Bioeconomy

Subjects: Environmental Sciences
Contributor: CAMILA CIDON

Bieconomy is the economy of the green technologies and is capable to offer global food security, improve nutrition and health, create innovative bio-based products and biofuels. Bioeconomy would help agriculture, forestry, aquaculture, and other ecosystems to adapt to the climate change. It is an opportunity to boost innovation, create jobs in rural and industrial areas, reduce fossil fuel dependence, and improve economic and environmental sustainability.

Keywords: bioeconomy ; organic agriculture ; green technology ; sustainability

1. Introduction

The main challenge of the first half of the twenty-first century will be to reinvent current methods of producing food and develop more sustainable approaches that could generate enough food for twice the world population without compromising terrestrial ecosystems; rather, such approaches should contribute to the substantial regulation of the climatic emergencies caused by global warming [1][2][3][4][5].

The factors associated with climate change include expansionist and intensivist agriculture activities, which reduce biodiversity, increase greenhouse gas emissions, and deplete critical ecosystem services, resulting in the land, water, and climate degradation [1][2][6]. The continued development of methods to quickly identify and control abiotic and biotic threats to agriculture is a priority for scientists, whose research will need to build resilience in adapting to climate change and help implement mitigation strategies [7].

The growing environmental problems, mainly resulting from human activities, require the control of production and consumer attitudes to protect natural resources and achieve sustainable development. The use of renewable resources can allow societies to maintain their economic growth while limiting negative impacts on the environment and preserving natural resources. Adapting to a bio-based economy requires a radical change in production patterns, which involves utilizing alternative clean energies and renewable inputs in production processes [8][9].

Since human needs tend to increase but are currently constrained by the necessity of significantly reducing emissions of carbon dioxide into the atmosphere, there is a trend towards a transition to a sustainable BE to help to reduce greenhouse gas emissions and human dependence on non-renewable resources [7]. The development of the BE will be an important determinant of the sustainable agricultural productivity growth required to meet food security goals and to generate jobs and income [10].

The BE promises economic growth and environmental gain through the conversion of renewable biological resources into the food, feed, fuel, chemicals, and fibers of the future [9], establishing the requirement that resources must be used and managed sustainably, while pressures on ecosystems must be minimized [11].

The BE scenario in agriculture results in food security and is capable of minimizing pressure on land and water resources, through advanced technologies may increase resource use efficiency [10]. Principles transformed in practice will be essential to activate sustainable agriculture productivity to meet food security goals [10].

In the same way, OA has common objectives within BE, such as sustainability of food production, minimum environmental impacts with a closed farming system that includes plants and animals to make feasible effective recycling nutrients [12]. Agroecological practices as organic soil management reduce vulnerabilities to climate change, including a diversification in the crop, water conservation, and increase biodiversity rates [13].

Based on how OA and BE concepts seem to be interlinked, this study aims to investigate the relation between OA and BE through a systematic literature review, focusing on recent studies published in the last 10 years, taken from the Scopus database. We highlighted results that point out the benefits of OA under perspective of the BE main aspects.

2. Analysis and Synthesis

To facilitate extracting a quality assessment of standardized data, we followed the analysis categories, named: the publication author, journal, year, title, objective, theories used, location, unit of analysis, methodology, and main findings. This represents the primary data from which we proceeded to further create a synthesis of the relevant elements for the study [14]. Accordingly, the synthesis facilitated the subsequent handling of the data for the purpose of establishing relationships and constructing the evidence [15].

Regarding the distribution of papers, we discovered that most of the selected articles were written and conducted in Europe, as shown in Figure 1. Of the reviewed articles, 23 were from Europe, and 18 of these overall were from Western Europe. Other continents are represented by no more than 1 or 2 articles, except Asia, with 7 studies. The total number of papers presented in Figure 1, exceeds the total number of reviewed articles (36) because some empirical studies were conducted in more than one country.

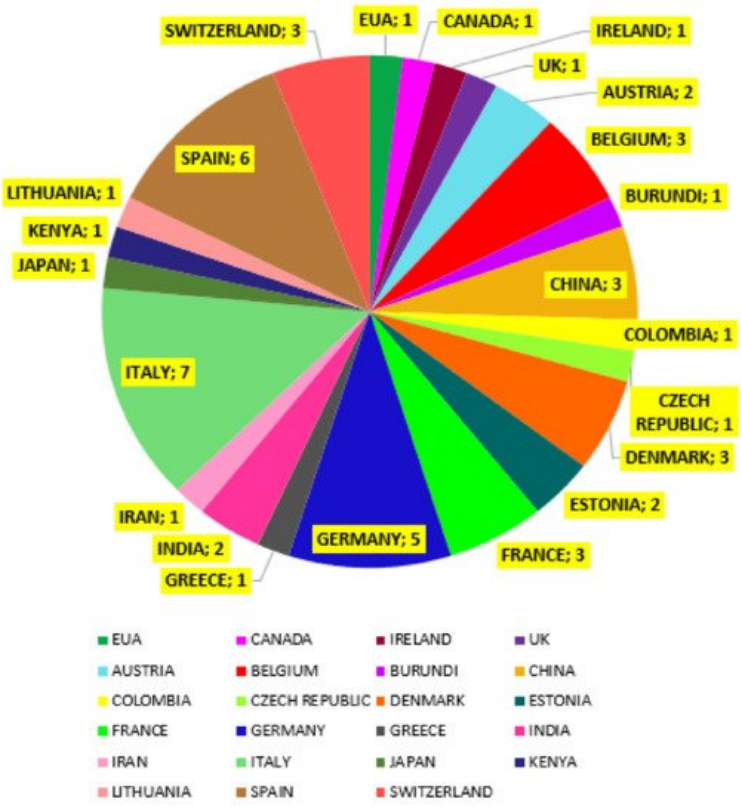

Figure 1. The distribution of the studies' origin per country.

3. Identification of Key Aspects for the Development of Bioeconomy

The following paragraphs provide a detailed description of the aspects that contributes to the development of the BE.

A mature and sustainable BE must offer global food security, improve nutrition and health, create innovative bio-based products and biofuels, help agriculture, forestry, aquaculture, and other ecosystems to adapt to climate change [16]. BE is an opportunity to boost innovation, create jobs in rural and industrial areas, reduce fossil fuel dependence, and improve economic and environmental sustainability [17].

The data presented in Table 1 shown the relevant aspects for the development of BE, which are the following: implementing life cycle perspectives for the certification and improvement of the sustainability of BE products throughout the supply chain [18]; promoting the involvement of citizens and final buyers to reduce the gap between science and society, with more research networks, education, training, and clusters of agricultural cooperatives [9][11][19]; using water, energy, and land resources sustainably [10][20][21]; improving productivity and land use through better crop management [10][20]; generating opportunities to separate agricultural growth from environmental degradation through more sustainable production methods using biotechnology [10]; utilizing biomass more efficiently [10][20]; achieving social well-being [22]; employing clean technologies to decrease greenhouse gas emissions, minimizing the inputs, and maximizing the outputs of the system [7]. To facilitate achieving these objectives, indicators and targets may be derived and developed to provide direction for the sustainable development of the BE [18].

Table 1. BE key aspects.

BE Key Aspects	References
Biotechnology	**Rosegrant et al. [10]**
Improved crop management	**Rosegrant et al. [10]; Uzoh and Babalola [20]**
Efficient utilization of biomass	**Rosegrant et al. [10]; Uzoh and Babalola [20]**
Well-being	**Mustalahti [22]**
Research networks, education, training and clusters	**Devaney and Henchion [9]** **Ramcilovic-Suominen and Pulzl [11]; Scheiterle et al. [19];**
Use of water, energy and land resources sustainably	**Rosegrant et al. [10]; Uzoh and Babalola [20]; Hertel et al. [21]**
Clean technologies	**Sarkar et al. [7]**
Efficient utilization of biomass	**Rosegrant et al. [10]; Uzoh and Babalola [20]**
Life cycle assessment	**O'Brien et al. [18]**

References

1. Foley, J.A.; Ramankutty, N.; Brauman, K.A.; Cassidy, E.S.; Gerber, J.S.; Johnston, M.; Mueller, N.D.; O'Connell, C.; Ray, D.K.; West, P.C.; et al. Solutions for a cultivated planet. Nature 2011, 478, 337–342.
2. Rayfuse, R.; Weisfelt, N. The Challenge of Food Security. Chall. Food Secur. 2012, 327, 812–818.
3. Tilman, D.; Cassman, K.G.; Matson, P.A.; Naylor, R.; Polasky, S. Agricultural sustainability and intensive production practices. Nature 2002, 418, 671–677.
4. FAO. Global Sustainable Development Report 2019. Available online: (accessed on 12 September 2020).
5. Prepare farms for the future. Nat. Cell Biol. 2015, 523, 381. Available online: (accessed on 16 June 2021).
6. Dewenter, S.I.; Kesler, M.; Barkmann, J.; Bos, M.M.; Buchori, D.; Erasmi, S.; Faust, H.; Gerold, G.; Glenk, K.; Gradstein, R.S.; et al. Tradeoffs between income, biodiversity, and ecosystem functioning during tropical rainforest conversion and agroforestry intensification. Proc. Natl. Acad. Sci. USA 2007, 104, 4973–4978.
7. Sarkar, S.F.; Poon, J.S.; Lepage, E.; Bilecki, L.; Girard, B. Enabling a sustainable and prosperous future through science and innovation in the bioeconomy at Agriculture and Agri-Food Canada. New Biotechnol. 2018, 40, 70–75.
8. Hernandez, A.S.; Esteban, E.; Garrido, P. Transition to a bioeconomy: Perspectives from social sciences. J. Clean. Prod. 2019, 224, 107–119.
9. Devaney, L.; Henchion, M. Consensus, caveats and conditions: International learnings for bioeconomy development. J. Clean. Prod. 2018, 174, 1400–1411.
10. Rosegrant, M.W.; Ringler, C.; Zhu, T.; Tokgoz, S.; Bhandary, P. Water and food in the bioeconomy: Challenges and opportunities for development. Agric. Econ. 2013, 44, 139–150.
11. Ramcilovic-Suominen, S.; Pülzl, H. Sustainable development—A 'selling point' of the emerging EU bioeconomy policy framework? J. Clean. Prod. 2018, 172, 4170–4180.
12. Chattopadhyay, G.N. Use of vermicomposting biotechnology for recycling organic wastes in agriculture. Int. J. Recycl. Org. Waste Agric. 2012, 1, 8.
13. Altieri, M.A.; Nicholls, C.I.; Henao, A.; Lana, M. Agroecology and the design of climate change. Agron. Sustain. Dev. 2015, 35, 869–890.
14. Gibbs, G. Analyzing Qualitative Data; SAGE Publications: Thousand Oaks, CA, USA, 2007.
15. Marshall, C.; Rossman, G.B. Designing Qualitative Research, 3rd ed.; Sage Publications, Inc.: Thousand Oaks, CA, USA, 1999.
16. Socaciu, C. Bioeconomy and Green Economy: European Strategies, Action Plans and Impact on Life Quality. Bull. Univ. Agric. Sci. Veter. Med. Cluj-Napoca. Food Sci. Technol. 2014, 71, 1–10.
17. European Commission (EC). Innovating for Sustainable Growth: A Bioeconomy for Europe; Directorate General for Research and Innovation, European Commission: Brussels, Belgium, 2012.

18. O’Brien, M.; Wechsler, D.; Bringezu, S.; Schaldah, R. Toward a systemic monitoring of the European bioeconomy: Gaps, needs and the integration of sustainability indicators and targets for global land use. Land Use Policy 2017, 66, 162–171.
19. Scheiterle, L.; Ulmer, A.; Birner, R.; Pyka, A. From commodity-based value chains to biomass-based value webs: The case of sugarcane in Brazil’s bioeconomy. J. Clean. Prod. 2018, 172, 3851–3863.
20. Uzoh, I.M.; Babalola, O.O. Rhizosphere biodiversity as a premise for application in bio-economy. Agric. Ecosyst. Env. 2018, 265, 524–534.
21. Hertel, T.; Steinbuks, J.; Baldos, U. Competition for land in the global bioeconomy. Agric. Econ. 2013, 44, 129–138.
22. Mustalahti, I. The responsive bioeconomy: The need for inclusion of citizens and environmental capability in the forest based bioeconomy. J. Clean. Prod. 2018, 172, 3781–3790.