Co-funded by the European Union

Novel Biotechnological Solutions in Climate Change Mitigation

2024-1-EL01-KA220-HED-000251373

PILOT TRAINING REPORT

BIOSHIELD PILOT COURSES

1. General Information

Partner Institution	*University North*
Department/Faculty	*Department of Food Technology*
Country	*Croatia*
Work Package	*WP4 — Pilot Course*
Date of Report Submission	*01.07.2026.*
Pilot Training Dates	*Summer semester 2025/2026*
Responsible Person(s)	*Dunja Šamec*
Associated Partner(s) Involved	Herešin composting facility and Podravka
Target Number of Participants	*15*
Actual Number of Participants	*22*

2. Overview of the Pilot Training

Provide a concise narrative (max. 1-2 pages) describing how the pilot training was organised and delivered at your institution. This narrative should give readers who were not present a clear understanding of what took place. Please address the points below.

2.1 Organisation and Preparation

Describe how the pilot training was planned and organised (e.g., recruitment of students, coordination with associated partners/industry, scheduling, allocation of trainers/facilitators, use of project materials such as the curriculum, video tutorials and the student handbook).

The BIOSHIELD pilot training was organised at the Department of Food Technology, University North, during the summer semester of the 2025/2026 academic year. It combined theoretical learning, student-led laboratory projects, joint activities with the University of Maribor and visits to associated partners and industry, connecting the project curriculum with practical challenges in sustainable food production and climate resilience.

Participation was voluntary and based on students' personal interests. An announcement inviting students to participate was circulated through the student representative. The training was organised throughout the semester, combining lectures and discussions with laboratory activities and study visits. This approach accommodated different interests: some students were more engaged in the theoretical component, while others participated more extensively in experimental work.

Dunja Šamec coordinated the pilot training and delivered teaching sessions alongside guest lecturers. Laboratory activities were supervised and supported by Dunja Šamec, Barbara Medvedec and teaching assistant Iva Jurčević Šangut. The teaching team guided students in developing their ideas, planning experiments, carrying out laboratory work and interpreting their findings.

Students were introduced to the BIOSHIELD learning materials, including the higher education curriculum, video tutorials and the student handbook, *Biotech Student's Guide to Future Projections*. These resources provided a foundation for independent learning, discussions and the development of practical project ideas. The theoretical sessions addressed the five curriculum modules:

1. Resilience Through Food and Microbiome Innovations.
2. Sustainable Food Systems: Biotechnology and Renewable Resources for Clean Label Products.

3. From Micro to Macro: Soil Microbiome for Climate-Smart Farming.
4. Biotechnology for Carbon Capture and Utilization.
5. Plant-based Solutions in Climate Change Mitigation.

The topics included cultured meat, sustainable starter culture production, alternative proteins, food by-product valorisation, soil microbiomes, climate-smart agriculture, GIS applications, biological carbon sequestration, phytoremediation and plant in vitro cultures.

At the beginning of the piloting phase, on 3 March 2026, University North students visited the University of Maribor. They were introduced to the BIOSHIELD curriculum, exchanged experiences and ideas with Slovenian students, and jointly visited the university's Botanical Garden and the Meranovo winery. This activity established opportunities for collaboration and peer learning throughout the pilot.

A reciprocal visit took place on 5 May 2026, when University of Maribor students visited University North. Together with Croatian students, they attended lectures and collaborative learning activities on phytoremediation and GIS applications. The programme also included visits to the Herešin composting facility and Podravka, connecting the curriculum with practical examples of sustainable resource management and food production. These exchanges enabled students to discuss their ideas and explore biotechnology applications in different academic and industrial settings.

The laboratory component encouraged students to develop their own ideas and investigate them with support from the teaching team. Two main research themes were explored. The first focused on seed priming as a sustainable approach to improving crop resilience to climate-related abiotic stress. Students investigated whether priming treatments could alleviate salt stress in pepper (*Capsicum annuum* L. cv. Podravka), assessing germination and early seedling growth under saline conditions. The experiments included proline priming and exposure to 50 mM NaCl, enabling students to evaluate plant responses and the potential of priming to support crop establishment under stressful conditions.

The second theme addressed the valorisation of food industry by-products within a circular economy framework. Students measured bioactive components in horseradish and cabbage by-products, exploring their potential as sources of valuable compounds. This work connected laboratory analysis with discussions about resource efficiency, waste reduction and the development of value-added food ingredients.

Visits to associated partners and industry—including Podravka, the Herešin composting facility and the Vindija factory—complemented the university-based training. Together, these visits connected the learning activities with industrial production and organic waste management, giving students practical contexts for considering sustainability challenges and possible biotechnological solutions.

As part of the pilot training, students prepared posters presenting their experimental approaches and findings on two themes: seed priming as a sustainable method for alleviating salt stress in pepper, and the valorisation of horseradish and cabbage by-products as sources of bioactive compounds within a circular economy framework. They presented these posters at the BIOSHIELD biotechnology fair at 15th of May 2026., sharing their work with other students, academic staff and industry representatives. Results arising from the pilot were subsequently presented by participating students at two scientific conferences: the 21st Ružička Days "Today Science – Tomorrow Industry", held in Vukovar, Croatia, on 9–11 September 2026, and "Rethinking Plant Systems for the Future", held in Maribor, Slovenia, on 17–18 September 2026. These activities extended the learning experience beyond the classroom and laboratory, enabling students to participate in the wider academic community, discuss their findings with researchers and gain experience in scientific communication.

Overall, the pilot connected project materials, academic expertise, international collaboration, student initiative and industry experience, while allowing students to engage according to their interests and develop ideas through practical investigation.

2.2 Methodology and Learning Activities

Describe the methodology followed (e.g., flipped/blended learning, Design Thinking process; Empathize, Define, Ideate, Prototype, Test), and the specific learning activities implemented (lectures, workshops, hands-on laboratory work, group work, use of digital tools, interactions with industry representatives and academic experts).

The pilot training combined blended and flipped learning with a practical, problem-based approach guided by the Design Thinking process. Students were introduced to the BIOSHIELD curriculum, video tutorials and student handbook to support independent preparation, while face-to-face sessions focused on lectures, discussions, collaborative idea development and laboratory investigations. The Design Thinking stages were applied to the student projects: students explored challenges facing agricultural producers and the food industry (**Empathize**), identified specific problems related to crop sensitivity to salt stress and the underutilisation of food by-products (**Define**), proposed possible solutions through seed priming and by-product valorisation (**Ideate**), developed experimental procedures with guidance from the teaching team (**Prototype**), and conducted laboratory experiments and interpreted their findings (**Test**).

Learning activities included lectures by Dunja Šamec and guest academic experts, workshops and group discussions during exchanges with the University of Maribor, hands-on laboratory work, and the use of digital learning resources and GIS-related teaching activities. Visits to Podravka, the Herešin composting facility and Vindija provided opportunities to interact with industry representatives and relate theoretical concepts to practical production and resource-management challenges. Throughout the training, students were encouraged to connect scientific evidence with their own ideas and critically assess the potential and limitations of the solutions they investigated.

Scientific communication formed an additional component of the learning process. Working in two experimental groups, students prepared posters on seed priming for alleviating salt stress in pepper and the valorisation of horseradish and cabbage by-products within a circular economy framework. Presenting these posters at the BIOSHIELD biotechnology fair gave them opportunities to explain their methods and findings to different audiences and respond to questions. The learning experience was further extended through student presentations of pilot-related results at the 21st Ružička Days in Vukovar and the international conference “Rethinking Plant Systems for the Future” in Maribor. These activities connected experimental learning with scientific dissemination and enabled students to engage with the wider academic community.

2.3 Participant Profile

Describe the profile of participating students (year of study, field/programme, prior knowledge or experience, group composition/working groups formed).

The participants were third-year undergraduate students enrolled in the Food Technology programme at University North who had expressed an interest in the topics addressed by the BIOSHIELD pilot training. Although they had foundational knowledge of food technology and related sciences, their formal education had provided limited previous exposure to the specific biotechnology and climate-related topics covered during the pilot. All students attended the theoretical sessions together, while the experimental work was organised into two laboratory groups according to their interests. One group investigated seed priming as a sustainable approach to alleviating salt stress in pepper, while the other explored the reuse and valorisation of food industry by-products by analysing bioactive components in horseradish and cabbage by-products. At the end of the pilot, students prepared posters presenting their research topics, experimental approaches and findings, which they subsequently presented at the BIOSHIELD biotechnology fair.

2.4 Additional Organisational Information

Include any other relevant organisational information (e.g., facilities/laboratories used, role of associated partners, deviations from the planned methodology and the reasons for them, support provided to students).

The pilot training used the teaching facilities and laboratories of the Department of Food Technology at University North. Laboratory facilities supported the two student research themes: seed priming experiments with pepper under salt stress and the analysis of bioactive components in horseradish and cabbage by-products. Students received guidance from Dunja Šamec, Barbara Medvedec and Iva Jurčević Šangut in planning experiments, using laboratory equipment, following laboratory procedures and interpreting their results. Additional support was provided in preparing scientific posters and communicating their findings at the BIOSHIELD biotechnology fair and scientific conferences.

Associated partners and industry contributed by hosting study visits and providing practical contexts for the topics explored during the training. Visits to Podravka, the Herešin composting facility and Vindija connected university-based learning with food production, resource management and sustainability challenges. Collaboration with the University of Maribor also supported student exchanges and access to complementary academic expertise.

Associated partners also participated in the BIOSHIELD biotechnology fair, where they interacted with students and provided feedback on their posters, research findings and proposed ideas. These discussions helped students consider the practical relevance and potential applications of their work from an industry perspective.

The organisation of the pilot allowed different levels of engagement according to students' interests. The theoretical sessions were attended jointly, while laboratory work was conducted in two thematic groups. This flexible arrangement enabled students to explore their preferred topics in greater depth while receiving supervision and access to the BIOSHIELD learning materials.

3. Pilot Training Indicators

The table below shows the quantitative results of the pilot training implemented at your institution. These indicators correspond to the quantitative (QN) indicators for WP4-O4 defined in the project application.

Indicator	Reported Value
Number of students participating in the pilot training	22
Number of students completing the satisfaction survey	13
Number of working groups formed	2
Number of research ideas and/or prototypes developed by the groups	2
Number of students successfully completing the pilot training	20
Number of students receiving certificates	20
Overall attendance rate	95%
Completion rate	91%
Number of academicians confirming effectiveness of course delivery methodology	5
Number of industry representatives confirming effectiveness of course delivery methodology	7
Number of student video testimonials collected	2

4. Satisfaction Survey Results

The table below reports the aggregated results of the post-training satisfaction survey administered to pilot participants, using a five-point Likert scale (1 = Strongly Disagree, 2= Disagree, 3= Neither Agree Nor Disagree, 4= Agree, 5 = Strongly Agree).

No	Survey Statement (5-point Likert Scale: 1 = Strongly Disagree, 5 = Strongly Agree)	1	2	3	4	5	4+5
1	I am highly satisfied with the overall quality and delivery of the BIOSHIELD training program.	0%	0%	0%	8%	92%	100%
2	The program effectively improved my transversal skills, such as teamwork, communication, and creative problem-solving.	0%	0%	0%	8%	92%	100%
3	I feel that my research skills in biotechnology (particularly related to climate change mitigation) have significantly improved.	0%	0%	0%	0%	100%	100%
4	I feel better prepared to enter the labour market as a result of this training.	0%	0%	0%	15%	85%	100%
5	The animated video tutorials effectively helped me understand the key concepts and prepare for hands-on activities.	0%	0%	0%	8%	92%	100%
6	The Design Thinking process enhanced my ability to generate innovative solutions to industrial challenges.	0%	0%	0%	15%	85%	100%
7	The “Biotech Student’s Guide to Future Projections” handbook provided valuable guidance on biotechnology applications and entrepreneurship.	0%	0%	0%	0%	100%	100%
8	The use of digital tools and interactive technologies enhanced my learning experience.	0%	0%	0%	15%	85%	100%
9	Hands-on laboratory activities were essential for testing and refining our biotechnology research ideas.	0%	0%	0%	8%	92%	100%
10	My team successfully developed a functional prototype or research project concept during the pilot training.	0%	0%	0%	15%	85%	100%
11	Interactions with industry representatives and academic experts helped me better understand real-world industrial challenges.	0%	0%	0%	15%	85%	100%
12	I intend to pursue a career in the biotechnology industry.	0%	0%	0%	8%	92%	100%
13	I have a strong intention to establish or join a biotechnology startup in the future.	0%	8%	8%	31%	53%	84%

5. Analysis of Survey Results

This section interprets the survey findings reported in Section 4 and discuss the pilot training's contribution to the project's objectives. Please address the following points.

5.1 Overall Participant Satisfaction

A total of 13 students completed the post-training satisfaction survey. The post-training survey indicated very high satisfaction with the BIOSHIELD pilot training at University North. All respondents positively evaluated the overall quality and delivery of the programme, with 92% strongly agreeing and 8% agreeing with the relevant statement. No neutral or negative responses were recorded for survey items 1–12. This consistent pattern suggests that participants valued the combination of theoretical learning, laboratory investigations, digital resources and interactions with academic experts and industry representatives.

The findings also indicate that the training was relevant to students with limited previous exposure to the biotechnology and climate-related topics addressed. Opportunities to develop their own research ideas and communicate their findings provided a practical context for engaging with the curriculum.

5.2 Strengths and Weakneses

A key strength of the pilot was the connection between theoretical content and student-led experimental work. Students investigated two practical challenges: alleviating salt stress in pepper through seed priming and valorising horseradish and cabbage by-products. The importance of laboratory activities was strongly endorsed, with 92% strongly agreeing and 8% agreeing that these activities were essential for testing and refining their research ideas.

The learning resources were another strength. All respondents strongly agreed that the student handbook provided valuable guidance, while 92% strongly agreed that the animated video tutorials helped them understand key concepts and prepare for practical activities. Exchanges with the University of Maribor, industry visits and feedback from associated partners at the biotechnology fair further connected learning with academic and industrial practice. Poster preparation and conference participation extended the experience into scientific communication.

The survey did not identify substantial dissatisfaction. However, entrepreneurial intentions were less uniform than other responses: 84% agreed or strongly agreed that they intended to establish or join a biotechnology startup, while 8% were neutral and 8% disagreed. This variation may reflect different career preferences and suggests an opportunity for more targeted entrepreneurship support. Students also participated in laboratory work to different extents, making individual practical learning experiences less uniform. Finally, the uniformly positive post-training responses provide limited information about specific difficulties or objectively measured learning gains.

5.3 Learning Outcomes

This section discusses evidence of improved research/transversal skills, employability perceptions, and career/entrepreneurship intentions in line with the survey items 2, 3, 4, 12, 13.

The survey provides strong evidence of perceived improvement in research and transversal skills. All respondents strongly agreed that their biotechnology research skills, particularly in relation to climate change mitigation, had improved. In addition, 92% strongly agreed and 8% agreed that the training strengthened teamwork, communication and creative problem-solving.

The activities implemented provide practical examples consistent with these perceptions. Students developed research questions, planned and conducted experiments, interpreted findings and worked collaboratively in two thematic groups. Preparing posters and presenting results at the biotechnology fair and scientific conferences provided opportunities to practise scientific communication and discuss their work with audiences beyond their immediate teaching team.

Employability perceptions were also positive: 85% strongly agreed and 15% agreed that the training had better prepared them to enter the labour market. All respondents expressed an intention to pursue a biotechnology career, with 92% strongly agreeing and 8% agreeing. Entrepreneurial intentions were positive but more varied,

with 84% agreeing or strongly agreeing that they intended to establish or join a biotechnology startup. These findings indicate increased perceived readiness and strong career interest, although the post-training survey alone cannot establish changes from baseline or predict subsequent employment and entrepreneurial activity.

5.4 Achievement of Project Objectives

Relate the results to the WP4-O4 objectives and expected results defined in the project application (e.g., effectiveness of course delivery methodology, prototypes/research ideas developed, certification, evidence for the biotechnology curriculum and video tutorials/handbook effectiveness).

The pilot findings support the WP4-O4 objectives concerning effective course delivery, the development of biotechnology research ideas and the evaluation of project learning resources. The combination of blended and flipped learning, Design Thinking, laboratory investigations and external engagement was positively assessed by participants. All respondents agreed or strongly agreed that Design Thinking enhanced their ability to generate innovative solutions and that digital tools supported their learning experience.

Two student research projects were implemented: seed priming to investigate the alleviation of salt stress in pepper, and the analysis of bioactive components in horseradish and cabbage by-products for potential valorisation. These projects constitute concrete research outputs from the pilot. All respondents agreed or strongly agreed that their teams had developed a functional prototype or research project concept; in the University North pilot, the documented outputs were experimental research projects and associated scientific posters.

The survey also provides positive evidence for the perceived effectiveness of the curriculum's supporting resources. All respondents positively evaluated the animated video tutorials, and all strongly endorsed the student handbook. Together with the successful implementation of curriculum-related activities, these findings support the suitability of the educational package for undergraduate food technology students.

Industry visits, associated partner feedback, university exchanges and student presentations contributed to the objective of connecting higher education with practical challenges and the wider academic community. Achievement of the certification component should be documented separately through records of certificates issued and the completion requirements applied.

5.5 Recommendations for Improvement

Future editions should retain the combination of theoretical learning, student-led laboratory work, digital resources and engagement with industry and academic experts. The positive feedback supports continued use of the BIOSHIELD video tutorials and student handbook, with clear links between preparatory materials and subsequent classroom or laboratory tasks.

As participants had limited previous exposure to several topics, a short introductory session and an initial knowledge assessment could help identify learning needs and tailor the training. Clear group roles and a shared minimum set of practical tasks could also ensure that all students gain experience in experimental planning, laboratory work, data interpretation and scientific communication while retaining flexibility to pursue their interests.

Entrepreneurship activities could be strengthened through practical workshops on identifying potential users, assessing feasibility and developing a basic business model. Feedback from industry representatives and startup practitioners could help students explore entrepreneurial pathways alongside research and other biotechnology careers.

Evaluation could be improved by combining pre- and post-training assessments with structured assessment of student projects and open-ended feedback. This would provide clearer evidence of learning gains and reveal difficulties that are not visible in the highly positive satisfaction ratings. Follow-up with participants could also help assess whether the training contributes to subsequent research involvement, further study or biotechnology-related employment.

6. Annexes

Please list and attach any supporting documentation referenced in this report.

Annex	Description	Uploaded (Y/N)
Annex 1	List of participating students	Y
Annex 2	Certificates issued (sample)	Y
Annex 3	Raw satisfaction survey data (Google Forms/Excel Sheet)	Y
Annex 4	Photographic documentation / activity evidence	Y
Annex 5	Student video testimonials (.mp4 or video file reference)	Y
Annex 6	Description(s) of research ideas / prototypes developed (Student Presentations)	Y
Annex 7	Other supporting documents (if applicable)	Y