Bioeconomy – an Interdisciplinary Approach

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Abstract

The paper proposes to find out the relevance of bioeconomy for sustainable needs of people. In order of this many researches were studied starting from concept to content. Due of industrial progress, the conventional resources were exccesiv exploited which conducted to diminishing of these. A such situation reduced the quality and maintenance of life with many consequences in time. As an interdisciplinary approach, this paper take into consideration issues such as renewable resources and their management, sustainable development, waste and bioenergy. It is found that bioeconomy has an enourmous contribution for industry and agriculture in terms of sustainability. This means that bioeconomy must be promoted because the advantages are higher that conventional economy. The paper is treated on the basis of personal accumulation, after were studied numerous references.

Keywords: *bioeconomy, renewable resources, sustainable development, waste, bio energy*

JEL classification: A12, O11, O13, P18, Q55

Introduction

Excessive use of natural resources has caused a number of problems with regard to their diminishing and the large amount of waste. For that is need to processing of renewable resources, as bioenergy sources. In this order, bioeconomy is defined as transforming sustainable, eco-efficient renewable biological resources for food, energy and other industrial products. The policy of European Union promotes the bioeconomy industrial perspective, proposing resource efficiency and sustainability, on the principle of aggregation of local knowledge, and improving capabilities, while allowing the maintenance of diversity and complexity. Bio-based Industries Consortium (BIC, 2016), a study on bioeconomy macroeconomic, enlarged on European states, shows that investments are made in the food, feed and beverages sectors, also in bio products - chemicals and plastics; pharmaceutical products, in paper and paper products, in forestry, textiles, biofuels and bioenergy. At the same time, employment in the European bioeconomy is important, but most employees work in primary production of biomass such as agriculture, forestry and

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fisheries. Therefore, the bio industry in the European Union is cumulated a turnover of 600 billion euros and 3.2 billion employees.

1. Bioeconomy and Promoters

The bioeconomy is a science which it refers to all production systems which involve biophysical and biochemical processes and which includes all the life sciences and technologies needed to make useful products. Georgescu-Roegen considers that only through economic development of the bioeconomy takes place economic development of human species on Earth in the context of global environmental. Georgescu-Roegen was mathematician and economist of Romanian origin, also a promoter of bioeconomy. In 1985, at Rome, Georgescu-Roegen has presented the own research in the field of bioeconomy, namely, new approaches to epistemology of science; interdisciplinary relationships between social sciences and natural; the impact of technology on social, economic and environmental; bioeconomy and green economy (Grinevald J., 1991).

Georgescu-Roegen is evolving vision of economic development of the human species associated with the laws of nature and, especially, the law of entropy as the second law of thermodynamics, which calls itself the most economical of the laws of physics. Georgescu-Roegen has realized the irreversibility of time, unpredictability and final "creative evolution" of nature. The scientific vanguard was noted Roegen N.G. (1971) and misunderstandings or controversies between entropy and evolution disappeared. Also, other scientists studied bioeconomy as Henry-Luis Bergson, who showed that determinism is an impossibility, and free will is pure mobility, and Alfred Whitehead (*The Concept of Nature*, 1920; *The Principle of Relativity with Applications to Physical Science*, 1922; *Process and Reality: An Essay in Cosmology*, 1929; *Nature and Life*, 1934).

For the new generation of bioeconomists, Georgescu-Roegen is the professional person who treats the human species in global ecological context.

The bioeconomy is development issue as underlined contemporary Roegen in their writings: Meyer F.(*L'Accélération évolutive*, Paris, Librairie des sciences et des arts, 1947; *Problématique de l'évolution*, Paris, PUF, 1954) and Jean Piaget (*Situation épistémologique de la biologie*, Ed. Logique et connaissance scientifique, Paris, Gallimard; *Encyclopédie de la Pléiade*, 1967, pp.781-821; *La surchauffe de la croissance: essai sur la dynamique de l'évolution*, Paris, Fayard, 1974). Through his socio-cultural, bio-anthropological and environmental concerns, Georgescu-Roegen anticipates nuclear era risks, and taking into account present and future generations of humanity, defines bioeconomy for the welfare of human and the health of the entire planet. The scientific paradigm (with its ethical dimension "Love your neighbor as yourself"), inseparable from the history of scientific and philosophical ideas of the twentieth century, proved to be thinking ahead of time. In Energy and Economic Myths, Roegen (1993) perceives reconciliation between economics (science particular economy attributed to the human species) and ecology (general science of the economy of nature, without ignoring man) only in

the direction of integrating the economy into the ecology respecting organizational and functional hierarchy (as in theory ecosystem / biological organization). Due of intensive industrialization and ignoring the ecology, including our membership at Biosphere, economy has gone bad (Ekins P. et al., 1992; Ekins P., 1986).

In the Program Bioeconomic minimal, Georgescu-Roegen has conceptualized some ideas able to ensure a standard of living humanity balanced and long. Thus, as a first priority, the author believes that not only the war itself, but also producing instruments of war should be forbidden completely. As a result, the developed countries as the main producer of arms, should reach a consensus on the ban. As a consequence of abandoning the policy of arming and using productive forces redundant, as by promoting measures planned, developing countries should be helped to reach an adequate standard of living and thus the wealth of the planet is no longer polarized. The level of living consists in food safety and security of the population, resorting to food from organic farming (based on natural stimulants). should decrease gradually, with the involvement of nations that register a population growth. Food consumption involves the loss or waste. Such situations, depending on the field, aimed at developing new industrial strategy on a global scale and adequate legislation. Exemplifying the author implies uncontrolled situations and managerial (nuclear and solar energy capture and storage), which limit energy waste (excess heating, cooling excess, excessive speed, excessive lighting, etc.), inclusive strict regulations.

The human evolution has led to immeasurable desire for extravagant gifts, energy goods, including cars. Companies that produce such consumer goods, according to Georgescu-Roegen proposed program, should focus attention on the sustainability of products, facilities utilization and especially their repair. Accordingly, the use and adaptation of multifunctional products are indicated by Roegen as bioeconomic lasting solution.

The desire to live "better", "mankind digging his own grave with his teeth!" Quotations listed are finding in wasteful consumption, from the annual even clothes to modernization, which, according to Georgescu-Roegen is a loss for economy. The solution of author goes to producers, raising the sustainability of products, use and repair facilities, and by consumers for the purposes of re-education for prolonged use of products not desire permanent new (despise fashion; to produce and consume products lesser as well as decreasingly sophisticated goods). Also, Georgescu-Roegen take into consideration not using disposable products (the circumdrome of the shaving machine). This thing is regarded from economic and ecologic point of view. As response to these ideas, the question is: is the human being willing to consider a program that involves a restriction of their habit? Recommendations of the program implemented are uncertain because destiny is to be short-lived but intense, exciting and extravagant, instead of a life long, uneventful and vegetative itself as Nicholas Georgescu-Roegen says. Some people live long, others live fast, this is the formula that works and among men and among other species. But man must not act in detriment of other living species that

populating Earth. In the current crisis, the world must act to conserve energy and matter (Roegen's answer). But here, there are two particularly important factors:

<table>
<tr><td>1.</td><td colspan="2">Reducing consumption for to slow depletion of vital resources to a minimum as to permit a reasonable survival of our species.
This involves adopting a program of austerity, not to go back to nature, how wrong some had interpreted the writings Roegenian</td></tr>
<tr><td rowspan="2">2.</td><td rowspan="2">To create a unique global management of material and energy resources, which have resource access equal to all the inhabitants of planet Earth. But Nicholas Georgescu-Roegen notes that this plan has obstructions</td><td>First of all, no one will give up willingly at luxury facilities to manufacture plows. The human species seems determined to have a brief existence but extravagant</td></tr>
<tr><td>Secondly, the nature conservation is not a program for a club, or a city or even a whole country. It requires the participation of all people in an organization that would manage the world resource use.</td></tr>
</table>

Romanian economists are pessimistic in the success of projects which could prolong human existence on Earth, because of selfishness "Probably, however, that the human race will disappear remaining economically segregated. It is possible that some of the last people to die in penthouses and others in shanties *Qui vivra verra!*"

The future of humanity will still be uncertain if not find industrial solution in order to protect environment. This statement is reinforced by the fact that the economists of the last century were located on efficiency issues at the expense of preserving and restoring the natural environment. The equilibrium comes through achieving "dynamic integration of humanity to the environment", which is a short definition of bioeconomy as a science. The special status of this science is in the fact that humanity have need ideas, concepts and laws in order to improve and clarify the ambiance of the planet. The living environment of humanity is defined by Şerban M. by the following relationship:

- Biological and diversity of the natural environment, aesthetic satisfactions, comfort offered by the natural environment, scientific developments determined by the environment = natural environment;
- Richness of useful artifacts created by people, aesthetic satisfaction and comfort offered by environment-related scientific developments antrophic, environment = anthropic environment;
- Richness of social relationship between people, degree of comfort and safety offered by the social environment, scientific developments related to social environment = social environment.

The environment is an important source of materials for human existence.

Therefore it needs to recognize its value. The problem is accentuated when environment is tampered with negative consequences in time. In this respect, the bioeconomy and its practices are essential. Through its support, economy measures

critical points between nature and policy (Brown L., 2011, pp. 12). Bioeconomy emphasizes the laws for reconstitute the biological voluntarism of humanity. Şerban M. (2013, pp. 113/114) specifies *the fundamental law of bioeconomy, which reffers to optimal living environment of humanity*. So it is imperative that, through appropriate mechanisms, to preserve the natural foundation and the climate system. The European Commission is working for transition of European countries towards a circular economy by stimulating global competitiveness and sustainability in order to generate new jobs. Saving civilization is possible by building a new economy, one without carbon emissin, one that allowed a diversified transport system, one that recycles everything (Brown L., 2011, pp. 163). The energy is an important factors in modern economy and privacy. About 89% of energy produced commercially comes from fossil fuels. But decrease of oil reserves and increase of its price, generated by geopolitical location of this fossil, have contributed to the promotion of biofuels. Thus, many countries increases the use of renewable energy in order to ensure its energy security of biofuels.

2. Bioeconomy as concept. European Commission position about bioeconomy

According to forecasts from statistical data, by year 2050, the world population will approach 9 billion people. In these conditions will grow requirements for food. To the truth that natural resources are limited, the European Commission has adopted a strategy and an action plan covering renewable biological resources need to food people and animals, but also for materials, energy and other products. A such situation lead to an innovative economy-a Bioeconomy for Europe. Specifically, the key aspects are: the development of technologies and processes for the bioeconomy; developing markets and competitiveness in bioeconomy sectors; a closer collaboration between makers and stakeholders.

Commissioner for Research, Innovation and Science, Máire Geoghegan-Quinn, has argued that "Europe must make the transition to a post-oil economy. A greater use of renewable resources is not just an option but a necessity. It is need to past from a society based on fossil fuel to a society based on ecological solutions, with research and innovation. This transition is good for our environment, our food and energy security, and for Europe competitiveness in the future (Source: European Commission). In this regard, Denmark, Finland, Germany, Ireland and the Netherlands as EU Member States have implemented bioeconomy strategy and at the international level, some countries as Canada, China, South Africa and USA have own strategies.

In the period 2010-2011, the European Commission organized conferences and workshops on the concept of bioeconomy. The bioeconomy is a concept which defines economy based on biological resources of land and sea and waste, including food waste as raw materials for industry and energy production. It also covers the use of ecological processes for eco-industries (European Commission, 2012b). The aim of bioeconomy is to achieve the policy objectives that have been

listed in the first draft of European Strategic and Action Plan for a sustainable bioeconomy by 2020 (European Commission, 2010c). These objectives are: reinforcing European leadership and creativity in the biosciences; optimizing innovation and the systems for knowledge transfer; research into safe, nutritious and affordable food; making rural and coastal economies more sustainable; improving the efficiency of agricultural, food and industrial production and distribution systems; maintaining the competitiveness of European industry and agriculture; building low-carbon industries; reducing emissions of GHG and waste. The results of these activities occur in 2012 in the Commission Innovation Sustainable Growth: a Bioeconomy for Europe (European Commission, 2012c). The progresses in bio-research allow Europe to improve the management of its renewable biological resources and to open new markets, diversified food and organic products. Thus, can create and maintain economic growth and jobs, reduce dependence on fossil fuels, with impact on improving the economic and ecological sustainability of industrial production and processing.

The Multi-annual Financial Framework for 2014-2020, and some of its key proposals, such as Horizon 2020 and the Common Agricultural Policy (CAP) post-2013, duly takes into account the bio-economy (European Commission, 2012c) (Schmid O. et all, 2012, pp. 49). EU intervention is essential to ensure the excellence and a critical mass for research and innovation, which will play a key role in developing bioeconomy (European Commission, 2012b).

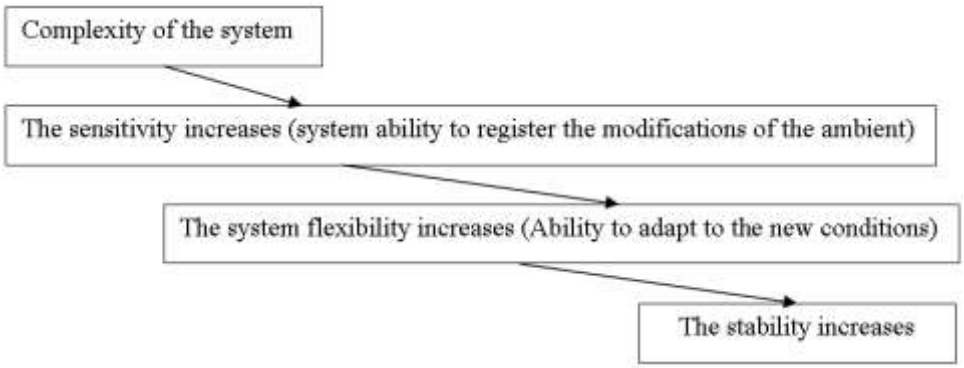
The relationships between bioeconomy concept and prospect of public goods. According to an OECD report on bioeconomy by 2030, the demand means " transforming science of life knowledge, eco-efficient and competitive, sustainable products" (The Organisation for Economic Co-operation and Development, OECD, 2009)**.** Bioeconomy manages the conversion of biomass (any biological material to be used as feedstock) for a range of food, for health, for fiber and industrial products and energy (The European Personnel Selection Office, EPSO, 2011:5). The biomass substitute fossil fuels hence present economic value.

To ensure the long-term economic growth of the bioeconomy, the definition should be non-restrictive (Schmid O. et al, 2012, pp. 58). A former Agricultural Commissioner, Franz Fischler, defined the Knowledge-Based Bioeconomy more broadly as: Production paradigms that rely on biological processes and, as with natural ecosystems, use natural inputs, expend minimum amounts of energy and do not produce waste as all materials discarded by one process are inputs for another process and are re-used in the ecosystem (European Commission, 2010b). The full potential of integrated bioeconomy should develop much more through relationships with public goods. In this respect, farmers have an important role.

3. Bioeconomy under inter- and transdisciplinary context

Eco and agro-eco-system. *Nature,* by living organisms, used ciclically the substances. For exemple, into respiration process, the animals use the oxygen and eliminate the carbon dioxide, that is necessary in photosynthesis of the plants, process which eliminates the oxygen. The plants biomass consists of $550*10^9$ t CO_2.

The vegetation products provide animal nutrition and their manure become a source of feed for plants and so on. Into this circulation, there are no wastes, residues or manure as standalone products. As a result, the ecological equilibrium is relatively stable over time, created during time between groups of micro-organisms, plants and animals, on one hand and the environmental conditions in which they are intrerconnected, on the other hand. The biological systems are open systems, informational ones and, due to their organization, they have the ability to self-preserv, self-reproduct, and self tune from simple to complex forms of organization. They have an anti-enthropic and complete behavior, which ensures stability in their relations with other systems. The biological system is a cybernetic one with milestones (reception, circulation, collection and processing of information, selection response, making system response to stimuli), defining self-regulation, as follows:



The living matter is organized on levels, the biological one representing the hierarchy into the organism (cell, tissue, organ) and supra-individuals (individuals, population, biocenosis, biom, biosphere).

The biological conditionings are present everywhere, and Şerban M. (2013) states that contemporary humanity is, at least, 15 times more related to natural circuits than her ancestors. The biocenotic level must be noticed, because the populations that interact fulfill essential functions (storage, processing and transfer of matter, energy and information), their activity taking place under abiotic conditions and the coexistence ensures balance. This level is the equivalent of anthropogenic activity, with objections to the biological productivity of plant and animal bodies operating as trading system.

Such statements would not have been possible without specialized studies, based on knowledge of organic chemistry, biology (physiology, morphology, systematic, genetic), climatology, meteorology, geography, soil science, geology and other (physical factors that influence organisms). Also, mathematics and computer simulation take a contribution in kind by long periods of time, while ensuring forecasting practical actions related to human activity at different levels, including managing climate change. Sixty percentage of the observations confirming global warming is attributed to increased CO_2 concentration from 280 ĩmol mol-1 during pre-industrial times to 360 mol-1 ĩmol nowadays. These accumulations have resulted from fossil fuel combustion activities (5-6*109 t / year), but also due to deforestation (1.1*109 t/year). In order to stop the increasing concentration of CO_2 such measures are recommended/promoted: programs to reduce the burning of fossil fuels; reducing deforestation and replanting programs elaboration; use of renewable energy sources; use of public transport etc.

The human being, creation of planetary ecosphere, to meet their own needs (own laws governing economic relationships), has acted on the environment and has caused disruptions into organic circuits. For an increased productivity, he had non-cyclically used "some substance" (contrary to the natural cycle), so lineary. The used scheme (raw materials - products - waste - waste or manure) builds and throws the residues into environment, which are sources of pollution to soil, water, air and thus lead to degradation of life conditions, generally speaking. As a result, the conflict between growth cycles trends managed anthropogenically and fixed natural resource limits it is inevitable, in other words, we are in difficultyof understanding the dynamics of exponential growth in a final environment.

Based on the estimation of the United Nations, the human population will continue to grow to 7.9 billion in 2025. Simultaneously, the demand for energy, food and nutrients will increase too.

Agriculture. All programming documents on strategies related to the bioeconomy in Romania refer to potential agricultural and agro-bio-economy value chains that rely on crop yield (Figure 1). Climate change is crucial in crop adjustments, having thus a significant impact on biodiversity and food security—considerable alterations in agricultural systems are required in the areas subjected to decisive modifications in climate (Andrei J.V. et al., 2016, pp. 400).

Intensive agriculture involves direct active energy consumption (fuel, electricity; 43-44%) and indirect active + passive one (fertilizers, pesticides and machinery; 37-56%) larger (ex .: France, Sweden; Mănescu B., 2000 cited by Bran M., 2005, pp. 31). Agricultural yield receives free renewable energy, in various forms (solar radiation, wind energy, organic material from plants and animal husbandry, mineral and soil organic matter), being already registered great possibilities for reducing consumption of conventional energy.

By analyzing the energy efficiency one can demonstrate the characteristic, less known, of the agriculture, as not consuming energy. Agriculture is the largest producer of energy in foods that maintain people's lives. Between economic analysis and energy crop of wheat, for example, there may be an inconsistency, in

the case that the price for a kg of grain is below cost for smaller yields (ex .: 3000 kg/ha). In this case, the crop is inefficient, in economic terms, but can be effective in terms of energy. The inconsistency is determined by the fact that nature is generous and makes the process of photosynthesis by using solar energy, the wheat yield could accumulate a larger amount of energy than consumed one, for 4-5 times greater. Thus, one unit of energy produces 4-5 units of energy, while cash benefit represents 30% of the value obtained from wheat crop or a profit rate of up to 50% (benefit x 100: total expenditure)(Bran M., 2005, pp 43). At higher yields (5000 kg wheat grains/ha +by-product yield), an unit of energy produces 5.37 energy units (3.49 units D.C. energy per unit energy consumed by grain yield). Energy efficiency best express the importance or value of crops as major sources of energy (Bran M., 2005, pp 43).

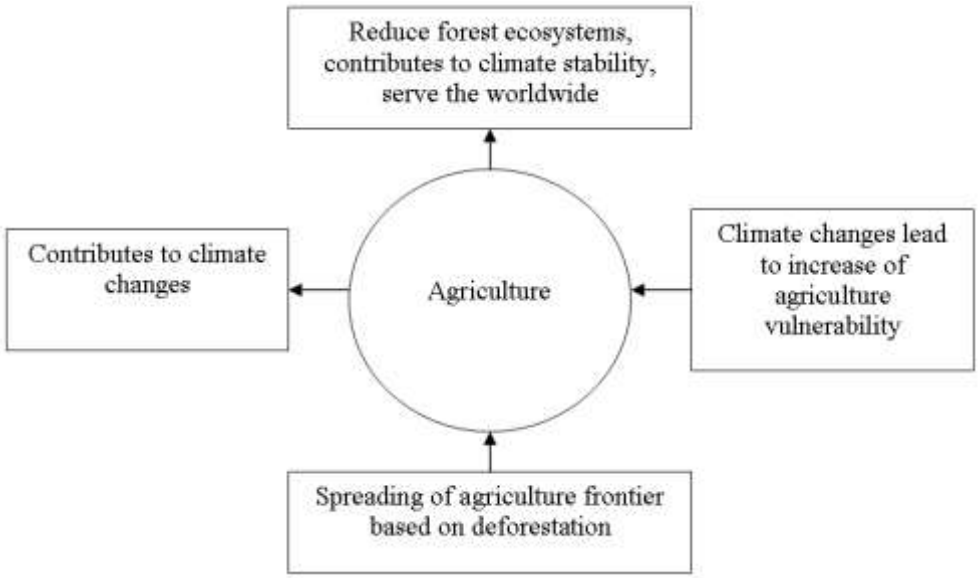


Figure 1. Agriculture and climate changes: need to change a perfect vicious cycle

The crop yield is dependent on environmental factors that cannot substitute for, but must be interdependent, pro-life (rational management of resources in order to avoid inbalances nature conservation, pollution prevention, ecological rehabilitation, if any).

The agricultural ecosystems have the same characteristics with natural ones, individualized by some peculiarities. For example, agricultural ecosystem biocenosis and biotope have some historical base, the farmer directs the biotic and abiotic conditions in an optimum way, based on the information level in the area, while maintaining dynamic balance. The number of exploited species is reduced, food chains are short, and the main yield is managed by different consumers,

depending directly on stability of intensity and character of anthropogenic interventions. The flows of energy and materials have increased, not always positive, and the flow of information enabled the modernization of production technology, currently pulling the alarm over the management of production resources. As a result, the system of sustainable agriculture is pursuing agroclimax status, economic efficiency for the farmer and the effects of conservation of natural resources, integrating livestock and vegetable sector, not least, harmonious rural development (Penescu A., 2015, pp. 172-174).

4. Bioeconomy, opportunity for Romania development

"Bioeconomy" after Romania's position is not just a term of "jargon" bureaucracy of Brussels, but an action plan which aims to mobilize scientific research and natural resources in a combination to determine the "economy innovative with less fewer emissions "harmful to human health," sustainable agriculture and fisheries "food and energy security and" long-term use of renewable biological resources for industry, ensuring environmental protection and biodiversity" (Buradu C., 2016).

The National Strategy for Competitiveness 2014 - 2020 consists of "objectives that involve employment of resources towards the release of some production and high-level research sectors in areas with high potential for smart specialization (bioeconomy, information technologies and communications, energy and the environment, eco-technologies), industrial rehabilitation through smart specialization and creativity knowledge as sources of competitive advance ".

The bioeconomy has the important economic role with high influence on employment in tourism and ecotourism. Also, its competitive dynamics must be manifested in food and beverage processing, given to consumer protection and construction of healthy products. The innovation, technological development and added value, as direction of industrial policy, identify the sectors with high potential for smart specialization, namely bio-economy (with implications for agriculture, forestry, fisheries and aquaculture), biopharmaceutical and biotechnology. These and other smart specialization areas offered by CDI Strategy 2014 - 2020 are indicated as providing structural dynamics of the economy and, through its role in boosting innovation and technological development, to ensure the integration of global value chains.

The Ministry of Education has promoted, in 2013, among the priorities of smart specialization in the field of bio-economy research, ie, some consumer goods industries: Safe, affordable and nutritionally optimized foods; Development of new products, practices, processes and technologies in horticulture; Adapting sector animal husbandry, veterinary, fisheries and aquaculture to the challenges of XXI century; Sustainable development production of field crops adapted to the impact of global climate change; Sustainable development of the forestry sector and increase its competitiveness; Bioenergy - biogas, biomass, biofuel; Bio-nano-technologies; Industrial Biotechnology; Environmental Biotechnology; Agri-food

biotechnology; Medical biotechnology and pharmaceuticals; Bioanalysis; Molecular design (bio) synthesis, semi-synthesis, high through screening; The *in vitro/in vivo* evaluation during the design process of generic drugs; Systemic formulations, and local transportation target for biopharmaceutical and pharmacokinetic profile optimization.

In Romania, bioeconomy is one of he most important sector in terms of share of the labor force (Figure 2, National Institute of Statistics, NIS, 2012). Prevailing are economic sectors that produce bioresources (agriculture, forestry and fishing) or sectors that processing bioresources with value-added relatively low (for instance food). Oancea F. (2014) noted, for Romania, the reduced weight of bio-economic sectors with high productivity, which to produce a significant added value and a major contributor to quality of life (industries, human health associated services / bio biomedical economy).

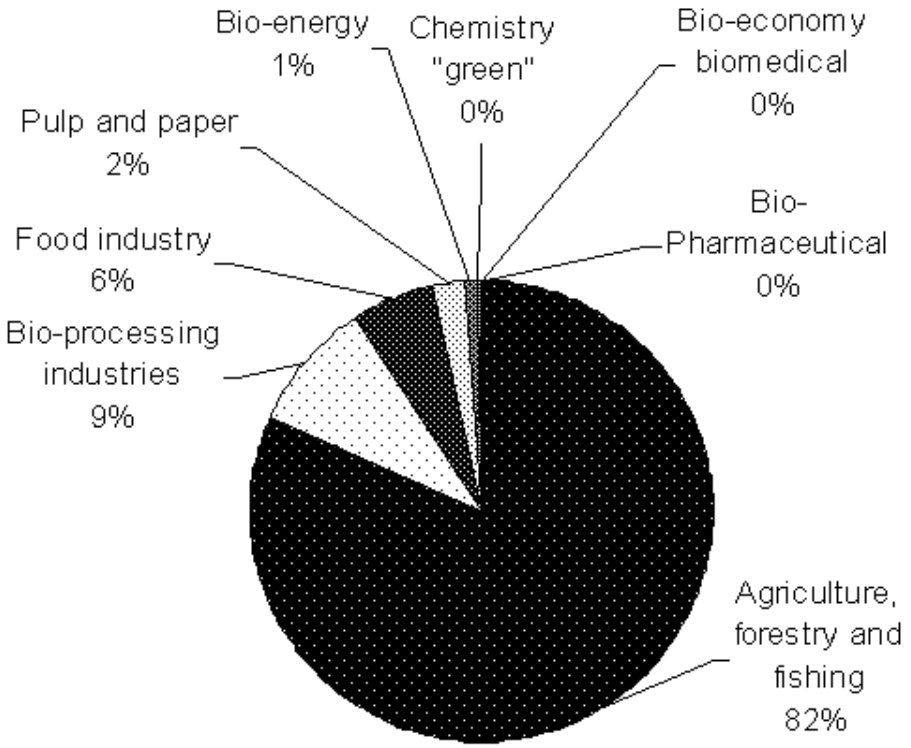


Figure 2. Romanian active labor force employed in bio sectors, %

The proposals are based on the economical arguments. For instance, regarding just foods, the NIS data (2011) showed that the food industry, by its 8239 registered operators, has produced 7-8% of Romania's total exports. The food industry, the largest manufacturing sector all over the country, exceeded the

turnover of 44 billions RON, while the foods had 35% of retail, at that moment. No matter of situation, the foods must be safe, affordable and nutritionally optimized.

Conclusion

It is found that the bioeconomy is a science which refers to all production systems that involve biophysical and biochemical processes and includes all the life sciences and technologies needed to make useful products. For the new generation of bioeconomists, Georgescu-Roegen is a personality in the bioeconomy field, who has treated the human species in global ecological context. Due of intensive industrialization and ignoring the ecology, including our membership at Biosphere, economy has gone bad. The future of humanity will still be uncertain if not find industrial solution in order to protect environment. It has been found that the environment is an important source of materials for human existence. The biological systems are open systems, informational ones and, due to their organization, they have the ability to self-preserv, self-reproduct, and self tune from simple to complex forms of organization. Mathematics and computer simulation forecasting ensured practical actions related to human activity at different levels, including managing climate change. The human being, creation of planetary ecosphere, to meet their own needs (own laws governing economic relationships), has acted on the environment and has caused disruptions into organic circuits. The European Commission has adopted a strategy and an action plan on key aspects: developing technologies and processes for the bioeconomy; developing markets and competitiveness in bioeconomy sectors; closer cooperation between policy makers and stakeholders. It was noted reducing of bio-economic sectors with high productivity, that to produce a significant added value and a major contributor to quality of life.

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