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WP4. ESTABLISHMENT OF DIAGNOSTIC AND TRAINING HUBS (DTHS)

One of the aims of WP4 is to upgrade the existing facilities of partner countries in service of PhD students', staff and professionals' needs. The goal is to establish diagnostic and training hubs with high expertise in particular fields available to serve as regional centers for education and spreading knowledge.

The first Task (4.1) was to establish the selection procedure of the equipment needs. During the HarISA kick off meeting, members of WP4 discussed the selection criteria and the selection procedure for diagnostic and training hubs and the equipment they need to operate adequately and cover the needs of plant health services. The main selection criteria concern the regional distribution, experience and scientific excellence in related area, human capacities, existing and requested equipment, and strategic action plan of the diagnostic and training hub. A template for the existing and the needed equipment list and criteria was developed.

During the second Task (4.2) a workshop was organised in Belgrade (October 2019) and WP4 members discussed the equipment suggestions of partner countries. The WP4 members evaluated the applications and proposed to applicants several improvements regarding the rationale of the puchase, the type and performance of the proposed equipment. Finally the best candidates for each specific area and partner country were approved. Partner countries will benefit significantly from the new equipment which will provide additional resources for their research work - increasing their scientific performance.

Below is the list of the selection criteria and the suggested approved equipment for each partner country.

Selection Criteria for the purchase of equipment

1. Regional distribution
2. Experience and scientific excellence in related area
3. Human capacities
4. Existing and requested equipment
5. Strategic action plan of the diagnostic and training hub

LIST OF EQUIPMENT THAT NEED TO BE PURCHASED FOR EACH PARTNER

(34,000 € / PARTNER COUNTRY)

P6. AGRICULTRAL UNIVERSITY OF TIRANA (AUT), Faculty of Agriculture and Environment, ALBANIA

	Equipment	Estimated price (€)
1	**Real-Time PCR Thermocycler** (for DNA amplification and further molecular analyses)	31.950
2	**Balance 0.01 g** (for weighing small amounts of salts and other compounds for molecular analyses)	750
3	**0.2ml PCR strip tube small centrifuge 5400 rpm lab mini centrifuge** (for centrifugation of samples for molecular analyses)	890
4	**Vortex** (for vortexing samples for molecular analyses)	410
	TOTAL	34.000

RATIONALE

In AUT laboratories related to plant health, there is a line of samples of plant origin for various pathogens and pests that are being analysed using DNA-RNA extraction and detection methodologies. The Department of Plant Protection (AUT) has a set of equipment for conventional PCR analysis but it really needs up-to-date equipment to train all the PhD students in modern molecular diagnostic methodologies. For this reason, AUT would like to purchase a Real-time polymerase chain reaction (Real-Time PCR) thermocycler that will serve in the diagnostic laboratory for the identification of plant parasites. Additionally, this equipment would need some small missing bench appliances: a small scale balance (0.01 g), a lab mini centrifuge for 0.2 ml PCR strip tubes and a vortex in order the molecular analyses to be performed according to the protocols. All PhD students enrolled in the Department of Plant Protection as well as in some other departments will work on this equipment.

The number of PhD students in each department is 7-8 students / year.

P7. "FAN S. NOLI" UNIVERSITY OF KORCA (UNIKO), Faculty of Agriculture, ALBANIA

	Equipment	Estimated price (€)
1	**Insect net cages and small incubators** (for experimental vector studies, establishment of insect test colonies)	600
2	**Analytical balance (0,0001g)** (for weighing small amounts of salts and other compounds for molecular analyses)	3.000
3	**pH meter** (scientific instrument that measures the pH)	1.500
4	**Centrifuge** (for centrifugation of samples for molecular analyses)	3.000
5	**Incubator** (to grow and maintain microbiological or cell cultures)	700
6	**Liquid nitrogen container – GT 35** (container for storage and transport of biological materials)	1.200
7	**Thermocycler** (for DNA amplification and further molecular analyses)	10.000
8	**Gel electrophoresis** (for fast nucleic acid analysis in gels)	4.000
9	**Gel reader** (measurement of chemi-luminescence, fluorescence and DNA intensity with high resolution image capture accuracy)	6.500
10	**Microscope – Optic** (for observation of plant pathogens)	2.000
11	**Vortex** (used to mix small volumes of liquid for cell disruption or homogenization)	350
12	**Refrigerators, -20 & -80 freezer** (will be used to keep enzymes, DNA and different molecular and biochemical kits)	1.150
	TOTAL	34.000

RATIONALE

At the Faculty of Agriculture, University of Korce currently does not have a doctoral program in the field of plant health. It is planned to be set up as a joint program with the Agricultural University of Tirana. So setting up a good laboratory in this field would be a great help in the realization of doctoral student study topics. Additioanlly, it would be a very good help for the Bachelor.

At the University of Korca, in the plant health laboratories, there are some equipment for the identification of plant pathogens. Detection methods are based mainly on morphological rather than molecular techniques. So, there is no line of analysis of plant origin samples for various pathogens

and pests using RNA/DNA extraction and molecular detection methodologies. UNIKO needs equipment for conventional PCR analysis as well as DNA detection of plant parasites. The listed devices serve for RNA/DNA extraction from plant parasites and for futher DNA analysis and pathogen detection.

Insect net cages and **small incubators** are needed for experimental vector studies and the establishment of insect test colonies. The **analytical balance** is necessary for high precision weighing in the preparation of various extraction and calibration solutions. The **pH meter** will serve to measure the pH of buffer solutions for RNA/DNA extraction and manipulation. The centrifuge will be also used during the RNA/DNA extraction process. The **Incubator** will use to grow and maintain microbiological or cell cultures. The **liquid nitrogen container** will be used for the transport and storage of liquid nitrogen and for deep freezing plant tissues, pathogens etc. The **Thermocycler (PCR)** will be essential to multiply and analyze the DNA. The **electrophoresis gel apparatus** is essential for DNA analysis. The **Gel reader** will be used for the measurement of luminescence, fluorescence (green and red emission) and band intensity. The **microscope** will be essential for the observation of plant pathogens. The **Vortex** will be used to mix small volumes of liquid for cell disruption or homogenization. The **refrigerators, -20 and -80 freezer** will be used to keep enzymes, DNA and different molecular and biochemical kits.

All the equipment will be all used to train the PhD students in molecular diagnostics methodologies. The number of doctoral students is expected to be 4-5 students / year.

P8. UNIVERSITY OF SARAJEVO (UNSA), Faculty of Agriculture and Food Sciences, BOSNIA AND HERZEGOVINA

	Equipment	Estimated price (€)
1	**Nanodrop** (for the measurement of RNA or DNA concentration in samples)	9.800
2	**Nanodrop PC + softwear** (necessary supplement for Nanodrop)	1.000
3	**Ice maker machine** (for RNA isolations, RT PCR, cloning etc.)	3.220
4	**Orbital incubator shaker** (for cloning procedures, TA, plasmids)	4.700
5	**Fluorescence microscope** (for plant bacteria detection, as well as plant studies on GFP, chloroplast…)	5.100
6	**Insect net cages** (for experimental vector studies, establishment of insect test colonies)	1.000
7	**3D printer** (for educational purposes and creation of 3D pathway models, as well as teaching material for plant studies)	7.600
8	**3D scanner**	1.580
	TOTAL	**34.000 ***

*VAT exluded, exchange rate according to InforEuro (https://ec.europa.eu/budget/graphs/inforeuro.html)

RATIONALE

The list of equipment planned to be procured within the HarISA project is in accordance with the mid-term Strategy of the Faculty of Agriculture and Food Sciences, University of Sarajevo, especially the strategic direction of improving the quality of PhD studies through strengthening scientific research capacities. For the Faculty of the Institute of Plant Protection and Food Safety, this plan entails further strengthening of the molecular research sector as a significant backbone in the continuous development of the Institute. In addition, the Faculty emphasizes sustainability and environment protection.

A PhD, although offered by a University, is far more than just a University course covered by lectures. It is a focused research in a particular area aimed at offering new contribution to knowledge in the field. Therefore, the quality of a PhD program is highly dependent on research capacities of the Facility. Candidates choose their research area and select lectures that suit their field of interest expecting to gain adequate knowledge and skills necessary for the successful implementation of their focused research.

Since 2015, a decrease in interest for PhD studies at the Faculty of Agriculture and Food Sciences has been observed, which is mostly associated with the increase in costs due to lack of proper research facilities. Most PhD candidates had to search for other laboratories outside Bosnia and Herzegovina

to conduct their research activities, which led to an increase in costs, effort and prolonged graduation time. This problem is especially eminent in the field of plant health studies, particularly plant pathology, microbiology and agricultural entomology where science, art and profession overlap more than in any other discipline. These mentioned disciplines rely on diagnostic procedures, molecular methods and modern equipment to achieve adequate understanding of a plant pathogen or insect. It is necessary to mention that in most cases these research activities are not financed by a governmental organization but rather by the students themselves. Consequently, this also increases the fear of failure and puts a high toll on the academic motivation and the overall well-being of students. It is precisely for this reason that a lot of effort has been invested in the establishment of a new laboratory that would enable student training in modern molecular techniques while providing a positive learning environment.

The Faculty is also aware of the fact that science, more specifically biotechnology research laboratories have a significant environmental impact due to the enormous use of disposable plastics. Plastic is very convenient when it comes to risk mitigation of contaminations in a lab, but the dependence on it and the consumerism attitude is worrisome. Therefore, within the HarISA project the Faculty intends to set up a "green lab" initiative in order to reduce, recycle and reuse plastic and to mark a first step towards a more sustainable laboratory. This would be achieved through teaming up with the Student association of the Faculty that has already a well-functioning recycling system.

Detailed description of equipment:

Nanodrop with desk computer and adequate software

A Nanodrop is a state-of-the-art piece of equipment that enables the measurement of purity and concentration of nucleic acids, protein and more. It represents a spectrophotometer designed for measuring concentrations in sample volumes of 0.5 microliter by using an unique sample retention technology. This technology makes use of the surface retention of a detection platform on which the sample is placed directly, those creating a column between the optical fiber ends. Besides providing important analytical information, the Nanodrop also represents a sample saving device, since it overcomes the need for cuvettes and high sample amounts. To be fully functional it has to be connected to a desktop computer with installed software for data analysis of the measurements. The Nanodrop is an essential piece of equipment in molecular techniques, because it provides useful information on the concentration and quality of RNA or DNA isolated from different samples. This information is needed for further laboratory procedures like sequencing and cloning, where the success rate is highly dependent on the concentration and quality of the isolated nucleic acid.

The Faculty would incorporate the Nanodrop in teaching courses on molecular laboratory techniques, plant virology, fruit breeding and data analysis. Students would be trained to use the Nanodrop for different purposes as already mentioned above. Since the Faculty has a good collaboration with the Institute for Genetic Engineering and Biotechnology Sarajevo (INGEB) that has lately procured a sequencing machine for small genomes, it would be also possible to further extend the cooperation. Student could prepare and analyze their samples with the use of the Nanodrop at the Faculty and then conduct further analysis (e.g. sequencing) at INGEB. This would also mean that the list of beneficieries of the Nanodrop would increase significantly.

Orbital incubator shaker and ice maker machine

Many plant pathology laboratory techniques involve the cultivation of microorganisms on nutrient media. Depending on the research purpose and the microorganism, the cultivation has to be carried out under specific environmental conditions. This is especially the case in procedures involving plasmid and bacterial cell transformations (PCR cloning experiments for plant virology, bacteriology etc.) where the cultivation takes place in a flask with nutrient media under a specific temperature regime and shaking to ensure optimal cell growth. The orbital incubator shaker was designed especially for the purpose of optimal cultivation of cells and microorganisms. It ensures optimal cultivation conditions for every microorganism, since the temperature intervals and the shaking speed can be adjusted accordingly.

The plasmid transformation procedures involve a crucial step, named "heat shock", that is aimed at increasing the "competence" of bacterial cells and enable the entering of plasmid into the cells. This procedure, as the name suggests, consist of two steps where the samples are first kept on ice for 30 minutes and then subjected to heat shock on 42 °C. This is just a small example. There are many more procedures in plant pathology that rely on the use of ice and the ice maker machine is an essential piece of equipment for any laboratory working with the diagnosis of plant pests. Especially, while working with RNA viruses it is necessary to keep and conduct all research steps on ice to prevent RNA degradation.

Since one of the strategic directions of the Faculty is to establish a modern laboratory for molecular techniques, it is necessary to procure these two machines. Combined with the Nanodrop, students can be trained to carry out even the most difficult transformation procedures. This would also mean that it will no longer be necessary for students to reach out to other Institutions to conduct this kind of experiments. In the past, students had to go to other countries' Institution to firstly learn the procedure and then to carry it out on their samples.

Fluorescence microscope

Fluorescence microscopes represent optical instruments that use fluorescence and phosphorescence to study properties of microorganisms or plant cells. These instruments are mostly coupled with a digital camera to capture fluorescence microscopy images. This is a multidisciplinary device and it can be used in the study of plant pathogens infection processes, structure of bacteria, structure of plant cells as well as in studies of pollen grains and pollen tubes. The fluorescence microscope can be used for educational purposes, as well as research and pathogen detection procedures, what makes it extremely valuable. The main beneficiaries would be students that could finally gain insight into the field of fluorescence microscopy what gives them access to knowledge previously unknown. The Faculty owns a few educational light microscopes and stereomicroscopes that do not represent adequate tools for a PhD study program. Many departments at the Faculty, including microbiology, plant breeding, plant physiology and beekeeping would benefit from this procurement. The microscope can be easily incorporated in many teaching classes, even in master study programs, what could motivate more students to engage in PhD study programs. Additional, this procurement, together with the other equipment would help in building ties between grade levels.

Insect net cages

Insect net cages are mostly used for insect rearing and would represent a contribution to the Entomology department. This means that specific insects and their food plants would be held in cages for behavior and vector studies. Entomologists at the Faculty work persistently on the conservation and restoration of insect specimens and are putting large efforts in transferring their knowledge to students. Having living insects in a laboratory or class room opens new possibilities for learning and improves students understanding of the subject. It makes it possible to present information to students in a different way. A rearing insect cage is also an opportunity to involve students more actively in the teaching process.

3D Scanner and 3D Printer

The idea of the "Green lab" initiative evolves around the incorporation of 3D technology to complement the curriculum and to mark a first step towards sustainability in a laboratory at the Faculty.

3D printers present a cutting-edge technology that opens unlimited learning opportunities. Students elevate from passive consumers of information to active participants in the teaching process. This is achieved by engaging them in the process of 3D printing right from the start; designing a project and its execution. For many students that enroll in plant health courses it is sometimes difficult to fully understand a topic, especially when it comes to genetics, microbiology, plant physiology or even insect anatomy. There are many reasons for this, but the most prominent can be found in the abstract nature of some topics (e.g. spores of microscopic fungi, bacteria and virus structure) and different learning styles of students. To create a positive learning environment it is necessary to acknowledge different learning style preferences of students and to adapt adequate ways of presenting information. In a research conducted by Kharb et al. (2013) among first year medical students it was concluded that 61 % of students had multimodal VARK (Visual, Aural, Read, Kinesthetic) preferences and 39 % had unimodal learning preferences. Among the unimodal learning preferences, Kharb et al. (2013) identified kinesthetic as the most common preference, followed by visual, auditory and read and write. For this spatial-kinesthetic learners the most suitable way of presenting information is through practice, what can be efficiently and economically achieved by introduction of 3D printing in the classroom or laboratory.

This new technology would be used at the Faculty, at first, to design models of plant pathogenic microorganisms, their reproductive structures, their infection process and pathways, making them more visible and understandable for students. 3D printers are connected to a computer with suitable design software that allows creating sophisticated models and visualizing real-life subjects. Afterwards, the models are printed out by using different plastic materials. The benefits for students that would use this technology are countless. For example, they would largely improve their spatial reasoning skills, learn to solve real life problems and get a better understanding of the subject in matter.

Besides the educational benefits, the 3D scanning and printing technology would serve also a different purpose at the Faculty. Namely, it would help to create a more sustainable environment. As mentioned before, 3D printers use plastic as a source material in form of blocks or filaments. These can be made out of recycled plastic. The Faculty of Agriculture and Food Sciences University of

Sarajevo has together with the Students Association established a small recycling system. Bottle caps are collected at the Faculty and recycled into small planters by using specific machines. The Student Association acquired even an extruder machine that would allow creating plastic filaments that are suitable for 3D printers. Every laboratory has a high demand for different types of plastic consumables, ranging from tips to boxes of various sizes. With the procurement of a 3D scanner and printer and by using recycled plastic filaments it would be possible to achieve a more sustainable laboratory environment. This would also help in raising awareness regarding the excessive use of plastics. Additional ways of usage would be explored as well as the use of different types of plastic.

Beneficiaries and indicators

All listed equipment would be used by students enrolled in the PhD program of the Faculty of Agriculture and Food Sciences, as well as master students and young rsearchers. In average the number of enrolled PhD students is 6 per year. The Faculty also offers a master degree program in plant heath studies that on average enrolls 10 students per academic year. To close the gap between grade levels and to motivate students to pursue a PhD in plant health studies, some of the equipment would be put to use in complementing the curriculum in the master study program. Since most of the equipment is multidisciplinary, from this procurement would benefit staff and students of different departments. This means that the number of beneficiaries is not only limited to students of plant health studies and can exceed a total number of 20 per year. As already mentioned, the 3D scanner and printer would also be used by members of the Students Association of the Faculty that are actively involved in the recycling project.

As indicators of success, the following are identified:

- Number of PhD students that are using the equipment
- Number of courses that incorporate one or more pieces of the listed equipment in the teaching process
- Number of created 3D models for teaching purposes
- Number of staff members that use the equipment

In the first year after procurement, the equipment will complement the following teaching courses: Agricultural Entomology, Microbiology, Mycology, Plant Virology, Experimental Methods in Plant Health Studies and Molecular Methods in Fruit Breeding. The 3D scanner and printer will additionally be used in courses regarding marketing and product design. It is expected that the number of students that use the equipment, as well as the number of courses that incorporate it, will increase over time.

P9. UNIVERSITY OF MOSTAR (SVEMO) - Faculty of Agriculture and Food Technology, BOSNIA AND HERZEGOVINA

	Equipment	Estimated price (€)
1	**PCR Thermal cycler** (for DNA amplification and further molecular analyses)	4.800
2	**Equipment for gel electrophoresis** (for fast nucleic acid analysis with high resolution image capture accuracy	1.700
3	**Gel documentation equipment** (for the measurement of chemi-luminescence, fluorescence and intensity)	6.500
4	**Vortex – VWR** (used to mix small volumes of liquid for cell disruption or homogenization	500
5	**Autoclave** (to be used for sterilizing media and utensils with moist heat)	6.500
6	**Fluorescence microscope** (for plant bacteria detection, as well as plant studies on GFP, chloroplast…)	5.100
7	**Nozzle Tester S-monitor with integrated software for the sprayer inspection** (necessary for measuring the flow rate of nozzles on a sprayer)	3.000
8	**Desktop computer x 1** (installation and use of the software for the Nozzle Tester S-monitor)	900
9	**Educational microscope x 8** (to identify the causal agents of plant diseases)	3.100
10	**Insect preparation sets** (tools for mounting of specimens)	900
11	**Insect collecting equipment** (entomological nets, beating sheets, exhauster aspirators)	1.000
	TOTAL	34.000

*VAT exluded, exchange rate according to InforEuro (https://ec.europa.eu/budget/graphs/inforeuro.html)

RATIONALE

The list of equipment that needs to be purchased is in accordance with the plan for implementing PhD study program in area of plant health at Faculty of Agriculture and Food Technology University of Mostar. Plant protection courses (Entomology, Phytopatology, Phytopharmacy, Herbology) are studied in Bachelor studies of Agronomy. Since academic year 2018/19, the Master study program in Plant Protection was introduced. Faculty currently does not have a doctoral program in the field of plant health protection alone. But there are courses on Plant Protection as a part of Ecology and Plant Sciences programs.

The list of equipment was created based on the criteria of Faculties' needs and future plans. The aim is to improve our curricula with special attention on Entomology and Mycology. We are aiming to use

HarISA equipment budget in this direction. Our Faculty is small with lack of space and equipment in general so we are planning to purchase equipment useful not only to Plant Protection Department but to others as well.

Conventional PCR. One of the most important issues at the Faculty has been the lack of equipment for molecular research activities in the fields of plant pathology, entomology and related sciences. Using molecular methods for plant disease diagnosis provides diagnosticians with a number of advantages over more traditional methods. They can allow the identification of morphologically similar species, increasing the efficacy, accuracy and speed of plant disease pest diagnosis.

Autoclave is needed for sterilisation of nutrient (growth) media for microorganism's growth among other purposes like sterilisation of laboratory utensils and accessories. Sterilisation is mandatory for any laboratory in plant protection and specially diagnosis.

Nozzle Tester S-monitor. The nozzle tester is a device that can define the flow rate of all types of nozzles mounted on sprayers with an accuracy of 1%. The nozzle tester is a hand held tool aimed at a fast and accurate control of the performance and wear of nozzles. The software for the test stations will allow integrating all technical and administrative aspects of the inspection of sprayers following EN13790. This equipment is needed for the research part of PhD thesis which is part of HarISA project. The PhD candidate will be trained under the WP 3 – subgroup sustainable use of pesticides of Project. The **Desk computer** of certain performance is needed for the installation and use of the software as well.

Fluorescence and educational microscopes. A microscope is one of the most useful tools that a plant pathologist needs when trying to identify the causal agents of plant diseases. The use of microscopes and good practices are among the most important skills for beginner students in plant protection. The Faculty of Agriculture and Food Technology at University of Mostar does not have sufficient number of microscopes for student's everyday learning. So, we would like to purchase educational microscopes but also a fluorescence one. The fluorescence microscope can be used for educational purposes, as well as research and pathogen detection procedures, what makes it extremely valuable. The fluorescence microscope would be used in different fields, covering plant science, herbology, genetics and others.

Insect collecting equipment. A really large part of our research in last few years is directed to monitoring and determination of quarantine as well as economically important pests. So, it is our plan to keep upgrading the laboratory equipment towards this direction and concern the purchase of equipment for collecting and breeding insects to adult form (sweep nets, beating sheets, aspirators, breeding cages). In the light of pest determination we need also equipment and supplies for microscopy and slide preparations (tools for mounting of specimens).

The proposed equipment will be used in all existing study programs related to phytopathology, entomology, as well as pesticides and herbology. In order to deliver high-quality PhD programs and innovative science to the students, new technologies and equipment present an essential element. So, setting up a modern pest diagnostics' laboratory in the field of plant protection would be of great help in the realization of doctoral student study topics during the HarISA project. Laboratory will be used in the future for bachelor, master as well as PhD studies along with research purposes. The proposed equipment will be used by students in all existing study programs (approximately 250

students). In addition, the equipment we plan to buy through the HarISA project is of great importance to several young researchers currently employed at the Faculty.

P10. UNIVERSITY OF BELGRADE (UB), Faculty of Agriculture, SERBIA

	Equipment	Estimated price (€)
1	**LAMP apparatus** (rapid and on-site detection of plant pathogenic microorganisms)	8.500
2	**PCR UVP UV workstation** (preparation of PCR master mixes)	2.500
3	**Laboratory pesticide spraying chamber** (precise distribution of the pesticide solution)	9.200
4	**Ice producing machine** (for conducting biochemical and molecular methods at 4 ^{o}C	1.800
5	**Desktop Computers x 7** (to install software and programs used for image and statistical analysis)	3.500
6	**2 Stereo microscopes** (to study morphology and anatomy of insects, mites and small vertebrates)	2.000
7	**Camera for stereo microscope + Image analyzing software** (for visualization of pest anatomical details and their analysis)	3.000
8	**Camera for light microscope + Image analyzing software** (for visualization of pest anatomical details and their analysis)	2.500
9	**Digital drawing table A4** (line drawings of animals using digital technology for illustrations)	650
10	**Refrigerator with deep freezer** (to store research samples and biological material for molecular studies).	350
	TOTAL	34.000

RATIONALE

The list of equipment intended to be acquired by the Faculty of Agriculture, University of Belgrade through the Harisa project corresponds to the mission and goals of our Institution: implementation of high-quality academic study programs at all levels of study, development of relevant scientific research and implementation of the acquired knowledge and skills in the field of plant protection and plant health. Proposed equipment will be used in all existing PhD study programs of Phytomedicine such as phytopathology, entomology and agricultural zoology, as well as pesticides and weed science.

Currently, 30 students are enrolled in the PhD studies in the field of Phytomedicine at Faculty of Agriculture, University of Belgrade. In order to deliver high-quality PhD programs and innovative science to the students, new technologies and equipment present an essential element. Most of laboratories at Faculty of Agriculture, University of Belgrade are well equipped for specific fields of

research such as detection and identification of plant pathogenic microorganisms and pests, detection of pesticides resistance in harmful organisms and pesticides residues in plants and plant products. However, most of these laboratories lack certain pieces of equipment making it challenging to plan and carry out particular research programs. Therefore, PhD students are forced to fulfil parts of their PhD thesis in some other national or more often international institutions. As a consequence, expenses of PhD studies are increased along with prolonged duration of the PhD studies. Supplying these laboratories with the missing pieces of equipment would help to overcome this problem and enable them to become regional diagnostic hubs in the field of plant health and plant protection. It would also reinforce and improve the research capacity of these laboratories, expand laboratory and personnel field of expertise and bring innovation in competitive research areas for existing and future PhD students and young researchers.

Numerous molecular methods have been developed for the detection of plant pathogenic microorganisms, but none are truly applicable for on-site use in the field. Recently, a new molecular technology called **LAMP (loop-mediated isothermal amplification)** has been developed and revolutionized clinical diagnostics and gained attention for improving plant pathogen detection and disease diagnostics. LAMP has a number of essential advantages over PCR: it is portable, generally faster, more specific, simpler to learn and interpret, making it an ideal method to be used in PhD programs for rapid and on-site detection of plant pathogenic microorganisms. Among the diverse detection methods that are available today, LAMP can provide PhD students and researchers with reliable information on the pest infection status of a field/orchard/greenhouse and hence is a very promising new tool for sustainable crop protection. **PCR UVP UV workstation** is necessary in order to expand the molecular studies in the field of phytopathology. PhD students are constrained to make all master mixes in a laminar flow hood making it difficult to achieve their work assignment due to the overcrowded laminar hood during the week. Purchase of the PCR workstation would help to overcome this “bottleneck” in the laboratory and ensure that research studies are conducted without interruption.

The Laboratory of Pesticide Resistance and Harmful Organism’s response to pesticides was established recently in order to investigate harmful organisms (weeds, fungi, insects, mites etc.) interactions with pesticides and their resistance to them. As resistance is a huge problem of modern agriculture many PhD students are interested to work on a PhD thesis in this topic. Over the last few years, sophisticated equipment for investigation of resistance on biochemical, physiological and molecular level was acquired, but equipment for some important steps of study is still missing. Namely, for all pesticides resistance studies, the first step is application of pesticides to target organisms, which should be very precise and adequately distributed in small laboratory amounts in order to obtain satisfactory and reliable results. For that purpose, a **laboratory pesticide spraying chamber** is necessary to achieve fully equipped laboratory which could be national and regional centre for diagnosis of resistance to pesticides and training hub for enhancement of knowledge and competences in the field of pesticide resistance. So far, for pesticide application a sprayer for chromatography was used, which does not ensure a uniform and precise distribution of the pesticide solution and depends on the skill of the worker to distribute the required amount of solution per unit area. Consequently, there is a risk of false positive results because of inadequate application of pesticides. Therefore, the purchase of a Spraying chamber will ensure that this problem will be overcome. Also, an **Ice producing machine** is necessary in this laboratory because many steps in

biochemical and molecular methods have to be carried out at temperatures below 4 ^{o}C which could be achieved by keeping the samples in ice.

At the Laboratory of Entomology and Agricultural Zoology, PhD researches are focused on very small animals (insects, mites and nematodes). Apart from bare observing these objects, measurements and illustrations (photographs and drawings) are required for correct identifications and descriptions. **Desktop computers** supplied with corresponding operating system and imaging software has become basic equipment for this type of study. However, most of desktop computers at the Labroatory of Entomology and Agricultural Zoology are outdated and cannot support new imaging software and programs used for image processing. Therefore, students fail to meet high standards of study in the field of visualization of structural details and their measurements. Acquisition of new generation desktop computers would enable the PhD students to study morphology and anatomy of insects, mites and small vertebrates in a more accurate and meticulous way leading to increased quality of their PhD study. Desktop computers will also be used by the PhD students for statistical analysis of various morphological parameters within insect and mites originating from different populations and environments. **Microscopes with image analyzing accessories** - The use of stereo microscopes (magnifications up to 100 $\times$) is essential in the field of entomology and agricultural zoology. Camera and additional device (monitor) are needed for visualization of anatomical details and their analysis. Image analysing accessory package is needed to provide specific conditions for morphometric analysis. A quality **A4 format digital drawing table** is necessary for producing line drawings of animals using digital technology for illustrations. The majority of PhD thesis at the Laboratory of Entomology and Agricultural Zoology require numerous line drawings of animals. Traditional manual drawing technique, performed by a trained professional illustrator, is too laborious and time consuming, and is not available for PhD students. **Refrigerator with deep freezer** - This piece of equipment is necessary for PhD students to store their research samples. The samples of plant material and soil are voluminous and require adequate storing conditions. A deep freezer is needed for storing biological material for molecular studies.

At Faculty of Agriculture, University of Belgrade, a total of 22 teachers (Assistant, Associate and Full Professors) are involved in PhD studies in the field of Phytomedicine. Also, a total of 30 PhD students are currently enrolled in the PhD studies at the faculty in the field of Phytomedicine. All teachers and personnel involved in the PhD studies are already acquainted with handling and trained in the utilization of the proposed equipment. Therefore, all devices that would be purchased through the HarISA project could be employed directly in the PhD studies during the duration of the project. Also, the new equipment would increase the visibility and range of expertise of laboratories at Faculty of Agriculture, University of Belgrade, making them recognizable training hubs and regional centres for PhD studies in various fields of Phytomedicine and plant health. In the future, this would enable exchange of PhD students from other international and national universities dealing with the same or similar area of research. Additionally, adequately equipped laboratories would attract even more interest in PhD studies and raise the competitiveness of research in phytopathology, entomology and agricultural zoology, as well as pesticides and weed science.

P11. UNIVERSITY OF NOVI SAD (UNS), Faculty of Agriculture, SERBIA

	Equipment	Estimated price (€)
1	**Giga-8dd Basic 8 channel EPG recording system** (for live visualization and recording of plant penetration by insects with piercing mouthparts)	6.440
2	**Insect rearing chamber, lCH750L MEMMERT** (to rear insect colonies under controlled conditions)	16.255
3	**Ultra freezer 393l SWUF D 400** (to store biological research samples at -80 ®C)	10.000
4	**Insect rearing cages** (to rear insect colonies)	1.305
	TOTAL	34.000

RATIONALE

In order to deliver high-quality PhD programs and innovative science to the students, new technologies and equipment present an essential element. Most of laboratories at University of Novi Sad are well equipped for specific fields of research such as detection and identification of plant pathogenic microorganisms and pests in plants and plant products. However, most of these laboratories lack certain pieces of equipment making it challenging to plan and carry out particular research studies. Supplying these laboratories with the missing pieces of equipment would help to overcome this problem and would reinforce and improve the research capacity of these laboratories, expand laboratory and personnel field of expertise and bring innovation in competitive research areas for existing and future PhD students and young researchers.

EPG (Electrical Penetration Graph) recording system provides a live visualization and recording of plant penetration by insects with piercing mouthparts, such as homopterans and thrips. This can be of great interest to understanding of aphids and other sucking insects feeding behavior, especially for students that are in a process of education and gaining knowledge. This technique can be used in biological laboratories at Universities for studies on plant and insect physiology, insect-plant interactions, host plant resistance, pathogen transmission or insect (evolutionary) ecology. This shows insect activity live, not visible by other techniques.

Together with previously described equipment, students need for laboratory experiments **insect rearing chambers and cages** to have insect colonies available for teaching process. On the other side, rearing of insects (e.g. obstacles in colonies development in controlled conditions, food sources and similar) are of great help in practical work in entomological laboratories.

Ultra freezer is necessary for PhD students to store their research samples. The samples of plant material and pests are voluminous and require adequate storing conditions.

Proposed equipment will be used in the existing PhD study programs of Phytomedicine. Currently, 27 students are enrolled in the PhD studies in the field of Plant Protection at University of Novi Sad, Serbia.

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	Equipment	Estimated price (€)
1	**PCR Thermal Cycler** (for DNA amplification and further molecular analyses)	8.000
2	**Electrophoresis Unit** (for nucleic acid analysis in gels)	3.500
3	**Gel Documentation System** (for measurement of chemi-luminescence, fluorescence and DNA intensity with high resolution image capture)	3.800
4	**Growth chamber with adjustable temperature-light-humidity for pathogenicity tests** (to conduct pathogenicity tests and verify Koch postulates)	8.500
5	**Autoclave** (for sterilization of nutrient media and laboratory utensils)	4.500
6	**Stereo microscope** (for observation and determination of insects)	1.700
7	**Incubator**	4.000
	TOTAL	34.000

RATIONALE

The list of suggested equipment that needs to be purchased is in accordance with the plan for implementing PhD study program in area of plant health at Biotechnical Faculty of University of Montenegro (UoM). The plan foresees establishing the molecular research segment as a significant unit in educational work in plant protection.

One of the biggest issues of the PhD program at the Faculty has been the lack of equipment for molecular research activities in the fields of plant pathology, entomology and related sciences. In this regard, future PhD candidates will have to search for other laboratories to conduct their research activities. Molecular tools need to be more developed in the area of plant protection at the Faculty. The lack of this equipment makes students not to be motivated to enrol in a PhD study program since their knowledge will not be adequately upgraded as it could be in other much better equipped institutions. This is also the shortage in attraction of foreign students who could come to the Biotechnical Faculty for mobility. This is the strong reason why a lot of efforts should be invested in the establishment of a new laboratory that would enable student training in modern molecular techniques.

The idea behind the list of equipment that needs to be purchased during the HarISA project is to modernise the PhD studies and to enable the development of areas of plant pathology (with the focus on mycology and fungal resistance to fungicides) and entomology. The list of needed equipment is made in accordance with priorities. The priority number 1 is the purchase of essential equipment for molecular research such as the **PCR Thermal Cycler**. Item number 2, **Growth chamber** – is needed to train students in conducting Koch postulates and pathogenicity tests as necessary step in diagnosis of plant pathogens and growth of plants in controlled conditions for many

demonstration experiments. Item number 3 – **Autoclave** is the third priority for routine work on sterilization of nutrient media and small laboratory utensils: the laboratory at this stage has only small bench autoclave with extremely small capacity. Item number 4 – **Stereomicroscope** would be important for work in entomology for better observation and determination of insects. Item number 5 – **Incubator** would be used for additional purposes since incubators that faculty possess are not adequate.

Proposed equipment will be used in the existing PhD study program of Biotechnical Sciences. Currently, 5 students are enrolled in the PhD studies at the Biotechnical Faculty, University of Montenegro. The equipment is very important for the current PhD program at the Faculty but also for the foreseen PhD program regarding plant protection in the future.