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BREEDTECH
Empowering Agriculture

PROJECT REPORT ON

DELIVERABLE WP2: D2.2; D6

Report on development of training materials for capacity building training 2 for students by building capacity in plant breeding and biotechnology education and research through partnership program in africa, middle east and europe for agricultural transformation (BREEDTECH) project

Submitted by BREEDTECH Project team
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Executive Summary

Plant breeding and biotechnology play a critical role in addressing global food security and climate resilience challenges. There is a need to enhance expertise and research capacity in these fields, particularly in emerging countries where the majority of the population rely on agriculture. The Building Capacity in Plant Breeding and Biotechnology Education and Research through Partnership Program (BREEDTECH) responds to this need and aims to strengthen education and research in plant breeding and biotechnology in a collaborative approach across institutions in Africa, the Middle East, and Europe.

This report presents Deliverable 2.2, outlining the roadmap for developing training content and selecting students for two training workshops that will be delivered by Scuola Superiore Sant'Anna (SSSA) in Pisa, Italy, and the Institute of Field and Vegetable Crops (IFVCNS) in Novi Sad, Serbia. Participants will come from six institutions: Egerton University and Laikipia University (Kenya), Haramaya University and Oda Bultum University (Ethiopia), and An-Najah National University and Al-Quds University (Palestine).

The first workshop (May 5–9, 2025, at SSSA) will focus on genomics, laboratory techniques, and molecular data analysis, covering wet lab procedures such as DNA extraction, PCR, genotyping, and molecular marker analysis and the application of molecular biology in plant breeding. The second workshop (September 22–26, 2025, at IFVCNS) will emphasize classical and modern breeding approaches, including field-based phenotyping, crop trials, tissue culture, emasculation techniques, and hybridization methods. This training will integrate conventional and advanced breeding techniques to provide a comprehensive understanding of plant breeding methodologies. By leveraging the expertise of both institutions, BREEDTECH offers a holistic training experience, bridging laboratory research and field applications. These workshops will

equip participants with essential skills to contribute to crop improvement, agricultural research, and food security initiatives in their respective regions.

1.0 Introduction

Student exchange programs offer students with invaluable opportunities for personal, academic, and professional growth. They broaden perspectives, enhance language skills, and foster intercultural understanding, making participants more adaptable and globally aware. Furthermore, these programs can lead to lifelong connections and build a global network, increasing employability in a diverse and interconnected world. In the BREEDTECH project student training is an activity that aims to provide students from African and Palestinian universities with an opportunity to participate in training and practical visits to European partner universities and research centers. During this five-day program, students will have the opportunity to engage in hands-on learning experiences and build their research and practical skills in the field of plant breeding. This will be achieved through a combination of lectures, laboratory work, field visits, and interaction with experienced researchers and professionals from the European partner institutions. The goal of this activity is to provide students with a comprehensive understanding of the latest research trends and best practices in the field, as well as to foster international collaboration and knowledge exchange. By participating in this program, students will have the opportunity to expand their professional networks and gain practical skills that will help them advance their careers in the field of plant breeding.

This activity will be a valuable complementary activity to the capacity building of the staff. During these visits, students will be able to gain hands-on experience and deepen their knowledge in the field of plant breeding and biotechnology. This can help to complement the theoretical training they receive in their own institutions and give them

a more comprehensive understanding of the subject. To maximize the impact of this activity, each Palestinian and African HEI has carefully selected two students to participate, taking into account their academic backgrounds and professional goals. This has led to the designing of a a structured program for the visits that includes opportunities for the students to observe, participate in, and reflect on the practical aspects of plant breeding and biotechnology.

2.0 Development of students training materials

The main oucome of this activity is to develop the program of the courses, develop the structure of the lectures, identify the ideal dates and venues for hosting the training. This activity is precided by identifying the training gaps that exist within the partner institutions.

2.1 Training needs assesment

A needs assessment was conducted to identify skill gaps and capacity-building requirements among students African and Palestinian Higher Education Institutions (HEIs) in plant breeding and biotechnology. As part of this process, the training institutions requested each participating HEI to submit documents outlining their specific training needs. These submissions were systematically reviewed and analyzed to identify common themes and priority areas. Following this initial assessment, a consultative meeting was held to discuss how each of the two training institutions could contribute to the program. This meeting ensured that the training delivery leveraged the institutions' respective areas of expertise while avoiding duplication of content. Each institution's role was defined based on its strengths, ensuring that the program provided comprehensive and high-quality training tailored to the identified needs.

2.2 Profile of Target Groups

The training is designed for students aiming to enhance their expertise in plant breeding and biotechnology. The target group includes undergraduate (BSc), master's (MSc), and doctoral (PhD) students. The first training session at SSSA enrolled 14 participants (9 males and 5 females) from diverse academic backgrounds including Plant Production, Plant Breeding, Biotechnology, Agronomy and Plant Biotechnology. The participants of the second training session at IFVCNS have a similar background to the first session, with students from diverse academic levels. In addition to the fields covered in the first training session, the second session also includes participants from Crop Protection. The group consists of 3 females and 9 males, with 2 participants from each iof the HEI's.

2.3 Research areas of focus

The first training workshop, scheduled to take place at Scuola Superiore Sant'Anna (SSSA) in Pisa, Italy, will emphasize genomics, laboratory techniques, and molecular data analysis. Students will gain hands-on experience in wet lab procedures, learning techniques used in DNA extraction, PCR, and genotyping. The workshop will also cover data analysis using molecular markers and introduce participants to modern biotechnological tools, including genome wide association. study Additionally, students will have the opportunity to review the latest advancements in molecular breeding and explore how these techniques can be integrated into plant breeding programs.The second training workshop, to be held at the Institute of Field and Vegetable Crops (IFVCNS) in Novi Sad, Serbia, will focus on classical and modern breeding approaches, field-based phenotyping, and crop trials. Participants will engage in practical sessions covering tissue culture, emasculation techniques, and hybridization

methods. The workshop will provide exposure to both traditional breeding strategies and emerging innovations, ensuring students develop a well-rounded understanding of plant breeding methodologies. An excerpt from the schedules currently designed for the SSSA training and the IFVCNS training is outlined below. The program is subjected to adjustments where need arises.

3.0 The program of the courses and Structure of the lectures

3.1 First Student Training workshop Scuola Superiore Sant'Anna, Pisa (SSSA), Italy

The training will be held between 5th to 9th May, 2025. The training involve 12 student participants from Kenya, Ethiopia and Palestine and will incorporate a variety of training methods sucha as lectures, hands-on sessions and personal reading among others. The training will start with a tour the table and for the to participants to share their training expectations. During the hands-on sessions the participants will get the opportunity to download softwares accessible at SSSA this allow them to use the softwares even when the return back to their home istitutions. At the end of the training the students will give their feedback regarding the training and they will be issued with a certificate of participation.

Table 1: Student Training Schedule at SSSA

BREEDTECH project: 1st Student Training Workshop 5th to 9th May 2025. Venue: Aula 6, Main building, Scuola Superiore Sant'Anna Pisa, Italy TITLE: ADVANCED APPLICATIONS OF GENETICS AND GENOMIC TOOLS in CROP IMPROVEMENT			
Day	Time	Activity	Facilitator(s) and trainers
Monday 5th May 2025	9:00-9:30am	• Registration • Welcome, introductions of ISP/SSSA and the training team • Ice-breaker: "Tour the Table" – sharing student backgrounds and interests • Summarize the course content and week activities	Facilitator: Matteo Dell'Acqua • Registration • Institute of Plant Science (ISP) Director: Prof. Matteo Dell'Acqua
	9:30 – 10:30 am	Lecture 1 • Basic concepts in genetics; molecular aspects of DNA as genetic material	Mario Enrico Pè
	10:30-10:45 am	Group photo	
	10:45-11.00am	Coffee Break	
	11:00-12:30 pm	Lecture 2 • Genetics continued	Mario Enrico Pè
	12:30-1:00pm	Questions and Discussion	Mario Enrico Pè

	1:00 - 2.00pm	Lunch break	
	2.00-3.00pm	Lecture 3 • Molecular markers and genetic maps	Mario Enrico Pè
	3.00-4:00pm	Lecture 4 • Principles of genomic DNA extraction (keep in mind extraction will follow the day after) • PCR, and electrophoresis	Ettore Riccucci
	4:00-4:30pm	Lecture 5 • Laboratory safety	Afewerki Kiros Martina Sechi
End of day 1			
Tuesday 6th May 2025	9:00 -9:30 am	• Arrival at the lab • PPE, protocol distribution • Laboratory tour and instruction (safety)	Facilitator: Martina Sechi Ettore/Martina/Afi (3-4 students in each group)
	9:30-11:00am	• Hands-on practical: Genomic DNA extraction from plant tissue using Qiagen kit	Ettore/Martina/Racheal
	11:00-11:15am	Coffee break	
	11:15-1:00pm	PCR set up and run	Ettore/Martina/Racheal
	1:00pm-2:00pm	Lunch break	
	2:00-3:30pm	Set up gel electrophoresis	Ettore/Martina/Racheal
	3:30-4:30pm	Run DNA and PCR products	Ettore/Martina/Racheal
	4:30-5:00pm	Check gels under UV	Ettore/Martina/Racheal
End of day 2			

Wednesday 7th May 2025	9:00 -10: 30 am	Discuss DNA and PCR results and present the results	Facilitator: Svenja Mager Ettore/Martina/Racheal
	10:30-11:00am	Coffee Break	
	11:00am-13:00	Lecture 6 • Basic concepts in genomics • Structure of a plant genome (genes, TEs, repeats) • Transcriptomics	Svenja Mager
		• Sequencing tech: Illumina and ONT	Svenja
	1:00-2:00pm	Lunch break	
	2:00-3:30pm	Lecture 7 student seminars • Discussion: Applications, limitations, and advancements in sequencing platforms • Case study presentation	Svenja Mager Case study 1- Tobias Recha Case study 2 - Bedasa Mekkonen
	3:30-4:00pm	• Questions and Discussion	Afewerki Kiros
	4:00-4:30pm	Prepare computers for Thursdays hands on. • Software download: Tassel • Demo Dataset download	Ettore/Afewerki/Tobias
	End of day 3		
Thursday 8th May 2025	9:00 – 10:30am	Lecture 8 • Introduction to population genomics, allele/genotype frequencies, and evolution. • GWAS	Facilitator: Afewerki Kiros Matteo Dell'Acqua

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	10:30-11:00am	Coffee break	
	11:00-1:00pm	Data analysis • Hands-on practical: Using TASSEL for GWAS and data analysis.	Leonardo, Ettore, Afewerki
	1:00-2.00pm	Lunch break	
	2:00-4:00pm	Data analysis- continued	Leonardo, Ettore, Afewerki
	4:00-4:30pm	Discussion and wrap up	Leonardo Caproni
	5:30 - onwards	Dinner /Pizza / networking	
	End of day 4		
Friday 9th May 2025	9:00-10:00am	Lecture 9 • Framing GWAS and genomics in breeding pipelines.	Facilitator: Matteo Dell'Acqua Matteo Dell'Acqua
	10:00-10:30am	Coffee break	
	10:30-11:30pm	Lecture 10 • Introduction to genome editing tools (e.g., CRISPR/Cas9).	Leonardo Caproni
	11:30-12:30pm	Case study • Paper presentation on CRISPR use in crop improvement	Leonardo Caproni
	12:30-1:00pm	Questions and Discussion	Matteo, Leonardo, Afewerki, Ettore, Svenja
	1:00-2:00pm	Lunch break	
	2:00-3:00pm	Course wrap-up: Interactive group discussion, feedback, and takeaways	Matteo, Leonardo, Afewerki, Ettore, Svenja
	3:00-4:00pm	Assessment and certificate awards.	Matteo Dell'Acqua

End of day 5 and departure

3.2 Second Student Training Workshop at Institute of Field and Vegetable Crops, National Institute (IFVCNS), Serbia

This training is scheduled on 22nd to 26th September 2025 at IFCVS. The training will involve 12 student participants from Kenya, Ethiopia and Palestine and trainers will be expert in plant breeding and biotechnology from IFCVS. The course will focus on classical and modern approaches in crop breeding. Also, the training will capture aspects of tissue culture, field trials and data analysis. The train will be climaxed by a field trip to demonstrate the various research crops at IFCVS and seed production which is part of the commercial breeding.

Table 2: Student Training Schedule at IFCVS

Course name: Classical and modern approaches in crop breeding
Date: **22-26 September 2025**
Organizer: **IFVCNS**
Participants: **12 graduate students**, 2 from each partner from Kenya, Ethiopia and Palestine
Day 1
9.00-9.30 Introduction (Dr. Dragana Miladinović) and Tour de Table (All participants)
9.30-10.30 Pre-breeding and use of genetic resources (Dr. Sanja Mikić/Dr. Ana Marjanović Jeromela)
10.30-10.50 Questions and Discussion
10.50-11.20 Group Photo and Coffee Break
11.20-12.20 Line Breeding: Bulk, Pedigree, Backcross (Dr. Milan Mirosavljević/Dr. Jegor Miladinović)
12.20-12.40 Questions and Discussion
12.40-14.00 Lunch

14.00-15.00 Hybrid Breeding (Dr. Milan Jocković)
15.00-15.20 Questions and Discussion
15.20-16.20 Breeding for Stress Resistance (Dr. Sandra Cvejić)
16.20-16.40 Questions and Discussion
Day 2
9.00-10.00 Tissue Culture in Breeding (Dr. Ankica Kondić-Špika/Dr.Dragana Trkulja)
10.00-10.20 Questions and Discussion
10.20-10.50 Coffee Break
10.50-11.50 Molecular Breeding (Dr. Marina Ćeran/Dr. Aleksanda Radanović)
11.50-12.10 Questions and Discussion
12.10-13.30 Lunch
13.30-14.30 HTPP in Lab (Dr. Aleksandra Radanović)
14.30-14.50 Questions and Discussion
14.50-15.50 HTPP in Field Trials (Dr. Vuk Đorđević)
15.50-16.10 Questions and Discussion
Day 3
9.00-12.00 Field trip
Crop demonstration trials. Each crop field will be hosted by researchers from IFVCNS, who will give short introduction and then answer the questions and give explanations.
Pre-breeding – Sunflower wild species (Dr. Jelena Jocković)
Breeding – Rapeseed (Dr. Ana Marjanović Jeromela)
Breeding – Legume crops (Dr. Vuk Đorđević)
Breeding – Soybean (Dr. Jegor Miladinović)
Commercial breeding – Sunflower (Dr. Siniša Jocić)
Commercial breeding – Maize (Dr. Goran Bekavac)
12.00-13.30 Lunch
13.30-16.30 HTPP and Speed Breeding
Sunflower emasculation and pollination (Dr. Milan Jocković)
HTPP root phenotyping - Rhizotrons (Dr. Boško Dedić)
HTPP phenotyping – WinRHIZO (Dr. Aleksandra Radanović)

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Speed Breeding – Basics and Requirements (Dr. Vuk Đorđević/Dr. Marina Ćeran)
Day 4
9.00-12.00 DNA Extraction
DNA extraction from leaf tissue
Lab 1 (Dr. Dragana Trkulja)
Lab 2 (Dr. Marina Ćeran)
Lab 3 (Dr. Aleksandra Radanović)
12.00-13.30 Lunch
14.00-16.30 Gel Electrophoresis
Checking of DNA quality on gel
Lab 1 (Dr. Dragana Trkulja)
Lab 2 (Dr. Marina Ćeran)
Lab 3 (Dr. Aleksandra Radanović)
Day 5
9.00-10.00 Seed production, biology and quality (Dr. Vladimir Miklič)
10.00-10.20 Questions and Discussion
10.20-10.50 Coffee Break
10.50-11.50 Field Trials Data Analysis (Dr. Goran Bekavac)
11.50-12.10 Questions and Discussion
12.10-13.30 Lunch
13.30-14.30 Integrated Data Analysis (Dr. Vuk Đorđević)
14.30-14.50 Questions and Discussion
14.50-15.20 Closing Remarks and Certificate Awarding

3.3 Resource materials

The training for both workshops included a combination of lectures and practical sessions to provide participants with a comprehensive learning experience. The latest research findings were be incorporated to ensure that the content remains relevant, evidence-based, and aligned with current advancements in the field. All materials from

both trainings have been openly deposited on Figshare, an open-source and easily accessible platformal (DOI: **https://doi.org/10.6084/m9.figshare.30811823**), where they are permanently archived under an open-access license. In addition, the complete set of materials has been uploaded to the Teams platform hosted by Al-Quds University, Palestine, which serves as the shared learning and communication environment for all institutions involved in the project. This ensures immediate accessibility for all partners and facilitates cross-institutional use of the training content.

The uploaded materials include:

1.Training programmes, providing a detailed overview of daily activities, learning objectives, session topics, and practical components.

2. Lecture presentations covering all theoretical modules, including introductory concepts, methodological guidance, analytical workflows, and applied examples.

3.Laboratory and field protocols, outlining step-by-step procedures used during practical sessions; these are provided as stand-alone documents to facilitate replication and independent use.

4.Training materials and datasets, including all files used during hands-on exercises, enabling participants to repeat analyses, follow demonstrations, and further practice independently.

5.Peer-reviewed papers and reference articles, which formed the scientific foundation for lectures and practical activities. These documents provide additional background reading, methodological justification, and context, supporting deeper learning and encouraging further exploration by participants.

All resources are clearly organised, labelled, the user can readily navigate the content, understand the procedures, and apply the same methods in their own research or teaching environments.

The Training materials are open access and available on the BREEDTECH webpage. They are accessible on the links below

https://breedtech.edu.ps/training-for-student/