ΙΔΡΥΜΑ ΚΡΑΤΙΚΩΝ ΥΠΟΤΡΟΦΙΩΝ IKY

EUROPEAN UNION

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# BIOSHIELD

# WORKSHOP REPORT

# WORKSHOP OBJECTIVES

The local-level workshop on Biotechnology Responses to Global Climate Change was successfully conducted with active participation from academicians, industry representatives, and students. It provided a platform for discussion and brainstorming on the role of biotechnology in addressing the challenges posed by climate change.

## Overview

The workshop aimed to:

- Specify the effects of global climate change and the increasing number of disasters threatening biological life on Earth, particularly their impact on agricultural product yields.
- Clarify the areas in which industrial and agricultural biotechnology have provided solutions so far and assess their effectiveness on a global scale.
- Identify future research directions and potential industrial and agricultural solutions or remediation strategies that can be developed through biotechnology.
- Contribute to innovation in higher education in biotechnology by enhancing student upskilling through curriculum development.
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# PROGRAMME FLOW

01 **Opening**

Welcome and presentation of the workshop objectives

02 **Session 1**

Overview of Climate Change and Its Global Impact - Climate Change and Disasters' Effects on Agricultural Productivity

03 **Session 2**

Current Biotechnology Applications in Climate Change and Climate Change-Oriented Disaster Mitigation

04 **Session 3**

Promising Research Areas in Biotechnology and Role of Biotechnology in Disaster Resilience

05 **Session 4**

Discussion for Regional Variations in Climate Change Effects - Case Studies - Experiences

06 **Evaluation**

Participants'' Opinions on Workshop Organization

07 **Closing**

Participants'' Opinions on Workshop Organization

# DATA COLLECTION METHOD

Data Collection Process included document preparation for workshops, questionnaire preparation, stakeholder communication, workshop facilitation, quality evaluation survey design, and implementation.

## Participant Profiles

The workshop was attended by:

Professors from the Department of Molecular Biology and Genetics, who provided academic insights into the latest research in climate-resilient biotechnology.

Industry Representatives:

Mr. Bezirgiannidis from BIOSMART Milk Solutions, who shared expertise on biotechnological advancements in the dairy industry.

Dr. Pergantas from BioApplications, who contributed knowledge on applied biotechnology for environmental and industrial solutions.

PhD and postdoctoral students, who engaged in discussions on emerging biotech research and its future directions.

## Workshop Materials

All partners contributed to the development workshop organization materials, presentations, and resources.

## Know-how Exchange

Participants exchanged their know-how on climate change, the resulting disasters, its effects on agriculture, current biotechnological applications, and emerging research areas. Workshop questions guided participants to share their know-how, creative ideas, and proposed solutions.

## Workshop Outcomes

Case studies and recommendations were generated during the workshops.

# Data Analysis

Data analysis includes demographic information about participants, themes derived from their responses to the questions, session highlights, and quality evaluation results.

## Participant Profiles

| Participant Profiles | Academician | Sector | Student |
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| Number / Percentage | 8/50% | 2/13% | 6/37% |

## Participant Age

| Age Range | 26-35 | 36-45 | 46+ |
|---|---|---|---|
| Number / Percentage | 4/24% | 6/38% | 6/38% |

## Gender

| Gender | Female | Male |
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| Number / Percentage | 9/56% | 7/44% |

# Data Analysis

## Session 1

| Questions of Session 1 | Themes | Sub-themes | Excerpts of participants |
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| **Q1**<br>**What specific skills and knowledge gaps are there in current biotechnology education to combat climate change?** | **1. The Role of Biotechnology in Climate Change Mitigation**<br>**2. Gaps in Current Biotechnology Education**<br>**3. Essential Knowledge and Skills for Students**<br>**4. Bridging the Gap Between Academia and Industry**<br>**5. Interdisciplinary Approach to Biotechnology Education**<br>**6. Curriculum Development and** | 1. Biotechnology can help combat climate change by enhancing agricultural resilience, leveraging genetic engineering and synthetic biology, and utilizing microorganisms for carbon sequestration and soil health.<br>2. Existing curricula lack structured climate change education, with knowledge scattered | <u>**Key Gaps in Biotechnology Education**</u><br><br>**Lack of Structured Climate Change Education**<br><br>**Professor Papageorgiou:** *"One major gap is that we don't have a structured course dedicated to climate change within our biotechnology curriculum. There are scattered references in some modules, but no targeted training on mitigation strategies."*<br><br>Currently, climate change-related topics are integrated into various lectures within the Department of Molecular Biology & Genetics at Democritus University of Thrace, rather than being offered as a standalone course. This limits students' ability to develop a comprehensive understanding of climate-focused biotechnology.<br><br>**Limited Practical Applications & Industry Exposure**<br><br>**Mr. Bezirgiannidis:** *"From an industry perspective, I see that graduates often lack experience in applied research. They need* |
| **Q2**<br>**What knowledge and skills should** | | | |

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| **the students acquire?** | **Implementation Strategies** | across courses and insufficient integration of climate science and policy studies.<br>3. Students need expertise in climate science, genetic engineering, microbiome research, computational biology, and problem-solving methodologies to effectively address climate change challenges<br>4. To enhance employability, biotechnology education must include practical training, industry collaborations, and real-world | *greater exposure to field-based studies and the real-world implementation of biotechnological solutions. In business, we need professionals who can bridge the gap between academic research and commercial application".*<br><br>Students often lack hands-on experience in genetic engineering, synthetic biology, and climate-specific biotechnology applications. There is a significant need for internships, fieldwork, and industry collaborations to help them gain real-world skills.<br><br>**Insufficient Interdisciplinary Learning**<br><br>**Dr. Pergantas:** *" Another critical gap is the understanding of cross-disciplinary approaches. Addressing climate change requires collaboration across biotechnology, environmental science, and data analytic".*<br><br>Climate change solutions involve multiple disciplines, yet biotechnology students rarely receive formal training in environmental science, computational biology, or policy studies. An interdisciplinary approach is essential to equip them with the relevant skills.<br><br>**Deficiency in Data Science & Computational Biology**<br><br>**Professor Papageorgiou:** *"We need better integration of computational biology and machine learning. Climate modeling,* |

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| | | applications of biotechnological innovations5. A well-rounded curriculum should integrate biotechnology with environmental science, data science, policy, regulation, and entrepreneurial skills to prepare students for diverse challenges.<br>6. Developing a structured biotechnology and climate change program requires interdisciplinary learning, pilot testing, and international collaboration for maximum impact. | *genetic adaptation studies, and predictive analytics are becoming essential tools, yet many of our students graduate without strong computational skills".*<br><br>Bioinformatics, climate modeling, and predictive analytics are becoming essential tools in modern biotechnology. However, these areas remain underrepresented in current curricula.<br><br>**Proposed Improvements in Biotechnology Education**<br><br>**A. Core Knowledge Areas**<br><br>• **Climate Science & Biotechnology** – A stronger foundation in climate science, its impact on agriculture, and biotechnological mitigation strategies.<br>• **Genetic Engineering & Synthetic Biology** – Hands-on training in biotechnological solutions, such as genetically modified crops and microbiome engineering.<br><br>**B. Hands-on & Industry Exposure**<br><br>• **Applied Research & Industrial Training** – Internships, field-based studies, and industry-academic collaborations to bridge the gap between research and commercial applications.<br><br>**C. Data Science & Computational Skills** |

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| | | | • **Integration of Bioinformatics & AI** – Training in climate modeling, genetic adaptation studies, and AI-driven agricultural biotechnology.<br><br>**D. Interdisciplinary & Soft Skills**<br><br>• **Policy & Science Communication** – Courses on policy literacy, regulatory frameworks, and effective science communication.<br>• **Entrepreneurship & Commercialization** – Business strategies for translating biotech research into market-ready solutions.<br>• **Problem-Solving & Design Thinking** – Structured methodologies for approaching climate-related challenges innovatively.<br><br>**Summary of Key Takeaways**<br><br>**Key Gaps in Biotechnology Education:**<br><br>1. **No dedicated climate change course** – Current programs only include scattered references instead of structured training.<br>**2. Limited practical applications** – Students lack hands-on exposure to real-world biotech solutions for climate mitigation.<br>3. **Weak interdisciplinary collaboration** – Biotechnology students need exposure to environmental science, data analytics, and policy studies. |

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| | | | 4. **Deficiency in data science skills** – Graduates lack training in bioinformatics, AI, and climate modeling.<br>5. **Insufficient science communication & policy awareness** – Greater emphasis is needed on effectively communicating scientific findings.<br><br>**Proposed Improvements:**<br><br>1. **Develop a dedicated climate change & biotechnology module** to provide structured learning.<br>2. **Enhance practical applications & industry partnerships** to offer real-world experience.<br>**3. Strengthen computational biology training, including AI and predictive analytics.**<br>**4. Promote interdisciplinary collaboration with environmental science and policy experts.**<br>5. **Improve science communication training to prepare students for effective engagement with policymakers and the public.** |

# Data Analysis

## Session 1 – HIGHLIGHTS

**Key Gaps in Biotechnology Education**

1- At the Department of Molecular Biology & Genetics at Democritus University of Thrace, climate change mitigation issues are integrated into various lectures, rather than being taught as a separate course.

**Improved Knowledge Areas for Education**

1-Interdisciplinary knowledge.

2-Climate-specific biotechnology skills.

3-Data-driven skills, including bioinformatics.

4-Soft skills and policy awareness.

# Data Analysis

## Session 2

| Questions of Session 2 | Themes | Sub-themes | Excerpts of participants |
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| **Q1**<br>**What are the key gaps in biotechnology research for climate change mitigation?**<br><br>**Q2**<br>**Which technologies for analyzing climate data are currently most useful in biotechnology and agriculture, and how can they be integrated** | **1. Gaps in Biotechnology Research for Climate Change Mitigation.**<br>**2. Technologies for Analyzing Climate Data in Biotechnology and Agriculture.**<br>**3. Indicators for Assessing Biotechnological Impact on Greenhouse Gas Emissions.** | 1. Lack of structured courses in biotechnology for climate change mitigation; fragmented knowledge across disciplines.<br>2. Limited collaboration between biotechnology, environmental science, and data science.<br>3. Need for field-based studies to evaluate biotech solutions for carbon sequestration and methane reduction.<br>4. Slow regulatory adaptation and | **Key Gaps in Biotechnology Education & Research**<br><br>**Lack of Structured Learning in Climate-Focused Biotechnology**<br><br>**Professor Papageorgiou:** *"One of the biggest gaps is the lack of dedicated coursework and structured learning in biotechnology focused on climate change mitigation. Students receive fragmented knowledge through scattered references across different courses".*<br><br>**Professor Grigoriou:** *"We discuss adaptation strategies in evolutionary biology, but we don't cover biotechnology-based mitigation approaches. There is little emphasis on conservation techniques, sustainable bioengineering, or biotech-driven climate solutions".*<br><br>Current programs lack dedicated courses on climate-focused biotechnology. Biotech-driven climate solutions, |

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| **into educational programs?** | | scepticism towards biotech solutions.<br>5. Integration of climate data technologies into agricultural and biotech programs through hands-on learning and partnerships. | such as conservation techniques, microbial inoculants, and bioengineering approaches, are underrepresented<br><br>**Limited Interdisciplinary Collaboration**<br><br>**Professor Papageorgiou:** *" Climate change research requires input from multiple fields—genetics, data science, environmental science, and engineering. However, our programs do not facilitate such cross-disciplinary learning".*<br><br>Climate change solutions require collaboration between biotechnology, environmental science, engineering, and data analytics. Academic silos hinder students from gaining the cross-disciplinary expertise essential for tackling climate challenges<br><br>**Insufficient Real-World Application Studies**<br><br>**Professor Papageorgiou:** *"We discuss using microorganisms to enhance soil carbon sequestration, but there is minimal field research evaluating its long-term impact".*<br><br>**Mr. Bezirgiannidis:** *"Biotech solutions for reducing methane emissions from livestock are underexplored. While modifying the microbiome of ruminants can reduce* |
| **Q3**<br>**What are the most appropriate indicators for assessing the impact of biotechnological solutions on reducing greenhouse gas emissions in agriculture?** | | | |

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| | | | *greenhouse gas emissions, there is insufficient funding and research focus on scaling up these solutions".*<br><br>There is a gap between academic research and field studies, leading to a lack of data on real-world effectiveness. Research on biotechnological approaches for soil carbon sequestration and methane emission reduction requires expansion and increased funding.<br><br>**Regulatory and Public Perception Challenges**<br><br>**Mr. Tegopoulos:** *"There is a disconnect between biotech advancements and policymaking. Stringent regulations in some regions slow down innovation, while a lack of standardized frameworks in others creates uncertainty for investors and researchers".*<br><br>Regulatory barriers hinder the widespread adoption of biotech-driven climate solutions. Public scepticism toward biotechnology, particularly genetic modification, poses a challenge to adoption. Science communication strategies are needed to build public trust and improve understanding of biotech's role in sustainability.<br><br>**<u>Emerging Technologies in Climate-Smart Biotechnology</u>**<br><br>**Remote Sensing & Climate Data Technologies** |

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| | | | **Dr. Pergantas:** *"Satellite imagery and remote sensing help monitor crop health, soil moisture, and climate patterns in real-time. Machine learning models can analyze historical climate data to predict future conditions".*<br><br>Remote sensing and GIS enable climate impact assessments and precision agriculture. Machine learning and AI enhance climate modelling and predictive analytics for agricultural biotechnology.<br><br>**DNA Sequencing & Bioinformatics**<br><br>**Professor Grigoriou:** *" DNA sequencing and bioinformatics are becoming increasingly relevant. By studying how different plant species respond to changing climates, we can develop more resilient crops".*<br><br>Genomic analysis of climate-adaptive species can enhance crop resilience. Bioinformatics tools enable targeted genetic engineering for climate mitigation.<br><br>**Hands-On Data Science Integration**<br><br>**Dr. Pergantas:** *"One approach is to introduce hands-on training sessions where students work with real climate datasets and machine learning models. This will prepare them to apply these technologies to real-world scenarios".* |

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| | | | Students need direct exposure to data-driven climate science, integrating biotechnology with environmental and computational fields. Cross-departmental collaboration (biology, computer science, and environmental science) can bridge knowledge gaps.<br><br>**<u>Measuring the Impact of Biotechnological Climate Solutions</u>**<br><br>**Environmental Indicators**<br><br>**Mr. Bezirgiannidis:** *"One important metric is methane emissions from livestock. Monitoring how biotechnology reduces these emissions—such as through modified animal feed or microbiome engineering—can be a key indicator".*<br><br>**Professor Papageorgiou:** *"Carbon sequestration in agricultural soils is another key factor. The effectiveness of bioengineered crops or microbial inoculants in increasing soil carbon storage should be measured over time".*<br><br>**Dr. Pergantas:** *"Remote sensing and satellite data can track soil carbon changes, while direct gas measurement technologies can assess methane and nitrous oxide levels".*<br><br>**Key Metrics for Evaluating Biotech Climate Solutions:** |

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| | | | ❖ Methane emission reduction from biotech-modified animal feed and microbiome engineering.<br>❖ Soil carbon sequestration through bioengineered crops and microbial inoculants.<br>❖ Nitrogen-use efficiency of biotech crops reducing synthetic fertilizer reliance.<br><br>**Socio-Economic & Policy Indicators**<br><br>**Professor Grigoriou:** *"Adoption rates of biotechnological solutions by farmers can serve as an indirect, but powerful indicator. If biotech-based approaches are widely adopted, it suggests that they are not only effective but also economically viable".*<br><br>Adoption rates of biotech solutions by farmers indicate real-world feasibility. Consumer demand for sustainable biotech-driven products reflects market acceptance. Regulatory adaptability & policy support determine the speed of biotechnological integration in climate action.<br><br>**<u>Proposed Improvements in Biotechnology Education & Research</u>** |

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| | | | **A. Core Knowledge Areas**<br><br>• **Dedicated Climate Biotechnology Courses** – Structured learning in biotech-driven mitigation strategies.<br>• **Biotech Solutions for Conservation & Sustainability** – Incorporating sustainable bioengineering, soil carbon sequestration, and microbial climate solutions.<br><br>**B. Interdisciplinary Collaboration & Practical Training**<br><br>• **Cross-Disciplinary Learning** – Expanding coursework to include genetics, environmental science, data science, and policy studies.<br>• **Industry-Academia Partnerships** – Real-world research opportunities with biotech companies and agricultural institutions.<br><br>**C. Integration of Emerging Technologies**<br><br>• **Remote Sensing & AI Applications** – Training students in GIS, climate modeling, and machine learning for biotech solutions. |

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| | | | • **Bioinformatics & DNA Sequencing** – Enhancing genetic resilience research and climate adaptation strategies.<br><br>**D. Regulatory & Public Engagement Strategies**<br><br>• **Science Communication Training** – Equipping students with skills to engage policymakers and the public in biotech sustainability solutions.<br>• **Policy & Market Research** – Encouraging biotechnology policy literacy for effective climate action integration.<br><br><u>**Summary of Key Takeaways**</u><br><br>**Key Gaps in Biotechnology Education & Research:**<br><br>1. **Lack of structured coursework** on climate-focused biotechnology.<br>2. **Limited interdisciplinary collaboration** in biotech, environmental science, and data science.<br>3. **Insufficient research on real-world applications** of biotech-driven mitigation strategies.<br>4. **Regulatory & public perception barriers** limiting biotech adoption.<br><br>**Emerging Technologies for Climate-Smart Biotechnology:** |

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| | | | 1. **Remote sensing & GIS** for climate monitoring.<br>2. **AI-driven climate modeling & predictive analytics.**<br>3. **DNA sequencing & bioinformatics** for resilient crop development.<br><br>**Measuring Biotech's Climate Impact:**<br><br>1. **Methane emission reduction** through microbiome engineering.<br>2. **Carbon sequestration in agricultural soils** using bioengineered crops.<br>3. **Market adoption rates** as an indicator of biotech feasibility. |

# Data Analysis

## Session 2 – HIGHLIGHTS

**Gaps in Current Research and Applications**

1-Collaboration between biotechnologists, climate modelers, policy makers, and economists remains weak.

2-Inadequate focus on climate-driven applications.

3-Research gaps related to ecological risks and public acceptance.

4-Barriers to the adoption of biotechnological innovations.

**Strategic Educational Alignment**

1-Incorporating tools like bioinformatics, GIS, AI, and climate simulation models.

2-Cross-disciplinary curriculum.

3-Comparative studies with real-world agricultural application.

# Data Analysis

## Session 3

| **Questions of Session 3** | **Themes** | **Sub-themes** | **Excerpts of participants** |
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| **Q1**<br>**What are the key industry demands for biotech professionals in this field?** | **1. Industry Demands for Biotech Professionals.**<br>**2. Interdisciplinary Approaches in Biotech Education.**<br>**3. Emerging Biotech Fields for Climate Adaptation.**<br>**4. Infrastructural Needs for Biotech Learning.**<br>**5. Digital Skills for Climate-Related Biotech Applications.** | 1.Technical Skills.<br>2. Data analytics and bioinformatics.<br>3. Genome editing (CRISPR) and bioprocess engineering.<br>4. Integration of molecular biology, environmental science, and machine learning.<br>5. Understanding global environmental regulations and compliance.<br>5. Addressing public scepticism about biotechnology in agriculture. | <u>**Key Gaps in Biotechnology Education & Workforce Readiness**</u><br><br>**Need for Strong Analytical & Data-Processing Skills**<br><br>**Dr. Pergantas:** *"One of the main industry demands is strong analytical and data-processing skills. Employers seek professionals who can interpret complex biological and environmental data to develop biotech solutions".*<br><br>Students must be trained in data analysis, bioinformatics, and climate modeling to work with large datasets and optimize biotechnological interventions. AI-driven analytics and machine learning are becoming essential in biotech research and precision agriculture.<br><br>**Lack of Interdisciplinary Knowledge & Technical Training**<br><br>**Professor Grigoriou:** *"Companies value interdisciplinary knowledge—molecular biology, environmental science,* |
| **Q2**<br>**How can we integrate interdisciplinary approaches, such as systems thinking and ecological economics, into biotech education for climate** | | | |

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| **adaptation and mitigation?** | | 6. Evaluating biotech solutions within economic and environmental contexts. | *and machine learning are becoming increasingly important".*<br><br>**Professor Papageorgiou:** *"Expertise in genome editing technologies like CRISPR is crucial, especially for developing climate-resilient crops and microorganisms that improve soil health. Another key skill is familiarity with bioprocess engineering to scale up lab-based innovations into commercially viable products".*<br><br>Students need cross-disciplinary training in molecular biology, environmental sciences, and computational technologies. Genome editing (CRISPR), synthetic biology, and microbial biofertilizers are critical for sustainable agriculture and climate adaptation.<br><br>**Regulatory & Science Communication Gaps**<br><br>**Dr. Pergantas:** *"There is a growing demand for biotech professionals who can work in regulatory affairs. As biotech solutions become more prominent, companies need experts who understand global environmental regulations and compliance requirements".*<br><br>**Mr. Tegopoulos:** *"There's a disconnect between biotech advancements and policymaking. Stringent regulations in* |
| **Q3**<br>**Which emerging biotech fields (e.g., synthetic biology, CRISPR-based crop editing, microbial biofertilizers) hold the most promise for climate adaptation and resilience, and how can these be integrated into the curriculum?** | | | |
| **Q4**<br>**What infrastructural needs (lab equipment, digital resources, field stations) must be** | | | |

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| **addressed to support hands-on learning in biotech relevant to climate challenges?** | | | *some regions slow down innovation, while a lack of standardized frameworks in others creates uncertainty for investors and researchers".*<br><br>Regulatory literacy is essential for biotech professionals navigating global environmental policies. Effective science communication is also critical for building public trust and promoting the adoption of biotechnology-based climate solutions.<br><br>**<u>Educational Innovations for Climate-Smart Biotechnology</u>**<br><br>**Project-Based Learning for Climate Adaptation**<br><br>**Professor Kedraka:** *"Introducing design thinking into the curriculum will help students analyze biotech solutions as part of a complex network—including supply chains, consumer acceptance, and environmental impact".*<br><br>**Dr. Pergantas:** *"One way to incorporate this is by introducing project-based learning. For example, students could work in interdisciplinary teams to design climate-resilient biotech products while assessing the economic and ecological trade-offs".*<br><br>Interdisciplinary, real-world projects will enhance students' ability to develop viable biotech solutions. Case |
| **Q4<br>What specific skills related to digital tools (e.g., bioinformatics, climate modeling) should be<br>included in the biotechnology curriculum to prepare students for climate-related challenges?** | | | |

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| | | | studies on circular bioeconomy models can improve understanding of sustainable biotechnology.<br><br>**Integration of Ecological Economics & Policy Simulations**<br><br>**Professor Papageorgiou:** *"We should have students simulate policy decision-making by role-playing as policymakers, biotech developers, and environmental advocates debating the approval of biotech innovations".*<br><br>Case studies and simulations will help students understand the economic feasibility and regulatory challenges of biotech solutions. Collaborations with industry professionals can provide valuable insights into market dynamics.<br><br>**<u>Emerging Technologies for Climate-Smart Biotechnology</u>**<br><br>**Remote Sensing & AI for Climate Monitoring**<br><br>**Dr. Pergantas:** *"Satellite imagery and remote sensing help monitor crop health, soil moisture, and climate patterns in real time. Machine learning models can analyze historical climate data to predict future conditions".*<br><br>Remote sensing and GIS enable precision agriculture and climate impact assessment. Machine learning and |

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| | | | predictive modelling can optimize biotech applications for climate resilience.<br><br>**CRISPR & Synthetic Biology for Climate Resilience**<br><br>**Professor Papageorgiou:** *"CRISPR-based crop editing is one of the most revolutionary tools for climate adaptation. We can develop crops that are more drought-resistant, pest-resistant or even capable of capturing more carbon"*.<br><br>**Professor Grigoriou:** *"Synthetic biology allows us to engineer microbes for carbon sequestration, bioremediation, or nitrogen fixation—reducing reliance on chemical fertilizers"*.<br><br>CRISPR and synthetic biology offer biotech-driven solutions for drought-resistant crops, microbial biofertilizers, and bioremediation strategies. Microbial engineering supports sustainable agriculture by reducing greenhouse gas emissions and improving soil health.<br><br>**Bioinformatics & AI for Climate Impact Assessment**<br><br>**Dr. Pergantas:** *"We should introduce data-driven approaches—teaching students how to use AI and machine learning to predict the effectiveness of biotech interventions in different climate scenarios"*. |

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| | | | Bioinformatics tools can analyze microbial genomes, model genetic modifications, and simulate environmental impacts. AI-based climate modeling can improve biotech-driven carbon sequestration and precision agriculture strategies.<br><br>**<u>Infrastructure Needs for Climate Biotech Research & Training</u>**<br><br>**Advanced Molecular Biology Labs**<br><br>**Professor Papageorgiou:** *"We need state-of-the-art molecular biology labs for CRISPR-based gene editing, synthetic biology, and microbial biofertilizer research".*<br><br>Key lab equipment: NGS (Next-Generation Sequencing) machines, PCR systems, and bioreactors for microbial cultivation.<br><br>**Climate-Controlled Growth Chambers**<br><br>**Professor Papageorgiou:** *"We need climate-controlled growth chambers to test the resilience of genetically modified crops under simulated climate conditions—drought, high temperatures, or increased $CO_2$ levels".* |

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| | | | Growth chambers allow students to conduct real-world adaptation experiments, bridging theory and practice.<br><br>**Field Stations & Industry Partnerships**<br><br>**Dr, Pergantas:** *"Field stations are as important as lab spaces. Students should test biotech solutions outside controlled lab settings".*<br><br>Collaboration with farms and agritech companies enables real-world testing of bioengineered plants and microbial fertilizers.<br><br>**Digital Infrastructure for AI & Bioinformatics**<br><br>**Dr. Pergantas:** *"Students need cloud-based platforms, where they can model genetic modifications, simulate ecological impacts, and analyze large datasets on climate patterns".*<br><br>Key tools: High-performance computing (HPC) for biotech simulations, GIS for crop monitoring, and drone-based remote sensing.<br><br>**<u>Key Curriculum Enhancements for Climate Biotech Education</u>** |

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| | | | 1. **Dedicated Courses** – A new Biotechnology for Climate Resilience course covering CRISPR, synthetic biology, and microbial biofertilizers.<br>2. **Hands-on Training** – Labs on gene editing, microbial cultivation, and climate impact modeling.<br>3. **Interdisciplinary Projects** – Collaboration across biotech, environmental science, and agriculture.<br>4. **Industry Partnerships** – Capstone projects with biotech startups and sustainability-driven companies.<br>5. **Data Science Integration** – AI-based climate modeling for biotech applications.<br>6. **Science Communication & Policy Training** – Preparing students to engage with regulators, industry, and the public.<br>7. **Ecological Economics & Market Analysis** – Case studies and simulations on biotech cost-benefit analysis and policy decision-making.<br><br>**<u>Summary of Key Takeaways</u>**<br><br>**Key Gaps in Biotechnology Education & Research:**<br><br>• Lack of structured climate-focused courses in biotechnology.<br>• Insufficient interdisciplinary collaboration between biotech, environmental science, and data analytics. |

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| | | | • Regulatory & public perception challenges slowing biotech adoption.<br>• Limited hands-on experience in applying biotech solutions in real-world agricultural and industrial settings.<br><br>**Emerging Technologies for Climate-Smart Biotechnology:**<br><br>• Remote sensing, GIS, and AI for climate monitoring and precision agriculture.<br>• CRISPR & synthetic biology for climate-resilient crops and microbial biofertilizers.<br>• Bioinformatics & AI-driven climate modelling for predicting biotech solutions' impact.<br><br>**Essential Infrastructure & Curriculum Needs:**<br><br>• Advanced molecular biology labs & climate-controlled growth chambers for hands-on research.<br>• Field testing stations & industry collaborations for applied biotech solutions.<br>• Digital tools (AI, cloud computing) for bioinformatics and predictive modeling. |

# Data Analysis

## Session 3 – HIGHLIGHTS

1-Integrating biotechnology with environmental science.

2-Advanced skills in gene-editing technologies, expertise in bioinformatics.

3-Focus on scalable & innovative solutions.

4-Genomic & ecosystem analysis, predictive modelling, GIS expertise (track and interpret geographic and ecological changes.

## Session 4

| Questions of Session 4 | Themes | Sub-themes | Excerpts of participants |
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| **Q1**<br>**How will the curriculum align with EU policies like the European Green Deal and Sustainable Development Goals (SDGs)?**<br><br>**Q2**<br>**How can universities and industry work together to develop interdisciplinary programs that combine biotechnology, climate science, and policy**<br><br>**Q3** | **1. Aligning Biotech Curriculum with EU Policies & SDGs**<br>**2. Strengthening University-Industry Collaboration in Biotech**<br>**3. Enhancing Research-to-Industry Transfer in Biotech**<br>**4. Public Perception & Ethical Considerations in Biotech** | 1. Climate-smart agriculture and sustainable biotech solutions.<br>2. Training in EU policies (Farm to Fork Strategy, Biodiversity Strategy).<br>3. Combining molecular biology, climate science, and EU policy knowledge<br>4. Using climate. modelling to optimize biotech deployment.<br>5. Environmental safety: Conducting rigorous risk assessments.<br>6. Creating transparent and participatory biotech regulation processes. | <u>**Key Gaps in Biotechnology Education & Workforce Readiness**</u><br><br>**Aligning Biotech Education with the European Green Deal & SDGs**<br><br>**Professor Papageorgiou:** *"The European Green Deal aims for a climate-neutral Europe by 2050, focusing on sustainable agriculture, circular economy, and biodiversity protection. Our biotech curriculum must reflect this by integrating climate-smart agriculture, bio-based alternatives, and conservation biotechnology".*<br><br>**Professor Grigoriou:** *"The SDGs, especially Goal 13 (Climate Action), Goal 15 (Life on Land), and Goal 2 (Zero Hunger), emphasize sustainable food production and biodiversity conservation. By introducing synthetic biology for carbon sequestration, CRISPR for climate-resilient crops, and microbial biofertilizers, we align biotech education with these sustainability goals".*<br><br>Students must be trained in policy frameworks, such as the European Green Deal, Farm to Fork Strategy, and biodiversity regulations to develop market-ready biotech solutions. Biotech applications in sustainable food production must be emphasized, including synthetic |

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| **How can we improve the transfer of research findings in biotechnology to industrial practice for more effective climate change mitigation? What are your suggestions, best practices?** | | | biology, CRISPR-edited crops, and microbial biofertilizers for climate resilience.<br><br>**Limited Industry-Driven Applied Training**<br><br>**Professor Papageorgiou:** *"One major gap is that universities focus on theoretical knowledge, while industries require applied skills. Many biotech graduates lack exposure to real-world environmental and policy challenges".*<br><br>**Dr. Pergantas:** *"From an industry standpoint, biotech innovations must meet EU sustainability standards and green economy regulations. If students lack training in EU regulatory frameworks, they may struggle to develop market-ready solutions".*<br><br>Practical training in life cycle assessment (LCA), carbon footprint analysis, and regulatory compliance is needed for biotech applications. Industry-driven case studies, internships, and joint research projects should be integrated into biotech education.<br><br>**<u>Strengthening University-Industry Collaboration for Climate Biotech</u>**<br><br>**Joint Research Centers & Industry Partnerships** |
| **Q4**<br>**How can we ensure the scalability and economic feasibility of biotechnological solutions for small-scale farmers? How can we scale-up biotechnological research/results from micro to** | | | |

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| **macro level? How can we better align biotechnology research with regional and global policy frameworks for climate change?** | | | **Professor Papageorgiou:** *"We should create joint research centers, where Universities and companies co-develop climate-smart biotech solutions".*<br><br>**Professor Kourkoutas:** *"To summarize, university-industry collaboration can be strengthened through:*<br><br>*1. **Joint Research Centers** – Universities and biotech companies co-develop climate-smart solutions.*<br>*2. **Industry-Led Courses & Workshops** – Professionals provide real-world biotech training.*<br>*3. **Internship & Fellowship Programs** – Students should gain hands-on experience in industry and policy.*<br>*4. **Data-Driven Collaboration** – Industries provide climate data for academic research and modeling.*<br>*5. **Innovation Challenges** – Students propose biotech solutions for climate resilience".*<br><br>**Bridging Research and Commercialization**<br><br>**Professor Papageorgiou:** *"One key barrier is the lack of structured collaboration between academia and industry. Researchers focus on scientific discovery, while industries prioritize market viability."*<br><br>**Dr. Pergantas:** *"From an industry standpoint, many research outputs lack scalability and regulatory compliance. Universities should integrate product* |
| **Q5**<br>**What role does public perception and acceptance of biotechnology play in its implementation for climate change mitigation? What are the potential ethical concerns related to the use of advanced biotechnological tools in addressing climate challenges, and** | | | |

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| **how can they be addressed?** | | | *development, regulatory training, and commercialization strategies into biotech research."*<br><br>Industry-funded PhDs and PostDocs should focus on corporate-driven climate mitigation projects. Pilot-scale production facilities within Universities can help test biotech innovations before industry adoption. Technology transfer offices should actively connect researchers with biotech firms to patent and commercialize biotech solutions.<br><br>**<u>Integrating Climate-Smart Biotechnology into Education</u>**<br><br>**Dedicated Courses & Practical Training**<br><br>**Professor Papageorgiou:** *"We should introduce a dedicated course on Biotechnology for Climate Resilience, covering CRISPR applications, synthetic biology, and microbial solutions".*<br><br>**<u>Key Curriculum Enhancements</u>:**<br><br>1. **Climate-Smart Biotech Courses** – Covering CRISPR crops, microbial biofertilizers, and conservation strategies.<br>2. **Hands-on Training – Labs** on gene editing, microbial cultivation, and climate impact modeling.<br>3. **Industry Partnerships** – Capstone projects with biotech startups and sustainability-driven companies. |

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| | | | 4. **EU Policy & Regulatory Education** – Training in Farm to Fork, circular economy, and green certification processes.<br>5. **Life Cycle & Carbon Impact Assessment** – Teaching students to measure biotech solutions' environmental sustainability.<br><br>**Interdisciplinary Learning & Industry Exposure**<br><br>**Professor Kedraka:** *"Introducing design thinking into the curriculum will help students analyze biotech solutions within economic, regulatory, and environmental systems".*<br><br>**Dr. Pergantas:** *"One way to incorporate this is through project-based learning, where students design climate-resilient biotech products and assess their economic and ecological trade-offs".*<br><br>Case studies and simulations will help students understand biotech sustainability, economic feasibility, and regulatory challenges. Guest lectures from industry professionals will provide real-world biotech application insights.<br><br>**Scaling Biotech Innovations & Addressing Barriers**<br><br>**Open-Source Biotech & Accessibility**<br><br>**Professor Kourkoutas:** *"One of the biggest barriers to biotech adoption by small-scale farmers is the cost and lack of accessibility. We need open-source biotech models* |

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| | | | *that allow farmers to access genetically improved seeds and biofertilizers without excessive costs".*<br><br>Public-private partnerships and microfinance initiatives can improve biotech accessibility. Digital tools—such as AI-driven climate modeling and big data analytics—can help scale biotech solutions by identifying optimal deployment regions.<br><br>**Aligning Biotech Research with Climate Policy**<br><br>**Dr. Pergantas:** *"We should integrate EU policies like the Green Deal and Farm to Fork Strategy into biotech research programs".*<br><br>Ensuring compliance with EU Green Deal, SDGs, and global sustainability frameworks is critical. Early engagement with policymakers can streamline regulatory approvals for biotech innovations.<br><br>**<u>Public Perception, Ethics, & Governance of Climate Biotech</u>**<br><br>**Overcoming Public Resistance & Building Trust**<br><br>**Dr. Nelios:** *"Many biotech solutions face resistance due to misinformation, distrust in science, and regulatory uncertainty".*<br><br>**Mr. Tegopoulos:** *"Public resistance is often fueled by lack of transparency and poor communication. Many* |

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| | | | *communities view biotech as a corporate-driven initiative rather than a science-based tool for sustainability".*<br><br>**Strategies to Improve Public Perception & Acceptance:**<br><br>1. **Science Communication** – Fact-based outreach explaining biotech's climate benefits.<br>2. **Community Engagement** – Inclusive discussions with farmers, consumers, and policymakers.<br>3. **Regulatory Transparency** – Open-access research and transparent decision-making.<br><br>**Addressing Ethical Concerns in Climate Biotechnology**<br><br>**Professor Grigoriou:** *"One major ethical issue is biological equity—who controls and benefits from biotech solutions? If large biotech firms patent drought-resistant seeds or microbial fertilizers, small-scale farmers may struggle to afford them".*<br><br>**Dr. Pergantas:** *"Introducing GMOs or engineered microbes into the environment could have unpredictable effects on biodiversity. We need rigorous environmental risk assessments and adaptive management strategies."*<br><br>**Key Ethical Considerations:**<br><br>1. **Biological Equity** – Open-source biotech models to ensure accessibility.<br>2. **Environmental Safety** – Thorough risk assessments before deploying biotech solutions. |

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| | | | 3. **Biosecurity & Governance** – Strict global standards for synthetic biology applications.<br>4. **Public Consent & Trust** – Democratic oversight of biotech development and deployment.<br><br>**<u>Summary of Key Takeaways</u>**<br><br>**Key Curriculum & Research Enhancements:**<br><br>1. **Climate-Smart Biotech Training** – CRISPR crops, bio-based materials, and microbial biofertilizers.<br>2. **EU Policy & Sustainability Metrics** – Teaching students compliance with EU Green Deal & Farm to Fork.<br>3. **University-Industry Collaboration** – Joint research centers, industry-funded PhDs, and internship programs.<br>4. **Open-Access & Scalable Biotech** – Affordable solutions tailored to regional needs.<br>5. **Public Engagement & Ethical Considerations** – Science communication, biological equity, and environmental governance. |

# Data Analysis

## Session 4 – HIGHLIGHTS

**Curriculum Design for Climate Mitigation and Policy Alignment**

1-European Green Deal and Sustainable Development Goals (SDGs) Integration.

2-Provide education on EU regulations.

**Strengthening Collaboration Between Academia, Industry, and Policymakers**

2-Collaborative curriculum design.

3-Workshops and policy forums.

4-Academia should create biotech-focused incubators to scale solutions targeting environmental challenges.

5-Design protocols to prevent ecological disruptions.

**Public Perception and Ethical Considerations**

1-Awareness campaigns.

# Quality Evaluation

| Profession | Academician | Student | Industry representative | | |
|---|---|---|---|---|---|
| Q1 | 50% | 37% | 13% | | |
| Questions | Strongly Disagree | Disagree | Undecided | Agree | Strongly Agree |
| Q2 | | | | | 9 |
| Q3 | | | | 1 | 8 |
| Q4 | | | | 3 | 6 |
| Q5 | | | | 3 | 6 |
| Q6 | | | | | 9 |
| Q7 | | | | 1 | 8 |

# COMMENTS ON THE QUALITY EVALUATION

The participant distribution for the workshop was as follows: 50% of the participants were academicians, 37% were students (PhD and post-doctoral), and 13% were sector representatives.

- **100%** of the participants **strongly agreed** that the workshop was well-organized.
- **88.9%** of the participants **strongly agreed**, and **11.1% agreed**, that the discussions and shared information on the effects of climate change on agricultural product yields were valuable.
- **66.7%** of the participants **strongly agreed**, and **33.3% agreed**, that the discussions and information shared during the workshops on evaluating industrial and agricultural biotechnology solutions for climate change and disaster mitigation were valuable.
- **66.7%** of the participants **strongly agreed**, and **33.3% agreed**, that the discussions and shared information on future research areas and industrial solutions to climate change challenges in biotechnology were valuable.
- **100%** of the participants **strongly agreed** that the question-and-answer sessions were conducive to idea development and sufficiently comprehensive.
- **88.9%** of the participants **strongly agreed**, and **11.1% agreed**, that each participant was able to exchange information and ideas during the discussion.