Opportunities and challenges in implementing a bioeconomy strategy: the university perspective

Chapter 3

Ülle Jaakma

1. Global challenges

To cope with an increasing global population, rapid depletion of natural resources, increasing environmental pressures and climate change, Europe is preparing to concentrate on more sustainable and responsible use of biological resources.

The world population is expected to increase by more than 30% in the next 40 years, reaching more than nine billion in 2050 (European Commission, COM(2012) 60 final).[1] The growing population needs more food. Global food production is expected to increase by 3% annually in the years before 2030, in contrast to recent growth of just over 2%. Improvements in food productivity are needed to reach this goal.[2] Food production is coming under pressure owing to limitations of land resources, environmental problems, and competition with other land users and expanding urbanisation. Earth has a finite amount of land and arable land constitutes only 1/32 of the total area of our planet.[3]

Climate change – which includes average temperature increases, droughts and flooding, storms and hurricanes, rising sea levels, polar ice melting – is another global challenge. According to data from the European Environment Agency, the average temperature during last 150 years has increased by nearly 0.8°C and in Europe, nearly 1°C. To prevent the most severe impacts of climate change, the countries that have signed up to the United Nations Framework Convention on Climate Change (UNFCCC) agreed to limit the global mean temperature increase since pre-industrial times to less than 2°C.[4]

The need to reduce greenhouse gases (GHG) emissions and the depletion of fossil fuels forces us to look for alternative energy resources and more efficient technological solutions. Renewable energy still remains underused in most countries. Unless we develop alternative and sustainable energy production and saving systems, the energy crisis problem cannot be solved.

The EUROSTAT monitoring report of the 2015 EU Sustainable Development Strategy[5] shows that while the EU has made progress towards several of its objectives, a number of unsustainable trends still persist. Regarding the environmental dimensions, GHG emissions have steadily decreased in the long run and primary energy consumption has declined since 2008. Meanwhile, biodiversity within the EU has been under continuous pressure mainly due to increased use of land for agriculture, infrastructure and human settlements.

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[1] http://ec.europa.eu/research/bioeconomy/pdf/official-strategy_en.pdf

[2] Watts, C. Agriculture in High Growth Markets, Economist Intelligence Unit., London, 2012, http://graphics.eiu.com/upload/eb/EIU-PC_AgricultureBRICs_Original_Web.pdf, accessed on 27.01.2017

[3] Rickson, RJ. The importance of soils for food security. Presentation on OECD CRP GB meeting, 01.12.2015

[4] The United Nations Framework Convention on Climate Change (UNFCCC), Paris Agreement 2015

[5] Sustainable development in the European Union. 2015 monitoring report of the EU Sustainable Development Strategy. ISSN 2443-8480, EUROSTAT, 2015, http://ec.europa.eu/eurostat/documents/3217494/6975281/KS-GT-15-001-EN-N.pdf

Development of bioeconomy strategies

To meet the global challenges and mitigate the unfavourable trends in Europe, we must set the course for a more resource-efficient and sustainable economy. On 13 February 2012, the European Commission adopted the strategy "Innovating for Sustainable Growth: A Bioeconomy for Europe".[6]

The bioeconomy refers to the production and conversion of biomass into value added products, such as food, feed, biobased products and bioenergy[7]. The bioeconomy offers an opportunity to address interconnected societal challenges such as food security, natural resource scarcity, fossil resource dependence and climate change, while also achieving sustainable economic growth. The strategy is focused on reaching the aims for three pillars: investments in research, innovation and skills; reinforced policy interaction and stakeholder engagement; and enhancement of markets and competitiveness.

Following a bioeconomy stakeholders' conference held in Utrecht in April 2016, a manifesto was published that sets out a roadmap for the development of the bioeconomy in the EU.[8] The manifesto defines the bioeconomy as: "those parts of the economy that use renewable biological resources (biomass) from land and sea – such as crops, forests, fish, animals and micro-organisms, as well as biological residues and waste – to produce food, animal feed, materials, chemicals, fuels and energy in a sustainable way." The manifesto sets out the main principles guiding the work towards a sustainable bioeconomy: "A foundational principle is ensuring the sound use of scarce land by promoting ecosystem resilience, nutrient balance, biodiversity and soil fertility. A bioeconomy closes the cycles of biomass and contributes to a circular economy." Investments are necessary in the optimal production, use and reuse of biomass, in waste prevention and in the recycling of waste. The manifesto highlighted the importance of education, training and the transfer of knowledge for a future bioeconomy. The central role of regions as key actors in developing a European bioeconomy was also stressed. Regions are important to enhance vital rural economies and to close regional cycles.

Many countries in Europe (Austria, Denmark, Ireland, Germany, Sweden, Finland, Norway, Netherlands, France, Belgium) and worldwide have already launched their bioeconomy strategies[9] and more countries are in the process of defining their national goals in the development of the bioeconomy. These strategies differ as the nature of global challenges and natural resources vary in different countries and regions. Regional collaboration is a key issue in developing sustainable bioeconomy.

Regional aspects in development of bioeconomy

Estonia together with the Baltic and Nordic countries, Poland and part of Germany belong to the Baltic Sea area. As part of the ECOSUPPORT project – a BONUS-funded project under the coordination of the Swedish Meteorological and Hydrological Institute combined future impacts of climate change and industrial and agricultural practices on the Baltic Sea ecosystem were assessed.[10] The climate-change scenarios for the Baltic Sea show that the water temperature will increase and salinity will decrease. Warmer water changes the oxygen saturation concentrations and turnover rates of biogeochemical processes, enhancing eutrophication effects. This means increased

[6] https://ec.europa.eu/research/bioeconomy/index.cfm?pg=policy&lib=strategy
[7] Definition of the European Commission COM(2012) 60 final
[8] http://www.bioeconomyutrecht2016.eu/
[9] http://www.bio-step.eu/background/bioeconomy-strategies.html
[10] http://www.baltex-research.eu/ecosupport/

hypoxic bottom areas, reduced biodiversity and increased risk for acidification. The results indicate that further nutrient load reductions are necessary to reduce human-induced impacts on the state of the marine environment. A sustainable green economy, including energy systems, agriculture, forestry, transport and urban development, are critical to save the ecosystems of the Baltic Sea and surrounding countries with 85 million inhabitants.

The European Union Strategy for the Baltic Sea Region (EUSBSR), approved in 2009, is the first macro-regional strategy in Europe. It is divided into three objectives, which represent three key challenges: saving the sea, connecting the region and increasing prosperity. The strategy also includes horizontal actions, which for example, include cooperation on spatial planning or climate change mitigation and adaptation.[11] The Baltic Sea region has rich natural resources and could serve as an excellent model for the implementation of bioeconomy principles. Scandinavian and Baltic countries are famous for their forests – they are sources of wood, novel products and materials, chemicals, and biomass for energy. This region is quite rich in land for the production of food, biomass for feed, biofuels and materials. Besides the Baltic Sea, there are lakes and rivers that are important providers of ecosystem services. The region has well-developed infrastructure and technological and environmental knowledge. The Nordic Council of Ministers is taking leadership in the for the EUSBSR action plan to enhance cooperation within the bioeconomy.[12]

Although some countries in the Baltic Sea Region have already established holistic bioeconomy policies and strategies, in other countries the processes for developing such policies and strategies are still in progress. For example, in Estonia, bioeconomy principles have until now been realised through sector policies, such as within agriculture, fishery, forestry, environment, research and innovation.

Bioeconomy strategy in Estonia

In Estonia, the development of bioeconomy-related sectors falls mainly under the government's responsibility, namely the Ministry of Rural Affairs, the Ministry of the Environment, and the Ministry of Economic Affairs and Communications. The Ministry of Rural Affairs has coordinated the process of preparing the Estonian Bioeconomy Strategy. "The purpose of the preparation of the Estonian Bioeconomy Strategy is to create a strategic framework for binding the areas of bioeconomy, which would, for the growth of the welfare of the people, help to make the production and use of biomass as effective and environmentally friendly as possible, thus increasing the value of the existing land and water resources to the limit."[13]

In February 2015, a conference was held to gather input from public and private stakeholders on developing the strategy. In Estonia, there is twice as much arable land per capita than the EU 27 average (0.69 ha and 0.37 ha, respectively). The proportion of jobs in agriculture, forestry and fishery is 4.3% (around 26,500 employees); meanwhile, the proportion of value added in these sectors was only 3.6% of total value added in 2013. Nearly half of the country is covered by forests (48.2%), 75% of which is under management, making Estonia one of the most forest-rich countries in Europe. The share of renewable energy was 13.5% in 2014 and is increasing (16.2% in 2015[14]).

There are more than 20 different bioeconomy-related strategies and action plans across the different sectors. However, but no common strategic framework exists to connect the different areas and fully utilise the value of existing land, forest and water resources or support effective and

[11] https://www.balticsea-region-strategy.eu
[12] http://bsrbioeconomy.net/eusbsr.html
[13] https://www.agri.ee/en/objectives-activities/bioeconomy
[14] http://www.erametsaliit.ee/2015/10/21/biomassist-toodetud-elektrienergiat-60-taastuvenergia-toodangust

environmentally friendly production and biomass use (oral presentation by A. Noot, 04.02.2015[15]).

The analysis and proposals to develop the Estonian bioeconomy strategy until 2030 were prepared by the Ministry of Rural Affairs in 2016.[16] As stated in the paper, the main problem in bioeconomy-related areas is the low value added per employee (EUR 23,000–25,000 versus an average of EUR 61,000 in the EU). Furthermore, we do not efficiently use all bioresources or the potential to produce these resources. For example, 11.2% of agricultural land is out of agricultural production, while the supply of meat, eggs, fruits and vegetables is not sufficient. Important components for development are food security and energy security (i.e., renewable energy, efficient use of waste, innovation) in terms of both processes and products as well as balanced regional development.

Despite all the preparation processes, there is still no consensus on the need for a common national bioeconomy framework at government level. Nevertheless, ministries have agreed to launch an open call for the research-based analysis "Increase of value added and efficiency in the sectors of bioeconomy", and establish a coordination committee for future activities.

University and bioeconomy

Developing the bioeconomy and the circular economy is impossible without substantial support by universities and research institutions providing well-educated and skilled specialists and the scientific base to create new technologies. However, in terms of the bioeconomy, this is a difficult task. We have already mentioned the need for well-designed collaboration between sectors and individual companies guided by well-grounded and feasible strategies. At university level, we need to develop an integrated approach involving economy, society, natural sciences, technology and lifelong learning. This involves efficient linking of new knowledge with innovative production processes, awareness of markets and the economy. The universities should rethink the traditional approach where the curricula are faculty-based. We must move towards a multidisciplinary approach.

Estonian University of Life Sciences (EMU, www.emu.ee) is the only university in Estonia where all academic and research activities are related to the sustainable development of natural resources as well as the preservation of heritage and habitat. It is a small university with about 400 academic staff and 3,300 students. According to QS World University Rankings by Subject (2016), EMU is one of the top 100 universities in the world in the field of agriculture and forestry, ranked 51 to 100.

The Estonian University of Life Sciences development plan for 2016–2025 focuses on serving society and increasing the university's competitiveness by building up and boosting the strength of the university through an integrated value chain approach in bioeconomy sectors. The university's mission is to create and share knowledge with bioeconomy promotors for the best of nature and humans.

The university's academic specialisations are concentrated in six main areas – agriculture, environment, forestry, health and food, technology and engineering, and rural economy (Fig. 3.1).

[15] https://www.agri.ee/sites/default/files/content/ministeerium/uritused/2015/biomajandus-2015-02-04-noot.pdf; in Estonian

[16] https://www.agri.ee/sites/default/files/content/arengukavad/biomajandus/2030/analuus-2016-biomajanduse-strateegia-2016-05-17.pdf; in Estonian

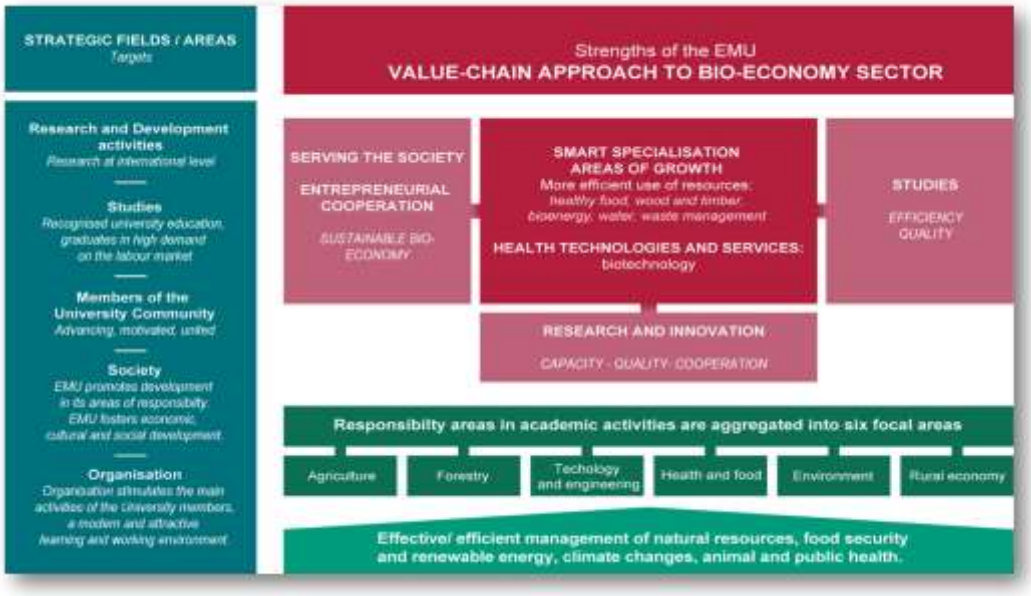

Figure 3.1. The focal areas, tasks and strategic targets of the Estonian University of Life Sciences in 2016–2025.

Internationally competitive **research and development work**, which forms a basis for **teaching** at all levels of higher education, as well as activities promoting the development of the **society** in speciality areas, are the driving force of the university. The university will gain the necessary competence to address different areas of bioeconomy in research and development activities and in teaching with sufficient coherence and from a value chain perspective.

There is a long way to go in shifting traditional teaching and focused research towards a multidisciplinary approach. However, we already have examples demonstrating that societal needs can be excellent driving forces for the development of a value chain approach.

Polli Horticultural Research Centre of EMU provides a good example of the pipeline of innovation and entrepreneurship (Fig. 3.2). Polli Centre is famous for breeding new apple, plum, sweet cherry, black currant and raspberry cultivars and research in new technologies for fruit and berry cultivation, plant protection and organic gardening.

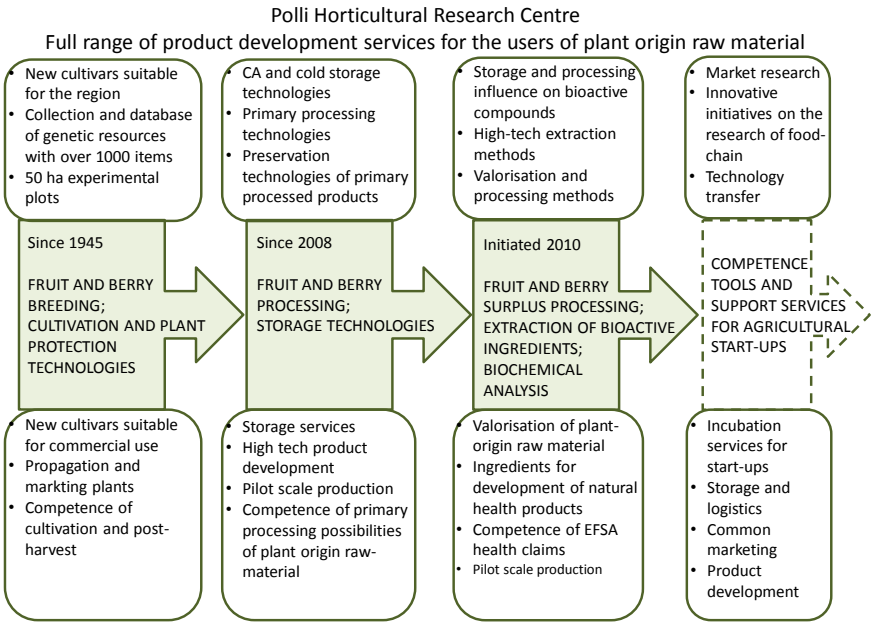

Figure 3.2. Development of the value chain approach at the Polli Horticultural Research Centre – from breeding and cultivation to valorisation of raw material, product development, technology development and market research.

Gradually, the knowledge in fruit and berry processing and storage technologies increased the build-up of advanced product development technologies and the implementation of modern storage technologies. In 2010, Polli Horticultural Research Centre, in collaboration with industry partners, established the PlantValor Competence Centre for Knowledge-Based Health Goods and Natural Products.[17] The Competence Centre is unique in Estonia as its main field of activity and niche lies in the research and development of health goods and natural products using modern, high-tech methods, including extraction of bioactive ingredients of plant origin that are used in functional foods, eco-cosmetics, household chemicals, pharmaceuticals etc. The main goal of the project is to consolidate and mobilise sectorial expertise as well as other resources and raise the sectorial competitiveness via international networking, research, and development based on both academic excellence and business innovation.

Today, the centre has more than 20 contractual partners and provides different services like laboratory and pilot scale extraction of bioactive compounds from plant material, infrared-, spray- and freeze drying, development of food and non-food products, quality analyses, consulting and project management. The centre is actively involved in university teaching, providing excellent opportunities for training and contacts with the companies.

Because Estonia generates more than 40% of the bioeconomy turnover in forestry[18], the university's role in supporting the forestry value chain is of great importance. Today, forest value chain is partly

[17] http://www.plantvalor.ee/index.php/home/

[18] Ronzon, T., Santini, F. and M'Barek, R. (2015). The Bioeconomy in the European Union in numbers. Facts and figures on biomass, turnover and employment. European Commission, Joint Research Centre, Institute for Prospective Technological Studies, Spain, 4p.

covered by the academic teaching, research and innovation at EMU (Fig. 3.3). It is well developed in areas such as silviculture, production and harvesting technologies, wood construction, renewable energy and recreation services and supported with basic and applied research in these fields. Wood processing and biorefining, however, are covered in collaboration with other universities in Estonia.

Figure 3.3. Forest value chain – one of the most important for the Estonian bioeconomy.

These were two examples where research and development, teaching and collaboration with the industry clearly support the value chain approach and thus contribute to development of the bioeconomy. However, there is still a long way to go. Many questions do not yet have a clear answer. We need efficient collaboration with policymakers and the bioeconomy sectors to identify what type of knowledge and competences need to be developed. Both universities and future students expect to get more information on the prospects of the labour market in the bioeconomy sectors.

Integration of the bioeconomy in the curricula is an important action with potential outputs in the medium and long terms. It is important to analyse and decide on whether to integrate bioeconomy and value chain approaches into the existing curricula (plant and animal science, food technology, forestry, energetics, etc.) or launch a separate curriculum to address different aspects of the bioeconomy. The diversity of bioeconomy sectors is especially hard to tackle for educational institutions in small countries. Another issue is choosing between individual approaches in teaching covering many areas of the bioeconomy versus option for a select number of tracks. Improved collaboration between the university and industry is necessary for the integration of academic studies and practical experience.

It is clear that the most promising innovation areas develop at the interface of different sectors. Development of a multidisciplinary approach is possible via active networking inside and outside the university. Exactly what the bioeconomy includes is not yet clear to society or even to policymakers at times. Often it is limited to improved use of natural resources; the ecosystem services and environmental aspects are considered secondary aspects.

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In Estonia, additional barriers for universities are related to research, development and innovation

funding, which has been quite unstable as it is mainly project-based. Most companies are still small and not able to make large investments in R&D.

Today's research and curricula changes will guide tomorrow's bioeconomy successes. Therefore, universities' responsibilities in making the right decisions is particularly important given the time lag between the initiation of research or new curricula and the uptake of results by users. The right decisions can be made only through active collaboration among a broad range of stakeholders.