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Dănescu, Tatiana; Căpușneanu, Sorinel; Topor, Dan Ioan et al.

## Article

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#### Kontakt/Contact

ZBW – Leibniz-Informationszentrum Wirtschaft/Leibniz Information Centre for Economics  
Düsternbrooker Weg 120  
24105 Kiel (Germany)  
E-Mail: [rights\[at\]zbw.eu](mailto:rights[at]zbw.eu)  
<https://www.zbw.eu/econis-archiv/>

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## Comparative Analysis of Master Programs in Bioeconomy and Their Development Perspectives in the Universities of Romania

Tatiana Dănescu<sup>1</sup>, Sorinel Căpușeanu<sup>2</sup>, Dan Ioan Topor<sup>3</sup>, Andreea Marin-Pantelescu<sup>4</sup>,  
Loredana Ciurlău<sup>5</sup>

<sup>1</sup>Petru Maior University of Târgu-Mureș, Romania, E-mail: [tatiana.danescu@ea.upm.ro](mailto:tatiana.danescu@ea.upm.ro)

<sup>2</sup>Dimitrie Cantemir Christian University, Bucharest, Romania, E-mail: [sorinelcapusneanu@gmail.com](mailto:sorinelcapusneanu@gmail.com)

<sup>3</sup>1 Decembrie 1918 University, Alba-Iulia, Romania, E-mail: [dan.topor@yahoo.com](mailto:dan.topor@yahoo.com)

<sup>4</sup>The Bucharest University of Economic Studies, Romania, E-mail: [marindeea@yahoo.com](mailto:marindeea@yahoo.com)

<sup>5</sup>Constantin Brâncuși University of Târgu-Jiu, Romania, E-mail: [lcurlau@yahoo.com](mailto:lcurlau@yahoo.com)

### Abstract

As the planetary natural resources are limited, the European Commission has adopted a strategy and action plan called “Bioeconomy for Europe” which aims at making the renewable and bio-renewable bio-resources sustainable in food, energy and other industrial products. The key aspects of the strategy refer to: the development of technologies and processes for bioeconomy, the development of markets and competitiveness in the bioeconomy sectors, close collaboration between all actors involved: local community, state, labor force, bio suppliers, specialists in the field, scientists, economists, chemists, energetics and all the bio-industries. This paper presents a comparative analysis of the most important master programs in bioeconomics at international level and the perspectives of the masters programs in bioeconomics in Romania. The necessity to occupy the positions of specialists in fields such as bio-energy, bio-economics, bio-pharmaceutical, food security, agriculture, fish farming, forestry, green chemistry, bio-food industry supports the idea of attending bioeconomy training courses. Beginning in this new area of activity, Romania should not lose its start by rapidly and dynamically engaging in economic research and study programs that support bioeconomy.

### Key words

Bioeconomics, multifunctional agriculture, biotechnology, master

**JEL Codes:** A2, I2

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### 1. Introduction

The 2012-2013 period is marked by the launch of a sustainable bio-economy strategy to ensure smart green development in Europe and the launch of the Innovation Action Plan for Sustainable Development: A Bioeconomy for Europe (European Commission, 2012; McCormick and Kautto, 2013). The aim of the strategy is to ensure biodiversity and environmental protection (Staffas et al., 2013). The question that appears is: How can we do this? Experts believe that this can be solved on the one hand by developing renewable biological resources in industry and by creating sustainable agriculture, fisheries and forestry (Schmid et al., 2012). In a 2012 report, people are consuming overwhelmingly and squandering huge amounts of food, and at the planetary level we throw 1.3 billion tonnes of garbage into food.) (FAO, 2017). Thus, the amount of food thrown each year is equal to more than half of the world's grain crops (2.3 billion tonnes).

Specialists believe that bio-economy is the eco-efficient and sustainable transformation of renewable biological resources into food, energy and other industrial products (European Commission, 2012; Ollikainen, 2014). Qualifications, abilities, skills, and skill have been identified as key elements (Marin-Pantelescu, 2017) for supporting the development of the bio-economy in Europe. Between 2010 and 2011, several conferences and workshops were carried out by the European Commission and the European Technology Platforms to shape and implement the Europe 2020 strategy. Advanced bioeconomy research will enable Europe to improve its management of renewable bio-resources, new markets based on organic food, rural development through new jobs in agriculture, forestry, fish farming, reduction of dependence on fossil fuels, sustainable development of the environment (Levidow et al., 2012).

The main objective of the article is to analyze the opportunities for setting up and running some masters programs in bioeconomy in Romania. Among the specific objectives of the paper are: (1) identifying the most advanced masters in bioeconomy at international level to serve as a model for Romania; (2) their comparative analysis; (3) identifying the needs of employers' needs and needs for master programs in bioeconomics in Romania; (4) perspectives for the development of master programs in bioeconomics in the northwest of the country.

## 2. Literature review

Although the bioeconomy concept is new (since 2005), there is an interpenetration between agriculture and public goods (soil functionality, water quality, nature biodiversity, forest landscaping, air quality, rural vitality, animal health and welfare, food security) that often depend on farmers and farmers' knowledge. Clarifying the term bioeconomy has sparked important polemics from a scientific point of view worldwide. OECD and multinational companies have looked at the concept from the perspective of the industrialization of agriculture, considering that bio-economy is the contribution of transforming scientific knowledge into new, sustainable, eco-efficient products (OECD, 2009). Many specialists have intensified their studies on the concept of multifunctional agriculture (Diedrich *et al.*, 2011; Levidow *et al.*, 2012; Vigani *et al.*, 2015). In the agri-food sector, several interventions have been carried out in recent years, some of which concern agricultural public policies, while others concern consumer protection by guaranteeing food security and promoting bio-products (Petrescu *et al.*, 2018). Other authors argue that bioeconomy primarily creates a field of fertile activity for professionals and specialists in the fields of agriculture, horticulture, food processing and bioenergy services (Bugge *et al.*, 2016).

The life of the distinguished economist professor Nicholas Georgescu-Roegen lies at the heart of the concept of bio-economics: "the happiness to live is the true goal of economic activity" (Georgescu-Roegen, 1995). The different, unique and original way of creating a link between economics and ecology led to the development of the bio-economy branch of prestigious universities such as Hohenheim University, Stuttgart, Germany, University of Edinburgh, UK or Iowa University in United States. Bio-economy is a new form of economy that relies on the production and processing of biological resources, its components being part of the primary economic sector (agriculture, forestry, fishing) and the secondary economic sector (food industry, paper industry, energy industry and the biotechnologies) (Philp, 2015). Together with organizations dedicated to environmental protection and sustainability, industry has begun to invest in environmental degradation and more environmentally friendly products. Environmental protection is ensured by investments made by entities interested in promoting compatibility between produced bio-assets and financial performance, thereby ensuring transparency of the image of the entity and investor behavior (Topor *et al.*, 2017).

The generation of new knowledge for the development of bioeconomy specialization goes directly to universities through study programs offered by teachers to their students. The interdisciplinarity of the bioeconomy (which includes the entire value chain from biological resources to their transformation into food, food and bioenergy) and the confluence between scientific disciplines (agriculture, natural sciences, economics, social sciences, and environmental sciences) require specialized professionals educated through master programs by elite professors and scholars in the field. The transition of the economy, from the one based on fossil raw materials to the one based on biogenic, renewable and biodegradable resources, could help society solve certain environmental problems closely related to technical and technological progress. Also, pursuing common good over individual interests within a national community is the foundation for the development of the concept of bioeconomy. The degree of involvement of enterprises in the circular economy can be assessed with regard to issues such as the activities carried out, the level of investments made, the sources of financing attracted and the level of managers' interest in order to implement bioeconomics (Oncioiu *et al.*, 2018).

## 3. Methodology of research

The present paper uses as a research method the elements of comparative analysis: the observation method, the comparison method and the causal analysis. Three masters programs in bioeconomics in Germany, the United Kingdom and the United States are investigated and compared (CWUR, 2017). For the comparative analysis the following were taken into account: the university curriculum, the number of credits, the study subjects, and the teaching staff involved, the way of financing, the employment and career prospects for the graduates. Also, in order to argue the initiation and deployment of masters in the bioeconomy and in Romania, statistical data are analysed on: the evolution of higher education in Romania during six academic years (2011-2012 until 2016-2017), the students enrolled in the programs Master of all Romanian students in the academic year 2016-2017, structure of higher education, by groups of specializations in the academic year 2016-2017, changes in the structure of the Gross Domestic Product for Romania, by category of resources, in 2016 as compared to 2006. Dynamic indices, weights, analytical charts, and systematization of data are included in tables.

## 4. Comparative analysis of the masters programs in bioeconomics

The penetration of bioeconomy in the university environment is necessary because mankind has already entered a new age, the chronic shortage of food, and considering this, in a metaphorical approach we can say that agricultural land (soils) are the new gold and food is the new oil (Alexandru *et al.*, 2014). European Union intervention in the field of bio-economy is essential to ensure excellence and funding for research and innovation in the bio-fields, which will now play an important role for the entire present and future society (Bran and Dobre, 2017).

From the top of the most prestigious universities offering bio-economics master's programs we selected for the comparative analysis the three most representative programs (CWUR, 2017): (1) Bioeconomy master at Hohenheim University, Stuttgart, Germany, (2) Biorenewable Resources and Technology master at Iowa University in the United States and (3) Management of Bioeconomy, Innovation & Governance Master at the University of Edinburgh, UK (Table 1). These programs represent for the Romanian university system a model to be taken into consideration given the concerns of the Ministry of Research and Innovation in our country regarding the development of innovative products, the integration of the primary economic activity sectors in the increase of the productivity of production, and the development of biodiversity.

Table 1. Comparative analysis of the three most prestigious masters programs in bioeconomics

Type of master	Bioeconomy master	Biorenewable Resources and Technology master	Management of Bioeconomy, Innovation & Governance master
Year of Master	Year of Master 2014	Year of Master 2013	Year of Master 2014
University	University of Hohenheim	University of Iowa	University of Edinburgh
Country	Germany	USA	Great Britain
Slogan	<i>Slogan: Change the system. Shape the future.</i>	<i>Slogan: Opening Doors to the Bioeconomy</i>	<i>Emerging technologies are met with high expectations and great uncertainty</i>
Duration and number of credits	4 semesters 120 credits	2 semesters 32 credits	4 semesters 120 credits
Running the program in	Running the program in English	Running the program in English	Running the program in English
Number of available places	No of available places: 45	No of available places: 30	No of available places: 40
Place of the master	Place of the master: Stuttgart	Place of the master: Ames, Iowa	Place of the master: Edinburgh, UK
Master's degree	Master's degree	Master's degree	Master's degree
Way of financing	"German and EU/EEA students are exempt from tuition fees. Tuition fee: € 1500 per semester for international students not from EU/EEA countries. "	Funding from the State Energy Department of the US.	Program funded by Innogen Scholarships and Highly Skilled Workforce Scholarships for UK & EU students
Institute membership	Hohenheim Research Center for Bioeconomy	Iowa State University's Bioeconomy Institute (BEI)	Innogen Institute

**Source:** Data collected by authors after Study programs: University of Hohenheim, The University of Edinburgh, postgraduate study and Iowa State University of Science and Technology, 2018.

## 5. Results and discussions

The curriculum for the Master of Bioeconomy from University of Hohenheim, Stuttgart, Germany consists of 2 years of study. In the first year of study, students gain basic knowledge about all aspects of bioeconomics. To ensure that all students successfully complete the program, despite having different university studies, three link modules are offered in the first semester. In addition, in some compulsory modules, students learn the necessary information and methods for a systematic analysis of the bioeconomics. In the second year of study, students are given the chance to choose from several modules. In the "Bioeconomic Research Projects" mandatory module, students apply the knowledge acquired through the development of research projects together with the private sector and other organizations that take into account the entire bioeconomic value chain. The program Bioeconomy from University of Hohenheim is completed with a master's degree in bioeconomics. Interestingly, this Hohenheim Master's program combines 9 disciplines and the faculty body of 3 distinct faculties at Hohenheim University, namely the Faculty of Agricultural Sciences (Faculty of Agricultural Sciences 5 with 4 disciplines within the framework of the Inter- and Transdisciplinary Approaches in Bioeconomy, Agricultural Economics and Strategic Management in Bioeconomy, Faculty of Natural Sciences, Faculty of Natural Sciences 3, with 3 subjects in the program: Sustainable Industrial Processes, Projects in Bioeconomic Research, Natural Science Concepts, Faculty of Economic and Social Sciences, Faculty of Business, Economics and Social Sciences 3, with 2 subjects in the program: Markets, Innovation and Social Acceptance of Biobased Products, Economics and Management). This interdisciplinary formula creates a successful master in the conditions in which bioeconomics represents the economy of the future.

With the *Change the system. Shape the future* slogan the master's program is a worthy model to take into account for the Romanian education system that has to align with the new European trends with intense concerns in the field of bioeconomics.

*Biorenewable resources and technology* was the first Master's Degree in Bioeconomics in the United States. BRT provides students with advanced studies in the use of plants and crops in the production of bio products (in the chemical, energy and fuel sectors).

The United States Department of Energy (DOE) is directly involved in the Master's program offering scholarships and internships, and the curriculum introduces the following 5 core disciplines: Fundamentals of Biorenewable Resources, Biobased Products Seminar: Research Presentations, Biorenewables Law and Policy, Biorenewable Resources Laboratory, Technology-Led Entrepreneurship in Biorenewables, and 4 optional subjects: Thermochemical Processing of Biomass, Bioprocessing and Bioproducts, Advanced Food Processing and Research in Bioeconomics, a total of 9 disciplines, as well as the Master's program in Bioeconomics in Germany. The Master's Teaching Staff consists of 7 professors from the Bioeconomy Institute and 2 CenUSA Bioenergy researchers.

The Master of Science (MSc) BIG (Management of Bioeconomy, Innovation and Governance) is the third master that we propose for analysis. The compulsory courses of study in the program are: Introduction to Risk, Regulation and Governance, Analysis and Shaping of Bioeconomy, Biobusiness, and Optional Disciplines 4: Energy Policy and Policy, Intelligent Agriculture, Industry and Entrepreneurship in Biotechnology and Product Development. MSc BIG is an innovative and dynamic mastership designed to meet the need for a skilled workforce in bioeconomics.

Untitled *Master in Bioeconomy in the Circular economy* (Bio-Circle) represents the Italy initiative to be active involved in bioeconomy (master Bio-Circle started on 15 of January 2018 in Milano-Bicocca, following Napoli 5-10/2/2018; Torino 26/2-2/3/2018, Bologna 9-13/4/2018). Bio-Circle received the prize for teaching innovation from the President of Italy in 2018. Master in Bioeconomy in the Circular Economy builds collaboration between the theoretical field of bioeconomy and business. Thus, 4 universities in Italy are involved in the Master: University of Turin, University of Milan Bicocca, University of Bologna and University of Naples Federico II, and three of the main Italian bioeconomy players (Novamont, GFBiochemicals and Science Park of Lodi). The BioCirce Master's Program includes four compulsory modules (each with 5 credits) offered by the four participating universities. The modules cover relevant scientific topics in bioeconomy field (<http://masterbiocirce.com/>).

In Romania there is the Romanian Bioeconomy Institute, which was set up in 2016, and has as its main objective the development of bio-economy sectors, including involvement in educational and research programs in the field of bioeconomy. The main areas where we need trained people are: agricultural biotechnology, sustainable food production, synthetic biology, industrial biotechnology, biofuels, and energy-related breakthroughs. The development of masters in bioeconomy for the Romanian university environment is reflected in the need to train specialists in new fields such as: renewable energy, renewable resources, biotechnologies, design of new systems in agriculture, food chemistry, crop genome, molecular genetics of plants, bioenergy, biogas and so on.

Table 2. The evolution of higher education in Romania

	Period					
	2011/2012	2012/2013	2013/2014	2014/2015	2015/2016	2016/2017
Higher education institutions (number)	108	107	103	101	99	97
Faculties	614	596	590	583	567	560
Students/enrolled students total	705333	618157	578705	541653	535218	531586
Students enrolled in the undergraduate programs	539852	464592	433234	411229	410697	405638
% of total students	76.54	75.16	74.86	75.92	76.73	76.31
Students enrolled in master	141663	132209	125480	111109	107269	106794
% of total students	20.08	21.39	21.68	20.51	20.04	20.09
Students enrolled in PhD	23818	21356	19991	19315	17252	19154
% of total students	3.38	3.45	3.45	3.57	3.22	3.60
Teaching staff in higher education	28365	27555	28211	27772	26949	26618

**Source:** Data processed by authors from the Statistical Yearbook of Romania, edition 2017, p.336

By reviewing the evolution of higher education in Romania (Table 2), we currently have 97 higher education institutions with approximately 531586 enrolled students, of which 80% in the Bachelor's degree program, 20% in the Master's degree and 10% in the Ph.D (Figure 1). Over 6 years of analysis, the number of faculties fell by 9%, the total number of students

dropped by 25%, the number of students enrolled in the masters fell by 25%, the teaching staff in higher education decreased by 6%. We draw an alarm signal for this downward slope of higher education in Romania and the need to revive it.

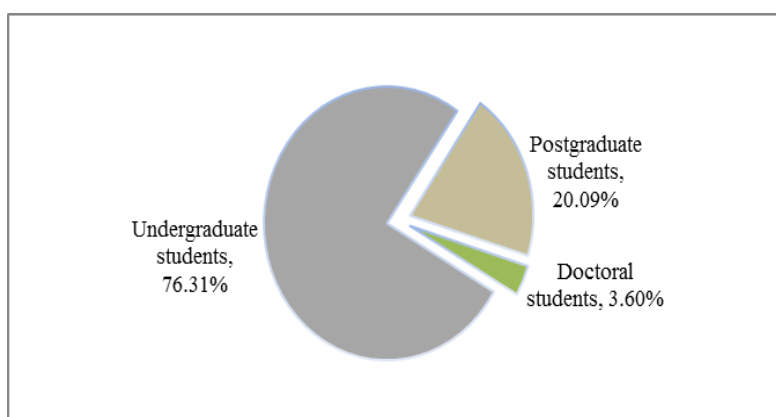


Figure 1. Share of the students enrolled in the master programs of the total number of Romanian students in the academic year 2016/2017

Students who have chosen specializations in the field of agriculture, forestry and fish farming represent only 4,83% of the total Romanian students, and among the lowest percentages we have also the natural sciences, mathematics and statistics specialization (4,60%), services, 02%) and education sciences (3,26%). On the other hand, most students go to business, administration, law (23,93%), and engineering (21,56%) (Table 3).

Table 3. Higher education, by groups of specializations in the academic year 2016/2017

Students/enrolled students - Total	531586	100
Field of specialization		%
Business, administration and law	127233	23,93
Engineering, processing and construction	114623	21,56
Health	72490	13,64
Arts and Humanities	48397	9,10
Journalism and Social Sciences	45244	8,51
Information and communication technologies	34814	6,55
<i>Agriculture, forestry, fish farming</i>	25669	4,83
Natural sciences, mathematics and statistics	24473	4,60
Services	21396	4,02
Education sciences	17247	3,26

Source: Data processed by authors in the Romanian Statistical Yearbook, edition 2017, p.305

In 2016, out of 121788 graduates with a degree in agriculture, forestry, fish farming, Romania had only 4895, representing 4% of all graduates. Moreover, in the field of employment with specialists in the field necessary for the promotion of biotechnologies, the situation is not very good. Also in 2016, of the total employed population, of 8449 thousand persons, in agriculture, forestry and fishing worked 1952 thousand persons (23%), and 196 thousand people (2,32%) in the field of professional, scientific and technical activities. The situation was even deficient in the field of electricity production, waste management and decontamination activities, i.e. 180 thousand persons, representing 2.13% of the total population employed in Romania in 2016.

If we analyse Romania's Gross Domestic Product by resource category, we will find out that in its structure the first sector of activity (consisting of agriculture, forestry, fishing) has a weight of 4% in 2016 compared to 8% in 2006. In 10 years of economic activity, the structure of the economy has undergone substantial changes. Thus, the services sector has come down strongly and now contributes 66% to the country's gross domestic product. The industry keeps its contribution of about 30% to GDP, and services are gaining ground at the expense of agriculture (agricultural, forestry, fisheries), which brings only 4% of GDP (Table 4).

Table 4. The Structure of the Gross Domestic Product for Romania, by resource category, in 2016 as compared to 2006

- millions of lei, current prices -

	2006	%	2016	%	R <sub>2016/2006</sub>
Agriculture	26861,9	7,79	31147,1	4,09	+16
Industry	110103,8	31,95	230391,7	30,22	+109
Services	207684,9	60,26	500803	65,69	+141
<b>TOTAL</b>	<b>344650,6</b>	<b>100</b>	<b>762341,8</b>	<b>100</b>	<b>+121</b>

**Source:** Data taken and calculated according to the Romanian Statistical Yearbook, editions 2007 and 2017

The EU's bio-economy strategy uses the turnover indicator. It measures the value of sales in the bio-economy sector (Agriculture, Bio-based chemicals, pharmaceuticals and plastics, Bio-based electricity, Bio-based textiles, Biofuels, Fisheries, Food, and furniture). Turnover in Romania in TOTAL BIOECONOMY sectors in 2015 was EUR 36507 million. Thus, Romania ranks 15th out of 28 in the European Union on turnover in the total bioeconomy sector for 2015. As regards Employment in Romania in TOTAL BIOECONOMY sectors in 2015, it reached 2610469 persons. Thus, Romania ranks second in 28 in the European Union on the number of people employed in Total Bioeconomy (Table 5).

Most of the revenues for bio-economy in Romania are generated by agriculture (38%), food, beverage and tobacco (34%), wood products and furniture (13%). The smallest stocks are generated by fisheries (0.06%), biofuels (0.37%) and bio-based electricity (0.38%). With regard to the workforce in the bio-economy, the sectors most represented are agriculture (82%), food, beverage and tobacco (7%), and wood products and furniture (4%). In sectors of activity such as: biofuels, bio-based electricity, fisheries, about 0.05% of all workers in the bio-economy are employed. Greater involvement by specialized labor force and substantial revenues for the development of bio-economy in Romania is needed.

Table 5. The structure of turnover and the structure of employment in bioeconomy in Romania in 2015

Total Bioeconomy	Turnover (Million EUR)	Employment (number of persons)
	36507	2610469
Agriculture	13822	2129600
Bio-based chemicals, pharmaceuticals and plastics	1112	13429
Bio-based electricity	104	2530
Bio-based textiles	2126	108006
Biofuels	141	1287
Fisheries	23	2872
Food, beverage and tobacco	12225	180000
Forestry	1523	51600
Manufacture of paper and paper products	867	13126
Wood products and furniture	4564	108019

**Source:** Adaptation after European Commission, Bioeconomy Knowledge Centre, Economy, Romania (2015), <https://biobs.jrc.ec.europa.eu/country/romania>

## 6. The Master's Degree Program in Bioeconomics in Romania

An early project is on the university market in Romania and is now the moment of its development. In the academic year 2016-2017 the first Master of Bioeconomics Management is launched in the context of sustainable growth by Danubius University, Faculty of Economic Sciences, business administration study field, with 50 places and 120 credits that can be accumulated during 2 years of study (4 semesters). The curriculum includes 9 study subjects in the first year and 8 subjects in the second year (Table 6). Compared with the master programs previously analyzed: Bioeconomy (University of Hohenheim), Management of Bioeconomy, Innovation & Governance (University of Edinburgh), Biorenewable Resources and Technology (Iowa University), Romania has 2 times more study subjects, covers as much as possible from the area of bio-economy activity. Focus is much better in foreign masters programs on a core element in bioeconomics: Farm Economics and Strategic Management in Bioeconomy, Natural Science Concepts and Markets, Innovation and Social Acceptance of Biobased Products. Starting from the comparative analysis of the masters' curriculum in bioeconomy, we note that they are relatively recent, because the field is still "cruel".

Table 6. "Bioeconomy Management in the Sustainable Growth" Master Plan

First Year	Second Year
"Lasting development Fundamentals of Bioeconomics EU bio-economic strategy Reaping the Bioeconomic Potential World Strategy for Bioeconomy Natural resources bioeconomy Computer systems used in bioeconomics Methodology of scientific research Specialty Practice"	Fundamentals of special bioeconomics Bioeconomy and the Challenges of the Global Crisis Legislation specific to bioeconomics Bioeconomics and biotechnology BioBusiness Bio-economy of industry and services Agro-alimentary bio-economy Research and dissertation

**Source:** Danubius University, Faculty of Economic Sciences, <http://www.univ-danubius.ro/images/facultati/StEc/2016-2017/MBCCD.pdf>

A single master degree in bioeconomics across Romania is not enough given the new trend in bioeconomics. In Romania there are 5 active clusters in the bioeconomy, all located in Cluj Napoca, namely: Risky Business, SprintPoint, Seed for Tech, StepUP, Simplon (according to the data provided by <http://biconsortium.eu/sites/biconsortium.eu/files/downloads/Country-Report-Romania.pdf>). Involving them in a Master's program developed by Babeş-Bolyai University in Cluj would be a good omen for new masters in bioeconomy in Romania.

Liberty Technology Park is the largest technology park in Romania. It is located in Cluj-Napoca, in the north-west region. It hosts several large hi-tech companies as Siemens and Altran, but also start-ups. No evidence of biobased operations was found. The involvement of Liberty Technology Park in a partnership with Babeş-Bolyai in Cluj for a master's degree in economics could follow the way of Bio-Circe master in Italy. Two large technology parks are currently being built (October 2017), Vox Technology Park in Timisoara (West) and Bihor MedTech Scientific and Technological Park in Oradea (north-west). It would also be a great opportunity for the West University of Timisoara and the University of Oradea to create a partnership between the university and the technology parks in order to implement the masters in the bioeconomy. The involvement of the Romanian business environment, which has common interests with the bio-economy, is essential by creating practical bases and setting up a research laboratory in the bioeconomy.

In the first phase, licensed students in Romania may not be familiar with the term bioeconomics. Therefore, it is necessary to publicize it, to provide all the necessary information regarding the necessity of such specialization in Romania, to lead research laboratories in mixed university-private teams in the field of bioeconomics, to involve students in such projects, to provide consultancy in the field of bioeconomics by specialists trained from a trained body and workers specialized in the environment, agro-food, or biotechnology. Questions such as: What can we do to regenerate resources? How do we measure sustainable economic performance? Can we deal with the current environmental changes we live in? How do we recover what generates consumption? How long do we diversify our resources so that future generations can enjoy it? can find appropriate answers through the proposal made in the present paper.

## 7. Conclusions

The analysis carried out consisted of the need to employ labor for sectors requiring specialists in the field of bio-economy. At international level there are master programs in bioeconomy with the year of 2013-2014, and in Romania 2016-2017. Improving the productivity of agricultural systems, taking account of new emerging technologies, will be needed to meet the increasing demand. Eco-farming and biotechnology will require specialists created by both the university system and the practical environment. However, from the variety of research disciplines involved in bioeconomy, science and engineering sciences have the most central role, being followed closely by economic sciences.

Students who have chosen specializations in the field of agriculture, forestry and fish farming represent only 4,83% of all Romanian students, and among the lowest percentages we have also the specialties of natural sciences, mathematics and statistics (4,60%), services, 02%) and education sciences (3.26%). On the other hand, most students go to business, administration, law (24%), and engineering (22%). In 2016, out of 121788 graduates with a degree in agriculture, forestry, fish farming, Romania had only 4895, representing 4% of all graduates, too few for current bioeconomic needs. Moreover, in the field of employment with specialists in the field necessary for the promotion of biotechnologies, the situation is not very good. Also in 2016, out of the total employed population of 8449 thousand people, 1952 thousand people (23%) worked in agriculture, forestry and fishing and 196 thousand (2.32%) in the field of professional, scientific and technical activities. The situation was even deficient in the field of electricity production, waste management and decontamination



activities, i.e. 180 thousand persons, representing 2.13% of the total population employed in Romania in 2016. To generate added value to the country through bioeconomy it is necessary new vision to prepare new specialists.

Public investment in research and innovation offered by the state of the university will continue to grow as new, bio-based products will need to be developed and marketed. Establishing a framework for development and financial agreements that will lead to continued investment in bioeconomic education is one of the greatest challenges, and through this paper we try to answer them. Romania has all the necessary prerequisites for the creation, implementation and running of master programs in bioeconomy in partnership with companies operating in bioeconomy.

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