	Not completely defined	[1]No [2]No	Plant Pathology and Bioinformatics	PhD in Biodiversity, Agriculture and Environment
AU	3 (max 4)	180 ECTS	[1]Yes	Entomology, Phytopathology, Herbology, Microbiology	Doctor of Science in Plant protection, Scientific major Entomology, Phytopathology, Herbology or Microbiology
AUA	3 (max 6)	N/a	[1]Yes [2]N/a	Entomology and agricultural zoology; Pesticide science; Phytopathology; Enironmental science	PhD in Plant Science
AUT	3 (max 5)	60 ECTS	[1]Yes [2]Yes	Plant Pathology; Entomology; Integrated Pest Management; Phytotoxicology	Doctor of Sciences Agriculture and Environment, Profile Plant Protection Science
UNKO	3 (max 5)	60 ECTS	[1] Yes [2] Yes	Entomology; Phytopathology; Weed science; Integrated control of diseases and pest in horticulture	Doctor of Sciences in Sustainable Horticulture

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UNSA	3	180 ECTS	[1]Yes [2]No	Agricultural entomology; Phytoacarology; Nematology; Weed science; Plant Pathology	Doctor of Agricultural Sciences
APTF	3 (max 6)	180 ECTS	[1]Yes [2]Yes	Zoology; Weed science; Interdisciplinary	Doctor of Biotechnical Sciences from the scientific field Agronomy, branch Plant production
UB	3 (max 8)	180 ECTS	[1]Yes [2]Yes	Entomology and Agricultural zoology (Acarology; Nematology); Weed Science; Phytopathology; Phytopharmacy	Doctor of Biotechnical Sciences, field Agricultural Sciences – module Phytomedicine
UNS	3	180 ECTS	[1]Yes [2]Yes	Zoology, Entomology, Phytopathology, Pesticide Science, Weed Science, Interdisciplinary	Doctor of Science in Biotechnical Sciences, field Agronomy, subfield Biotechnical Sciences: Zoology, Entomology, Phytopathology, Pesticide Science, Weed Science, or Interdisciplinary
UoM BTF	3	180 ECTS	[1]Yes [2]Yes	Plant Pathology; Pesticides	Doctor of Science in Biotechnical Sciences

*minimum ECTS or workload hours for PhD degree; **defined learning outcome (LO) according to the EQF level 8

4.1. **The comparison of the learning outcomes**

The PhD programs are covering mostly all relevant disciplines to Plant health, and ensuring students opportunity to create personal study program. Disciplines offered by the programs are rather traditional, except of several partners who give accents on disciplines principally oriented towards environmentally acceptable plant protection such as DISSPA-UNIBA and UNKO.

The learning outcomes of the programs and disciplines are described by active verbs according to the Bloom's taxonomy, which is globally accepted. Higher education study programs in Europe and USA prior accreditation process must provide the list of students competences that are comparable by Bloom's classification. In this analysis, we classified the descriptors in hierarchy of three categories: knowledge, skills and responsibility (Tables 9-16). The most of the partners struggled when using the Blooms classification to demonstrate appropriate level of student's competences. This indicates a necessity to organize workshops for partners to get more acquainted with the descriptors (the active verbs), the way to describe academic achievements and to be able to compare the most advanced level of knowledge proposed by EQF. All programs have already established learning outcomes.

The consortium strength is in compatibility of already exsiting programs and disciplines. However, the weakness of the consortium is that most of the partners don't offer competences for several disciplines (since they didn't define the learning outcomes that are aligned with the level 8 of EQF): Weed Science - 7 partners; Mycotoxins and Food safety – 8 partners. Other disciplines proposed by the project are represented evenly, and appropriate active verbs are used to define to competences. However, when cross analyzed with the aims of the disciplines, the descriptors for several partners and disciplines do not push back the frontiers and should be proposed for harmonization after in depth analysis by partners Insitutions. The disciplines or the subgroups proposed by the project (see document Project Methodology, Part 1, HARISA Description of WP 3) are not existing in this form in partners programs, they are not clearly defined and the competences are sometimes reported twice indicating overlapping. The partners found it rather difficult to recognize the student's competences for General Interest discipline.

The learning outcomes of disciplines are not defined at UNSA, so the student's competences presently cannot be recognized and compared to the other partners program. The PhD program at UoM BTF was the most recently developed. This partner offer more generalized competences related to Agronomy that are described by active words in the Table 9, and offer competences from two disciplines (Phytopathology and Sustainable use of Pesticides) which do not have clearly defined learning outcomes.

Programs at AU, DISSPA-UNIBA and AUA do not offer courses related to Plant health at PhD level, so the learning outcomes of disciplines are not clearly defined and comparable. Students achieve competences from different activities (seminars, reports, writing scientific papers etc.). However, these Institutions provide students with cutting edge knowledge in several disciplines (such as Plant Pathology, Entomology and Environmental Sciences).

At FAZ the learning outcomes of the study program for Plant health are not defined. Set of learning outcomes is defined for PhD study program and it is rather very broad and do not tackle any specific field including plant health. Learning outcomes of the particular courses are more content oriented but the level at which they are content oriented is varying across the courses. FAZOS offers doctoral education which is in compliance to the Croatian QF an EQF and declare competence of teaching staff as a strength. However, the content of the courses and learning outcomes should be upgraded, refreshed with state of the art knowledge, and harmonized to match the highest international standard since the level of knowledge of some courses do not correspond to the level 8 EQF. Similar was observed for UNS and UB.

AU is in the process of reevaluation of the PhD program, presently the students at this institution can get competences developed and aligned with the level 8 EQF only from the disciplines Plant feeders. At APTF in some of the curricula skills and competences were hardly described and should be reviewed and full filed in accordance to the proposed verbs of EQF. The list of elective modules could be reviewed and expanded according to the competences of teaching staff.

The active verbs used to describe the competences distributed by three categories are in most cases properly used, but there are some discrepancies observed for several programs. Basic studies may offer cognitive competences, however the advanced level of education must offer and define competences that reflect skills and responsibility of the PhD student for each course and discipline taught. There is a need for improvement in defining competences for all three categories for whole Consortium.

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Table 9 The comparison and distribution of the learning outcomes of the Programs by the descriptors of the level 8 EQF

	The active verbs used in defining learning outcomes or core competences according to the EQF LEVEL 8		
Partner	**KNOWLEDGE**	**SKILLS**	**RESPONSIBILITY AND AUTONOMY**
	Knowledge at the most advanced frontier of a field of work or study and at the interface between fields	The most advanced and specialized skills and techniques, including synthesis and evaluation, required to solve critical problems in research and/or innovation and to extend and redefine existing knowledge or professional practice	Demonstrate substantial authority, innovation, autonomy, scholarly and professional integrity and sustained commitment to the development of new ideas or processes at the forefront of work or study contexts including research
FAZ	Apply; Individually suggest and take part	Actively participate in the preparation; Guide and/or monitor; Develop Follow, synthesize and evaluate	Critically analyse and evaluate; Publish Create new proposals
FAZOS	recognize, identify, select, demonstrate	critically apply, manage, evaluate	estimate, create, develop, conceive, design, conduct, publish, present
UNIBA	recognize, identify, select, interpret, demonstrate	critically apply, teach, report, integrate, generate, evaluate, manage	plan, organise, create, develop, conceive, design, conduct, conclude, publish
AU	Know	synthesis; evaluate, solve; redefine	Demonstrate authority, innovative, self initiative, persistent
AUA	describe, identify, explain, interpret, elaborate, classifiy	critically apply, develop, predict, compare, evaluate	Decide, create, estimate, develop, design, propose
AUT	Define, match, identify, list, reproduce	Describe, discuss, explain, express, recognize, manage, evaluate.	create, design, propose
UNKO	recognize, identify, select, demonstrate	critically apply, manage, evaluate	estimate, create, develop, design, conduct, publish, present

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UNSA	assess, synthetize	apply, analyse, evaluate, work in a team, solve	judge, decide make, resolute
APTF	apply, propose, identiffy	diagnose, plane, combine,	conclude, solve, choose
UB	explain, recognize, identify, summarize, distinguish, interpret, describe	demonstrate, combine, solve, diagnose, predict, master, to acquire and demonstrate skills, to improve ability to communicate	independently recommend, independently, critically interpret and apply, lead a debate, manage, to know how to look, to acquire and demonstrate skills, to know the criteria
UNS	create, design, improve, upgrade, extend, explain, master, to understand, to be able to construct	use, detect, identify, apply, implement, select and apply, characterize and predict, master, to acquire skills, to acquire and demonstrate skills, to acquire basic skills, to improve ability to communicate	prevent, manage, master, explain, critically evaluate, plan and organize, determine, know how to look, recognize, appreciate the need, acquire and demonstrate skills, know the criteria, appreciate the qualities
UoM BTF	explain, discuss, recognize, define, describe	apply, evaluate, elaborate, distinguish	analyze, develop, formulate, suggest options

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The distribution of the learning outcomes of disciplines defined by Harisa project

Table 10 Discipline *Diagnosis in plant health and IPM*

	The active verbs used in defining learning outcomes or core competences according to the EQF level 8		
Partner	**KNOWLEDGE**	**SKILLS**	**RESPONSIBILITY AND AUTONOMY**
	Knowledge at the most advanced frontier of a field of work or study and at the interface between fields	The most advanced and specialized skills and techniques, including synthesis and evaluation, required to solve critical problems in research and/or innovation and to extend and redefine existing knowledge or professional practice	Demonstrate substantial authority, innovation, autonomy, scholarly and professional integrity and sustained commitment to the development of new ideas or processes at the forefront of work or study contexts including research
FAZ	integrate, select, apply, identify, recognize	plan, interpret results, identify and appoint	
FAZOS	explain, describe, recognize	predict, compare	create, estimate, develop, design, propose
UNIBA	describe, identify, recognise, measure, name, classify	predict, compare	solve, choose, identify, propose, plan, suggest options
AU	-	-	-
AUA	describe, identify, explain, interpret, elaborate, classifiy	select, critically apply, develop, predict, compare, evaluate	decide, create, estimate, develop, design, propose
AUT	describe, recognise, explain, understand	predict, compare	create, estimate, develop, design, propose
UNIKO	describe, recognize	predict, compare	create, estimate, develop, design, propose
UNSA	**-**	**-**	-
APTF	define, explain how	solve	criticize
UB	explain, recognize, understand, identify, distinguish, interpret, summarize, describe	demonstrate, combine, solved, derive, create, categorize, diagnose, propose, predict	independently recommend, independently and critically interpret,

			critically apply, lead a debate
UNS	create, design.	use, detect, identify	to prevent, manage
UOM BTF	-	-	-

Table 11 Discipline Sustainable use of pesticides

	The active verbs used in defining learning outcomes or core competences according to the EQF level 8		
Partner	**KNOWLEDGE**	**SKILLS**	**RESPONSIBILITY AND AUTONOMY**
	Knowledge at the most advanced frontier of a field of work or study and at the interface between fields	The most advanced and specialized skills and techniques, including synthesis and evaluation, required to solve critical problems in research and/or innovation and to extend and redefine existing knowledge or professional practice	Demonstrate substantial authority, innovation, autonomy, scholarly and professional integrity and sustained commitment to the development of new ideas or processes at the forefront of work or study contexts including research
FAZ	analyze and understand, criticaly elaborate identify	critically evaluate select and apply describe and elaborate effectively react	plan and carry out independently create chose and apply design
FAZOS	define, rank, classify, argument	select, critically apply, develop, predict, compare, evaluate	create, estimate, propose, design,
UNIBA	list, recognise, measure, compare, classify, interpret, predict	formulate, plan, propose, decide, determine, evaluate, judge, rank, assess, rate.	explain, predict, propose, design
AU	-	-	-
AUA	describe, identify, explain, interpret, elaborate, classifiy, analyze	critically apply, develop, predict, compare, evaluate, prevent, analyze	decide, create, estimate, develop, design, propose, execute, ban
AUT	list, recognise, measure, compare, classify, interpret, predict	demonstrate, combine, solved, create,	explain, predict, propose
UNIKO	-	-	-
UNSA	**-**	**-**	-
APTF	apply	improve, develop	decide
UB	explain, recognize, understand, identify,	demonstrate, combine, solved, derive, create,	independently recommend,

	distinguish, interpret, summarize, describe	categorize, diagnose, propose, predict	independently and critically interpret, critically apply, lead a debate
UNS	improve, upgrade	apply, implement, use	to master, explain, critically evaluate
UOM BTF	-	-	-

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Table 12 Discipline Plant feeders

	The active verbs used in defining learning outcomes or core competences according to the EQF level 8		
Partner	**KNOWLEDGE**	**SKILLS**	**RESPONSIBILITY AND AUTONOMY**
	Knowledge at the most advanced frontier of a field of work or study and at the interface between fields	The most advanced and specialized skills and techniques, including synthesis and evaluation, required to solve critical problems in research and/or innovation and to extend and redefine existing knowledge or professional practice	Demonstrate substantial authority, innovation, autonomy, scholarly and professional integrity and sustained commitment to the development of new ideas or processes at the forefront of work or study contexts including research
FAZ	distinquish and describe	select, calculate and predict, analyze and identify	develop, plan the research, analyse and assess, elaborate, evaluate and select,
FAZOS	explain, describe, classify, recognize,	monitor, collect, prepare, identify,	predict, propose
UNIBA	-	-	-
AU	understand, demonstrate, describe	demonstrate, create, interpret, critically analyze, evaluate, synthesize, develop, present, publish	demonstrate, act autonomously, plant, design, implement and adapt, participate actively, participate actively in the academic community
AUA	describe, identify, explain, interpret, elaborate, classifiy, analyze	critically apply, develop, predict, compare, evaluate, prevent, analyze	decide, create, estimate, develop, design, propose, execute, ban
AUT	explain, recognize, identify	demonstrate, combine, solved	predict, propose
UNIKO	describe, recognize, identify, classify	monitor, collect, prepare, identify,	predict, propose
UNSA	**-**	**-**	-
APTF	describe	report, choose	modify, evaluate
UB	explain, recognize, understand, identify, distinguish, interpret, summarize	demonstrate, combine, solved	independently recommend, independently and critically interpret, critically apply

UNS	extend, explain	Select, apply, characterize, predict	plan, organize
UOM BTF	-	-	-

Table 13 Discipline Plant pathology

	The active verbs used in defining learning outcomes or core competences according to the EQF level 8		
Partner	**KNOWLEDGE**	**SKILLS**	**RESPONSIBILITY AND AUTONOMY**
	Knowledge at the most advanced frontier of a field of work or study and at the interface between fields	The most advanced and specialized skills and techniques, including synthesis and evaluation, required to solve critical problems in research and/or innovation and to extend and redefine existing knowledge or professional practice	Demonstrate substantial authority, innovation, autonomy, scholarly and professional integrity and sustained commitment to the development of new ideas or processes at the forefront of work or study contexts including research
FAZ	Describe, Recognize Explain	Analyze and evaluate, Use	Create/design, conduct
FAZOS	describe, recognize, identify, classify	use, evaluate, compare	predict, propose
UNIBA	describe, recognize, identify, classify, measure,	formulate, use, evaluate, compare	predict, propose, organize, plan
AU	-	-	-
AUA	describe, identify, explain, interpret, elaborate, classifiy, analyze	critically apply, develop, predict, compare, evaluate, prevent, analyze	Decide, create, estimate, develop, design, propose
AUT	describe, recognize, identify, classify	use, evaluate, compare	predict, propose
UNIKO	describe, classify, recognize,	monitor, collect, prepare, identify,	predict, propose
UNSA	**-**	**-**	-
APTF	-	-	-
UB	explain, identify, recognize, predict	derive, create, predict, combine, demonstrate, categorize, diagnose and solve, propose, compute	lead a debate, critically apply
UNS	explain, master	master	determine
UOM BTF	-	-	-

Table 14 *Discipline Weed Science*

	The active verbs used in defining learning outcomes or core competences according to the EQF level 8		
Partner	**KNOWLEDGE**	**SKILLS**	**RESPONSIBILITY AND AUTONOMY**
	Knowledge at the most advanced frontier of a field of work or study and at the interface between fields	The most advanced and specialized skills and techniques, including synthesis and evaluation, required to solve critical problems in research and/or innovation and to extend and redefine existing knowledge or professional practice	Demonstrate substantial authority, innovation, autonomy, scholarly and professional integrity and sustained commitment to the development of new ideas or processes at the forefront of work or study contexts including research
FAZ	Define, Explain	Distinct, Argument Analyse, Evaluate	Lead, Participate
FAZOS	describe, identify, explain, interpret, elaborate, classifiy	distinguish, compare	predict, propose
UNIBA	-	-	-
AU	-	-	-
AUA	-	-	-
AUT	**-**	**-**	**-**
UNIKO	describe, identify, explain, interpret, elaborate, classifiy	distinguish, compare	predict, propose
UNSA	**-**	**-**	-
APTF	reqognize	defined	select
UB	identify, explain, describe, summarize, distinguish, recognize	demonstrate, design, compare, predict, diagnose, analyze	critically apply, independently recommend
UNS	upgrade, explain	**-**	**-**
UOM BTF	-	-	-

Table 15 Discipline Mycotoxins and food safety

	The active verbs used in defining learning outcomes or core competences according to the EQF level 8		
Partner	**KNOWLEDGE**	**SKILLS**	**RESPONSIBILITY AND AUTONOMY**
	Knowledge at the most advanced frontier of a field of work or study and at the interface between fields	The most advanced and specialized skills and techniques, including synthesis and evaluation, required to solve critical problems in research and/or innovation and to extend and redefine existing knowledge or professional practice	Demonstrate substantial authority, innovation, autonomy, scholarly and professional integrity and sustained commitment to the development of new ideas or processes at the forefront of work or study contexts including research
FAZ	-	-	-
FAZOS	classify, argument	assess, compare	suggest, develop
UNIBA	recognize, identify, classify, argument, select	assess, select, compare, choose	choose, suggest, propose.
AU	-	-	-
AUA	describe, identify, explain, interpret, elaborate, classifiy	critically apply, develop, predict, compare, evaluate	Decide, create, estimate, develop, design, propose
AUT	recognize, identify, classify, argument, select	assess, compare	suggest, develop
UNIKO	-	-	-
UNSA	-	-	-
APTF	-	-	-
UB	explain, identify, predict, recognize	derive, combine, demonstrate, categorize, diagnose and solve, propose	lead a debate, independently recommend
UNS	-	-	-
UOM BTF	-	-	-

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Table 16 Discipline General courses of transversal interest

	The active verbs used in defining learning outcomes or core competences according to the EQF level 8		
Partner	**KNOWLEDGE**	**SKILLS**	**RESPONSIBILITY AND AUTONOMY**
	Knowledge at the most advanced frontier of a field of work or study and at the interface between fields	The most advanced and specialized skills and techniques, including synthesis and evaluation, required to solve critical problems in research and/or innovation and to extend and redefine existing knowledge or professional practice	Demonstrate substantial authority, innovation, autonomy, scholarly and professional integrity and sustained commitment to the development of new ideas or processes at the forefront of work or study contexts including research
FAZ	Describe Explain Critically judge	Collect Distinguish and classify Carry out	Devise, organize and prepare To discuss, create and set up Formulate and design
FAZOS	plan, select, interpret, identify, explain	organize, set up, critically apply, predict, evaluate	design, develop
UNIBA	recognise, identify, summarise, describe, classify, distinguish, estimate, explain, formulate, interpret, translate, illustrate, discuss, predict, select, explain	organise, set up, critically apply, predict, evaluate	design, develop
AU	-	-	-
AUA	describe, identify, explain, interpret, elaborate, classifiy	critically apply, develop, predict, compare, evaluate	Decide, create, estimate, develop, design, propose
AUT	**-**	**-**	**-**
UNIKO	-	-	-
UNSA	**-**	**-**	-
APTF	aquire, show,	trained	propose
UB	explain and interpret obtained results	computer processing	independently compare and make conclusion
UNS	to understand to be able to construct	to acquire skills; to acquire and	to know how to look to recognize

		demonstrate skills; to acquire basic skills to improve ability; to communicate	to appreciate the need to acquire and demonstrate skills to know the criteria to appreciate the qualities
UOM BTF	-	-	-

5. CONCLUSION

Comparison of study programs revealed partner's strengths and missing knowledge, skills and competences. In order to improve education against common agreed standards of excellence, we indicated the disciplines or the structure of program that should be harmonized. However, due diligence reveal that partners are very successful in specific disciplines, offering cutting edge knowledge. This enables consortium to increase networking and interrelation, to share good practices and knowledge and achieve a strategic alliance in the region.

Joint PhD study program has to be prepared by following these steps: identification of the best structure and management practices, preparation of a draft of the learning outcomes for study program and for disciplines, after a broad discussion learning outcomes should be adopted, at this point it should be started to create the modules and courses. Modular system seems to be very good for the joint PhD study program. Joint study program should be developed according to the rules described at EU level. However, each Country has specific national rules to follow, otherwise there is the risk of non-approval of the project by own funding office. That's why the harmonization should take into account various needs and find a common direction with enough degrees of freedom.