Annual of Sofia University "St. Kliment Ohridski"
Faculty of Biology
Book 4 - Scientific Sessions of the Faculty of Biology
2022, volume 107, pp. 100-111
Scientific Conference "Kliment's Days", Sofia 2021

UNIVERSITY – BUSINESS ALLIANCE IN MODERN BIOTECHNOLOGY APPROACHES FOR CLIMATE CHANGE MITIGATION SOLUTIONS: IN SEARCH FOR NEW COMPETENCES

TRAYANA NEDEVA[1]*, VENTSISLAVA PETROVA[1], ANNA KUJUMDZIEVA[2], KLIMENT PETROV[3], PAVLINA MITKOVA[4], SAMANTZIS BABIS[5], ZOI GEORGIOU[6], DIANA DI GOYA[7], BRANKO KAUCIC[8], GAMZE YÜCEL IŞILDAR [9], DENIZ IŞILDAR[10]

[1] Sofia University "St. Kliment Ohridski", Faculty of Biology, Department of general and industrial microbiology;
[2] Intellect Foundation, BG;
[3] BULGAP Ltd., BG;
[4] EKO-Znanie GT Ltd., BG;
[5] University of Thessaly, GR;
[6] Biognosis, GR;
[7] University of Bologna, IT;
[8] Initut Ltd., SI;
[9] Gazi University, TR;
[10] Planart Ltd, TR
** Corresponding author: nedeva@biofac.uni-sofia.bg*

Keywords: blended learning, cloud-based web portal

Abstract: The initiative University-business alliance in modern biotechnology approaches for climate change mitigation solutions (BIO-Save) is focused on sharing best prac-tices and developing new strategies about the management of education and creative enterprises sectors. It fosters closer engagements between HE and business by en-couraging a better understanding of the role of the different professionals involved in BIO-Save implementation; practices implemented to strengthen cooperation between tutors and trainees to improve the quality of HE, its responsiveness to the labor market needs and assurance of high-quality learning experiences; empowerment of trainees in HE & Business.

BIO-Save strives to bridge the gap between HE and the biotech business; promotes the best practices and advanced knowledge and skills in modern biotechnology; boost innovation through a novel programme "Modern biotechnology approaches for climate change mitigation"; stimulates the shift of the education towards smart and green

competences; introduces up-to-date knowledge in climate protective biotechnology; uses ICT-based flexible, transferable Learning Outcomes and Learning Pathways to build a competence-based learning system; contributes to the (re)training of the work-force to answer the Industry 4.0 requirements for the digital transformation of the economy, the business, and our life.

The BIO-Save innovative differentiators are blending of different learning tools, "formal" hard-skill courses and resources, peer-to-peer learning, online support, a learning programme, a hub of cloud-based resources, events across Europe for networking, a web-based application for a diagnostic tool kit, a repository of learning objects, and personalized learning.

BIO-Save's main achievements comprise a cloud-based web portal, modular education programme, blended learning model, career guidance. The sustainability of these outcomes will be ensured by the flexibility and modularisation of the learning content, the diversity of the educational solutions and the versatility of the e-learning materials and blended learning methodology. The BIO-Save programme offers as well self-training and reproduction on-demand options that will close the "return on investment" cycle and focus on the "knowledge strategy" based on the competency-based model.

Thus, BIO-Save makes the difference by promoting smart and inclusive growth in Eu-rope by addressing sustainability, skills and mobility, cooperation and intersectoral re-lations.

INTRODUCTION

Biosecurity, defined by the FAO as a strategic and integrated approach that en-compasses the policy and regulatory frameworks (including instruments and activities) for analyzing and managing relevant risks to human, animal and plant life and health, and associated risks to the environment [FAO], relies heavily on technologies for green growth which draw on knowledge in genomics, genetics, and molecular biology. A major issue of global security is biosafety, which relates to various fields such as health, agriculture, security, science and technology, and education. The analysis of the state-of-the-art in biotechnology applied to climate challenges revealed that the technologies employed are based on basic knowledge in genomics, genetics, and mo-lecular biology. However, there is a shortage of high-level skills and advanced knowledge in the field, and incompleteness of national and sector-specific scientific data.

The gap between the competences required in business/the biotech industry and those acquired at university/higher education institutions is drawing more and more attention (Delebecque and Philp, 2019; Treanor et al. 2021). It becomes increasingly evident that innovation culture requires employees to possess skills and competence which are often beyond the traditional basic knowledge taught at undergraduate, graduate and post-graduate level (Meissner and Shmatko, 2019). This holds true for the field of climate change mitigation, too. At the same time, many countries suffer from a high level of youth unemployment, which is a source of social instability. Thus, there is a need to respond to the high demand

for professional workers with advanced expertise in modern environmental biotechnology. It has also been argued that atten-tion should go beyond the "skills gap" concept [Hora, 2019], highlighting the value of broader twenty-first-century skills (problem-solving, teamwork and communication) in postsecondary education, not simply more specialized technical training.

It is a common understanding that the quality of education for students, teachers and practitioners in the field of biotech can be improved with up-to-date knowledge in climate protective biotechnology approaches. One way to approach this is through ICT-based flexible, transferable Learning Outcomes and Learning Pathways with the ulti-mate aim to build a competency-based learning system. Such an approach can con-tribute to the (re)training of the workforce to respond to the Industry 4.0 requirements for the digital transformation of the economy, the business, and ultimately – our life.

In an effort to contribute to bridging the gap between teaching in the academic in-stitutions and the need for educated professionals in the biotech business, the initia-tive University-business alliance in modern biotechnology approaches for climate change mitigation solutions (BIO-Save) strives to promote the best practices in modern biotechnology research and to boost innovation in the biotech education and busi-ness. For this purpose, BIO-Save aims to establish an innovative programme in Mod-ern biotechnology approaches for climate change mitigation to implement advanced knowledge and skills to stimulate the shift of EU education towards smart and green competences.

METHODS

Target groups

The target groups of BIO-Save include higher education institutions, students, researchers and professionals, biotech companies and SMEs, non-governmental organizations and business stakeholders, who are active in Healthcare, Food and agricultural sectors, Pharmaceutical industry, Environmental industry and Biotech business.

Concept

To create the tools that its targets need in order to learn and acquire new skills and competencies in an easy and pleasant way, BIO-Save takes on business ideas and translates them into training content, opportunities and prospects for HE graduates to develop and share business ideas and join entrepreneurs' community. BIO-Save steps on the results of the ECO-Center (http://www.uni-ecoaula.eu/index.php/en/) and Bio-FIT projects (https://bio-fit.eu/) by emphasizing the latest developments in research on clean environment and bio-fertilizer technologies; transferring the outputs to new geo-graphical regions; furthering the need for introducing green-biotechnology principles into the agricultural sector; upgrading

the free-access multilingual educational pro-grammes through application of EQF/HE strategic system for organization of a training process.

The BIO-Save innovative differentiators include blending of different learning tools; creation of "formal" hard-skill courses and resources involving the university and the business sector; hosting peer-to-peer learning opportunities, such as the "action learning" approach; offering online support, a learning programme, a hub of cloud-based digital resources; organizing events across Europe to address the new opportunities for networking; developing a creativity-led web-based application as the basis for a diagnostic tool kit, a repository of learning objects, and provision of personalized learning.

In search of new competences, the BIO-Save initiative developed: a cloud-based web portal, modular education programme, blended learning model, career guidance.

BIO-Save cloud-based web portal

The web portal combines **digital** design and **cloud** technology. The **b-learning man-agement system (b-LMS)** is based on the Web Site Design Method (WSDM) and combines digital design and cloud technology. To guarantee security, it continuously scans for vulnerabilities and penetration attempts and monitors for prohibited behavior to guarantee the system security and data integrity and to prevent a data breach. Scalability is achieved through elastic IPs and load balancers over multiple regions.

BIO-Save modular education programme

The BIO-Save modular education programme offers web-based learning/ training mate-rials and a guide in five languages: English, Bulgarian, Turkish, Greek, Italian. It is dedicated to modern biotechnology approaches for climate change mitigation. The programme is arranged in modules that combine learning methods and specific con-tent. The Learning Outcomes define knowledge, skills, responsibility and autonomy to be achieved while covering the content. The programme is organized in Blended Learning Pathways (BLP) aimed at different targets and EQF / NQF / HE levels (3 rele-vant degrees of education are selected among EQF/NQF/HE levels 6, 7 and 8). Vari-ous e-learning opportunities are provided: offline and online, personalized paths, short intensive courses, skills training, etc.

BIO-Save blended learning model

The blended learning model provides methodology and guidelines on the web in five languages: English, Bulgarian, Turkish, Greek and Italian. It designs and sets up a flexible innovative blended learning system to be used by diverse higher education organizations and business stakeholders to provide an interactive training environment. The model develops a competence-based learning strategy grounded on the concept that different skills are required by different workforce

segments in different economic sectors depending on different technologies used in them. It aims to mediate the shift to modern technology for reading competences.

Career guidance

At least 10 Career Profiles in modern biotechnology (at the national level) are defined for graduates at different NQF/EQF/HE reference levels (6, 7 and 8). Common criteria and qualification standards are established for the development of sample documents to certify the university education. It also provides a scheme for the acquisition of competences and how to deliver information on completed and current education of an individual in the project area.

The methods include tracking, accumulation and relations of the trainee's knowledge and experience and usage of an operational scheme based on defined project meth-odology implementing the LO-based approach. For this purpose, the national specifics are investigated in respect to qualification description: questionnaires, inquiries, face-to-face meetings. Review, analysis and assessment of the relevance to the national higher education systems and EQF results in analytic reports. This is accompanied by an evaluation of the national independent value of the specific tools for the develop-ment of Career Profiles at EQF/NQF/HE reference levels 6, 7 and 8 within the sector. Additional activities include counseling, planning and controlling the development of EQF-relevant combinations of Learning Outcomes, as well as dissemination and ex-ploitation of results.

RESULTS

BIO-Save applies work-based learning with a focus on digital skills and competences to resolve the mismatch between the academy and the job market with respect to the distance between the knowledge gained in the university and the skills expected by the job market; the lack of entrepreneurial and strategic skills in modern biotechnology and the gaps in addressing the socio-economic challenges linked to climate change.

BIO-Save supports education in business by promoting a better understanding of the role of the different professionals, approaches to strengthening the cooperation be-tween tutors and trainees and practices to empower trainees in HE and business.

BIO-Save promotes smart and inclusive growth in the EU by addressing sustainability, skills and mobility, cooperation and intersectoral relations. It works towards meeting the need for existing and emerging knowledge in climate change prevention and bridging the gap between the academic world and the biotech business in the EU. To achieve this, BIO-Save promotes best practices for climate change mitigation based on modern biotechnology; applies novel methods for

upgrading learning programmes to connect them to the real-world job market; offers knowledge about novel biotechnology ap-proaches – in bio-fertilizers and energy-efficient farming; and proposes hands-on ex-perience with technology solutions (omics, system biology, among others).

BIO-Save cloud-based web portal

The Cloud-based web portal hosts the BIO-Save b-learning platform, the BIO-Save project database and the BIO-Save dissemination and exploitation materials (Figure 1). The cloud-based solution guarantees high upload and download speed. The cloud provides reliability via 24/7 full-service access. Data consistency is guaranteed by au-tomated cloud data backup services.

The portal provides online and offline courses in five languages: English, Bulgarian, Turkish, Greek and Italian. It is designed to make the training content more vivid and offers visualizationvisualization of the relations in biological structures.

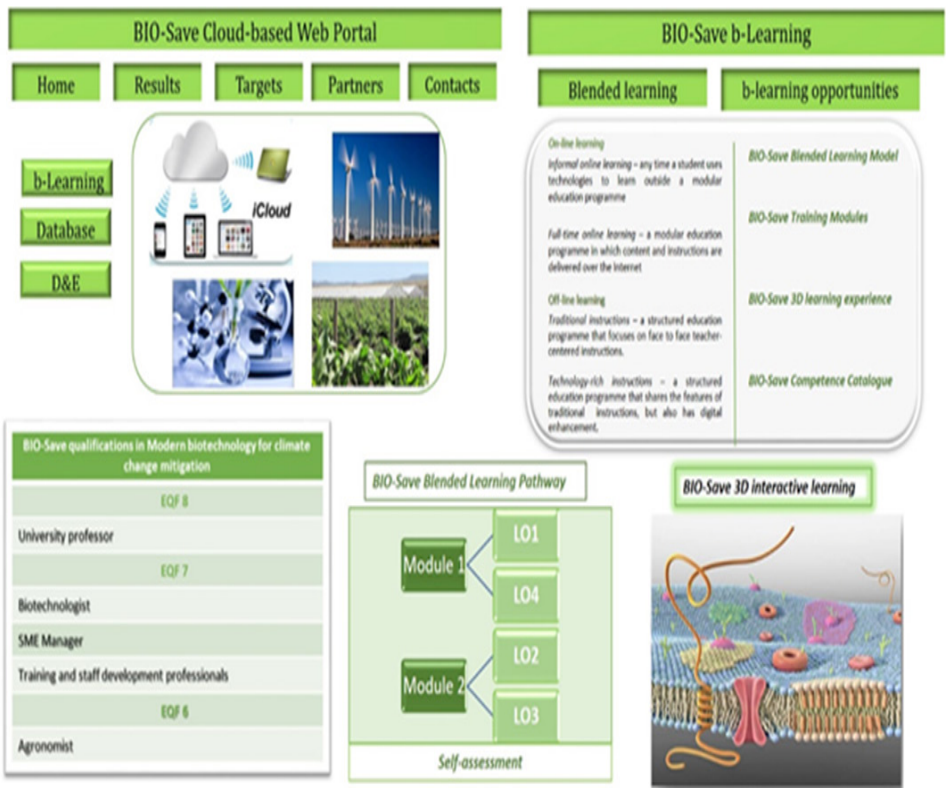

Figure 1. BIO-Save cloud-based web portal.

BIO-Save b-learning platform is an open-source learning tool that functions as a flexible e-medium to provide competence-based blended learning, knowledge database and experience exchange platform that hosts the BIO-Save results.

The BIO-Save project database hosts EU and national data about research and education in the project research area, with links to relevant legal, scientific and social documents and information about important events.

The BIO-Save dissemination and exploitation during the project and post-project life ensure the transferability of the BIO-Save results and its sustainable impact (incl. by giving information about events and links to social media profiles).

BIO-Save blended learning model

The BIO-Save blended learning model is based on an analysis of the needs for higher education training in modern biotechnology approaches for climate change adaptation and is oriented to the BIO-Save target groups (Figure 2). The knowledge that it provides corresponds to Education 4.0 multi-dimensional approach for Industry 4.0 workforce needs satisfaction. This approach interrelates the skills needed by the various economy and business dimensions with the educational offers in terms of anticipated competences to serve both individuals and institutions in their identification of skills' coverage for Industry 4.0 activities. The set of skills needed is classified as technological, contextual and traversal. This set of skills is offered in a combination of e-learning technology, assessment tests and offline materials in five languages. This way defined technological, contextual and traversal skills are brought together through optimal online and offline learning approaches.

Figure 2. BIO-Save blended learning model

The BIO-Save blended learning model is implemented into the b-**Learning Guide in Modern Biotechnology for Higher Education Professionals** which has three parts:

- **"New learning and teaching methods in HE programmes"** offers an analysis of the good practices and methods in teaching, learning and assessment, and how teaching, learning and assessment to be best organized to allow students to reach the intended Learning Outcomes.
- **"BIO-Save project learning"** describes the Learning Outcomes on the platform and defines how to use the online and offline benefits of the interactive environment.
- **"The use of ICT in HE"** gives short information on the use of ICT tools and applica-tions in higher education to enhance professors' and practitioners' awareness and digital skills.

BIO-Save modular education programme

The modular education programme is web-based. It employs the recognized European instruments EQF/HE/ECTS and the concept of a common and user-friendly 'language' for transparency, transfer and recognition of the Learning Outcomes. It creates a pro-cedure for the international transfer of acquired qualifications.

There are two outputs: the BIO-Save Learning Curriculum and the BIO-Save Guide "Green Business for Young Entrepreneurs".

The BIO-Save Learning Curriculum highlights the potential of modern technologies to increase productivity and to meet the rapidly growing demand for energy, food, nutri-tion, and health. It presents the impact of modern biotechnology approaches in climate change mitigation for improving quality of life, and is organized into two parts. **Part 1** is devoted to biotechnology for climate change mitigation (reduction of GHGS emission, use of energy-efficient farming, carbon sequestration, reduced use of synthetic ferti-lizer, adaptation to abiotic stresses and evaluation of adaptation measures). **Part 2** is focused on biotechnologies for climate change adaptation in agriculture (biotechnolo-gy approach to solve agricultural and natural resources problems and restore degrad-ed ecosystems; enhancing adaptive capacity of crops, innovation in plant breeding to develop crop varieties more resilient to climate change for agriculture; agroecosystem responses to the combination of elevated CO_2, ozone, salt and heat changes resulting from global climate change; crop diversification and opportunity for climate change re-silience; rue of new technologies and practices (e.g. soil and water conservation, pest and disease control); conservation and exchange of plant genetic resources; address-ing climate changes with ISO standards).

The curriculum is designed to support young entrepreneurs and practitioners in the biotech sector in gaining innovative knowledge, skills and competences. It also sup-ports the implementation of companies' green business management

systems to adopt cooperative sustainable strategies for climate change mitigation. It is intended to reach a broader audience interested in green business products and their practical use. The curriculum follows the testing of eco-innovative business ideas, consultations among the partners and stakeholders, and assessment of the capacity; and is blueprinted as Learning Outcomes and Units.

The BIO-Save Guide "Green Business for Young Entrepreneurs" raises awareness and promotes a better understanding of environmental risks and green business op-portunities. It shows how modern biotechnology approaches help in assessing, valu-ing and managing business decisions for compliance with environmental standards and certification schemes. The content is organized into different biotechnology sub-jects such as Learning Outcomes and is offered in English, Bulgarian, Greek, Turkish and Italian.

The Guide has two main parts. **Part I "Green products and bio-processes overview"** introduces new products and processes covering topics of engineering sustainable food production, using carbon dioxide as raw material and non-resource draining zero waste bioprocessing. P**art II "Green products development and business"** discuss-es short case studies on how the products are used by companies in different contexts and sectors.

BIO-Save career guidance

The guideline is web-based and is available in five languages: English, Bulgarian, Turkish, Greek, Italian. It produces the B**IO-Save Competence Catalogue.**

The Competence Catalogue offers the BIO-Save qualification scheme. The Competence Catalogue contains a detailed description of technological, contextual and traversal skills required for academic specialists and biotech practitioners. It describes qualifications on the EQF/HE levels, including particular skills and knowledge with respect to safety, communication and attitude. The Catalogue acts as a useful tool for better recognition of skills and competences of graduates seeking jobs in the real business and gives the trainees tools for easier transfer from academic to the business environment to support the national strategies for improving societal demands.

The Competence Catalogue is organized into two parts: Part I: **Career profiles,** and Part II: **Competence records.**

Part I: **Career profiles** are schemes for a description of qualifications for specialists and professionals in the target area based on Learning Outcomes (LOs) with basic components of a qualification: technological, contextual and traversal skills. The key career profiles facilitate the cross-border recognition of sectoral qualifications in accordance with the EQF/HE/ESTS and policy requirements of the biotech sector. The profiles for graduates at NQF/EQF/HE reference levels 6, 7 and 8 mirror a detailed view of STEM knowledge and job-specific skills.

The profiles depend on a concise definition of wider competences (general wide-ranging skills for professionals).

Part II: **Competence records** include a selection of model documents that reflect the skills, applied knowledge, and attitudes related to the specific occupation following the established EQF/NQF/HE quality criteria, procedures and standards: (EUROPASS passport; Digital Competence record; Certificates from previous education and relevant profiles, outlining, qualification and competence, self-directed learning activities, special training, publications, etc.)

DISCUSSION

The importance of developing entrepreneurial competences in early career researchers in the biotech field is increasingly acknowledged. Various approaches are being implemented to this end. For example, tailored short-term interventions, such as a bespoke entrepreneurship education competition, could foster entrepreneurial career outcomes [Treanor et al. 2021]. The BIO-Save initiative presented here stands on three pillars: (i) Linking higher education, research and business for excellence and regional development; (2) Stimulating the development of entrepreneurial and creative skills to promote innovation in higher education through an interactive learning environment; (3) Improving skills for the development of the biotech sector. However, the progress is hindered by the incompleteness of national and sector-specific scientific data. At the same time, there is a shortage of high-level skills and advanced knowledge on the job market, where ca. 80% of the biotech companies and organizations would need more educated professionals in the near future.

BIO-Save applies modern methods, such as digital and cloud-based technologies and testing and implementation of innovative practices in biotechnology. This is backed up by novel IT skills including 3D interactive education images and use of new materials and products, as well as managing new solutions for recognition and validation of the knowledge, skills and competences acquired via EQF/NQF/HE instruments. Thus, BIO-Save builds pilot training skills and green competency in the European Higher Education Area and promotes cooperation among regional authorities for efficient ed-ucation.

BIO-Save b-Learning is aimed at the target groups – students, professors and biotech practitioners – to provide them with learning opportunities tailored to their needs. The BIO-Save Blended Learning Model describes the optimal mix of learning methods and specific content. The Training Modules give the content in five different languages. BIO-Save 3D learning experience employs 3D educational images for each major top-ic. The Competence Catalogue offers the BIO-Save qualification scheme, which in-cludes career profiles and competence records.

Specifically, the BIO-Save approach provides training in modern sustainable technol-ogies in biotechnology (3D printing, genomics, nanotechnology and synthetic biology) and specific skills for handling new advanced biotech technologies. The risks posed by modern biotechnology are also introduced. Other aspects cover the new eco-friendly green use of agrochemicals which reduce pesticides through the deployment of genes conferring resistance or tolerance to biotic and abiotic stresses. Assessment and monitoring of eco-friendly technologies in addressing climate change are also in-cluded.

In line with the viewpoint that a bio-based economy requires crossing the boundaries of single sector competences (Sacchi et al. 2021), BIO-Save works towards achieving sustainability of the generated output as an investment in the future. A sustainable impact of the BIO-Save learning model and results is expected due to the flexibility and modularization of the learning content, the diversity of the educational solutions and the versatility of the e-learning materials and blended learning methodology. A novel and flexible educational framework can help creating a shared language [Sacchi et al. 2021]. Sustainability is further supported by the self-training and reproduction demand on-demand options. In addition, the cloud-based BIO-Save content is monitored in the mode of the "return on investment" cycle by continuous assessment of technological, contextual and traversal skills levels optimized for increased competitiveness. Another aspect that contributes to sustainability is the elaboration of a "knowledge strategy" for higher education and business stakeholders based on the BIO-Save competency-based model. The exploitation of the BIO-Save Competence Catalogue enables the end-users to transform their specific learning and help them remain competitive. The versatility of the BIO-Save e-learning materials and blended learning methodology can be promoted among external academic and business organizations.

CONCLUSIONS

The BIO-Save Consortium will maintain the BIO-Save programme by building capacity to foster project accessibility and incorporating (parts of) the BIO-Save programme in ongoing organizational or community activities. This will be further supported by col-laboration within the partners or associated participants and the upgrade of resources. New associated players can get involved. Sponsors can be sought to further the BIO-Save achievements. Higher education institutions will be encouraged to use the BIO-Save programme. Joint actions with other EU programmes will be established.

Specifically, all these efforts will ensure that the BIO-Save e-platform will operate after the end of the project. Dissemination and exploitation activities will

continue. The Units of Learning Outcomes and modules will be introduced into the formal university programmes. The universities will offer educational paths on-demand to business practitioners.

Acknowledgments: This publication has been financially supported by ERASMUS+ Knowledge Alliance project BIO-Save, Grant Agreement 621492-EPP-1-2020-1-BG-EPPKA2-KA.

REFERENCES

1. Delebecque, C.J. and Philp, J. (2019), Education and training for industrial biotechnology and engineering biology. Eng. Biol., 3: 6-11. https://doi.org/10.1049/enb.2018.0001
2. FAO green facts: Biosecurity tools to manage public health and environmental risks. https://www.greenfacts.org/en/biosecurity-fao-toolkit/l-2/index.htm
3. Hora MT. Beyond the Skills Gap: Preparing College Students for Life and Work. Harvard Education Press, 2019
4. Lorna Treanor, Hannah Noke, Susan Marlow, Simon Mosey. Developing entrepreneurial competences in biotechnology early career researchers to support long-term entrepreneurial career outcomes. Technological Forecasting and Social Change, Volume 164, 2021, 120031. https://doi.org/10.1016/j.techfore.2020.120031.
5. Meissner, D., Shmatko, N. Integrating professional and academic knowledge: the link between researchers skills and innovation culture. J Technol Transf 44, 1273–1289 (2019). https://doi.org/10.1007/s10961-018-9662-8
6. Simona Sacchi, Marina Lotti, Paola Branduardi. Education for a biobased economy: Integrating life and social sciences in flexible short courses accessible from different backgrounds. New Biotechnology, Volume 60, 2021, Pages 72-75. https://doi.org/10.1016/j.nbt.2020.10.002.
7. https://bio-fit.eu/
8. https://bio-save.eu/
9. http://www.uni-ecoaula.eu/index.php/en/