

Green skills that are required by farmers and related stakeholders as part of the circular economy society

Ingrida Kazlauskienė, *Gintarė Vaznonienė, Vilma Atkočiūnienė, Jurgita Zaleckienė

Vytautas Magnus University, Faculty of Bioeconomy Development, Department of Business and Rural Development Management, 10 Universitetas street, Akademija, Kaunas distr., Lithuania

Abstract. Sustainable global development calls for a circular economy society with green skills. Farmers and related stakeholders play a crucial role in moving towards a society based on a circular economy, and in line with this position the study focuses on green skills for farmers and related stakeholders managing rural change within the framework of a circular economy society. The aim is to investigate the green skills necessary for Lithuanian farmers and related stakeholders to successfully implement circular economy principles within the agricultural sector. Empirical survey background was formatted from literature review, the data for the empirical survey was collected using a questionnaire survey of Lithuanian farmers and related stakeholders and focus group with Vytautas Magnus University Faculty of Bioeconomy Development academic community and student discussions. The data were collated, synthesised and modelled in order to identify the green skills needed for farmers and related stakeholders to implement the principles of the circular economy in rural society and to be active circular economy society members. The findings explored the significance of developing cognitive, technological, social, and action green skills for farmers and related stakeholders through a whole institution approach (WIA). The links between green skills move in a circle: when cognitive green skills change, technological, social and action green skills change also. The pinnacle of circular economy society green skills lies in action prowess, empowering farmers to not only use, but also to innovate green technologies.

Key words: green skills, farmers, related stakeholders, circular economy society, whole institution approach.

Introduction

The shift towards a circular economy has arisen as a pivotal strategy for addressing pressing environmental challenges while fostering sustainable development worldwide. Central to this transition is the cultivation of green skills among various societal participants, enabling them to effectively integrate into green jobs and practices essential to a circular economy society. In particular, the agricultural sector plays a critical role in this transition, given its significant impact on resource utilisation, food production, and environmental sustainability.

This article aims to investigate the green skills necessary for Lithuanian farmers and related stakeholders to successfully implement circular economy principles within the agricultural sector. In doing so, it seeks to contribute to the broader discourse on sustainable agriculture, practices of circular economy, and the fostering of green skills

in rural areas. By examining existing literature and empirical evidence, this research aims to shed light on the specific green skills required for farmers and related stakeholders to excel within a circular economy setting and offer valuable perspectives into the potential pathways for their cultivation.

Previous studies (Bianchi, Pisiotis, & Giraldez, 2022; Jaeger-Erben *et al.*, 2021) have highlighted the importance of green skills in various sectors and their role in promoting sustainability. However, there remains a gap in understanding the specific green skills needed by farmers and related stakeholders in the context of circular economy principles, particularly in Lithuania. While some research has addressed the theoretical frameworks and principles of a circular economy society, there is limited empirical research focusing on the practical implementation of these principles in the agricultural sector and the associated green skills required.

* Corresponding Author's email:
 gintare.vaznoniene@vdu.lt

DOI: 10.2478/plua-2024-0014

© 2024 Gintarė Vaznonienė et al. This is an open access article licensed under the Creative Commons Attribution-NonCommercial-NoDerivs License (<http://creativecommons.org/licenses/by-nc-nd/3.0/>).

Building upon the work of scholars such as Padilla-Rivera, Russo-Garrido, & Merveille (2020), Nordin *et al.* (2022), and Velasco-Munoz *et al.* (2021), this study seeks to deepen our comprehension of the convergence of circular economy principles, agricultural practices, and green skills development. By identifying the green skills essential for Lithuanian farmers and related stakeholders, this research aims to inform policymakers, educational institutions, and stakeholders involved in agricultural development and sustainability initiatives.

The tasks of this study are:

- To explore the theoretical features of a circular economic society.
- To define and classify green skills.
- To identify the specific green skills needed by Lithuanian farmers and related stakeholders to participate effectively in a circular economy society.

Material and Methods

The implemented empirical research is the pilot research. The presentation of research results regarding this topic include just a part of Lithuanian findings as it was as part of an international ERASMUS project, in which several countries participated such as Italy, Greece, Lithuania, Romania and North Macedonia (see Acknowledgement). This justifies the specific sample size which was used in the first step of our research – for the implementation of the questionnaire method.

There were two research methods used and the research was conducted in the following sequence:

- 1) *firstly*, the most recent sources of scientific literature were analysed. This analysis helped to identify the variables of the study, identify circular economy description and theoretical features, define and classify green skills and to select the most appropriate empirical research methods;

- 2) *secondly*, on the basis of the theoretical analysis, a questionnaire for farmers and related stakeholders and questions for academics and students focus group were developed as the instruments of the empirical study.

Data for the empirical study was collected by applying a two-step research. Firstly, using a questionnaire, the survey was conducted with farmers and related stakeholders. Secondly, a focus group discussion with academics and students was implemented. The logic scheme of the study is presented in Fig. 1.

The farmers and related stakeholder's questionnaire survey aims to determine the frequency of application of circular farming skills needed to implement circular farming principles in a circular economy society. In general, respondents were asked to indicate which of the principles of circular agriculture they were aware of, which they had the skills to apply and which they had never heard of at all. The questionnaire for the farmers' and related stakeholders' survey consisted of 17 questions (see Table1).

There were 5 questions in the questionnaire directly related to green skills issue:

- Where did you get your knowledge about circular agriculture? (Q8)
- What opportunities exist to acquire knowledge and qualifications related to circular agriculture in Lithuania? (Q9)
- Where should the agricultural specialists who are to know the principles of circular agriculture be trained? (Q10)
- What knowledge and competences are important to develop circular agriculture? (Q11)
- Do you think you have enough knowledge and competence to develop circular agriculture? (Q12)

To all the questions mentioned above, the response options were the same: "Disagree", "Don't know/difficult to answer" and "Agree".

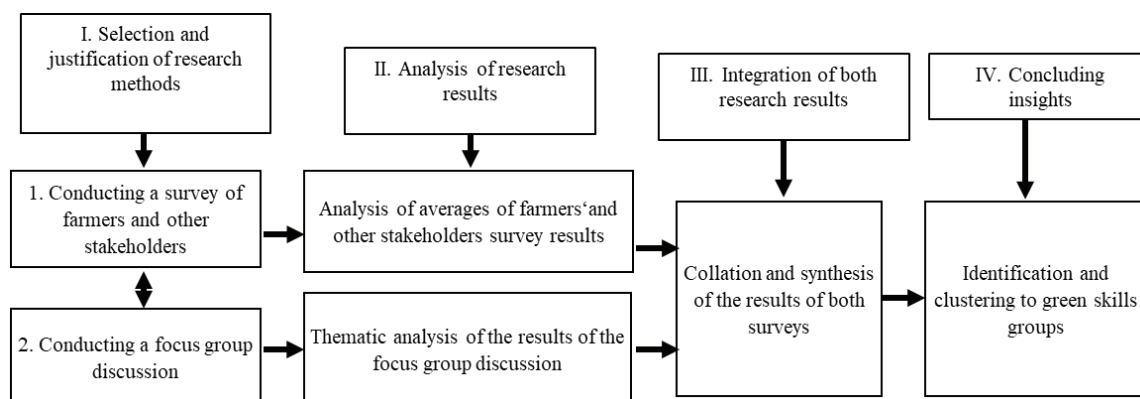


Fig. 1. The logic scheme of the research.

Table 1

Groups of questions and their aims

Group of questions	The aim of the group of questions	Questions number
1. Circular economy, circular agriculture and related decisions	To explore circular economy and agriculture principles and solutions, farm/business environmental characteristics and solutions, characteristics of production, political decisions important for implementation of circular economy principles, problems that are typical for the small and medium farms/enterprises	1–7
2. Knowledge and qualifications related to circular agriculture, green skills	To disclose importance of knowledge about circular agriculture, competences and qualifications related to circular agriculture, training possibilities	8–12
3. Respondent profile	To identify key sociodemographic characteristics of respondent	13–17

The questionnaire survey was conducted in November – December 2022. The questionnaire was anonymous. In order to achieve anonymity, convenience of conducting the survey, as well as the availability of respondents and user-friendly data import for processing, the data collection was carried out using the Google Forms data collection tool. A total of 50 responses were received as it was a pilot study. The results of the questionnaire survey were processed by calculating the averages of the responses to each question and then categorising them according to thematic areas - types of green skills. The results of the questionnaire are applied to the target group who participated in this survey. Some key sociodemographic data were obtained about this target group:

- 39 of the respondents live in rural areas (village, farmstead, suburb) and 11 of them live in urban areas (city, town);
- 20 of the survey respondents are farmers, 3 of the survey participants are entrepreneurs, 16 are specialists, 3 are academics, 5 are students, and interns, and 3 of the respondents are not active in the labour market;
- 35 of the survey respondents have higher education, 5 have college education, and 20 have secondary, vocational, or other education.

The data obtained from the farmers and related stakeholder's questionnaire was then used for focus group interviews.

The focus group discussion was held with Vytautas Magnus university Faculty of Bioeconomy Development academics (N=12) and students (N=7) who study in the master's study programmes of Rural Development Administration, Agricultural Business Management, Business Logistics. Academics were selected as experts, because they are key players in the green knowledge transition in Lithuania. The selected academics have carried out research

on sustainable rural development and the circular economy and agriculture and have been exposed through professional and study activities to the green skills that farmers and related stakeholders may need to be part of a circular economy society. The focus group discussion was conducted remotely using the MS Teams platform in April of 2023, and followed a semi-structured format, when open questions were asked, and participants were allowed to express their opinions freely. The questions given to the focus group discussion were:

- 1) What are green skills?
- 2) What skills do you need to work and live green - sustainably?
- 3) What skills farmers and related stakeholders lack in order to move to a circular economy?

A qualitative thematic analysis method was used to analyse the focus group data and categorise them according to thematic areas - types of green skills. The qualitative research software Maxqda was used for data processing. The focus group participants' statements and the results of the questionnaire survey were coded with the help of this software in order to classify the green skills to types and subtypes. Maxqda was also used to visualise the results. In order to maintain the confidentiality of the focus group participants, they were given codes consisting of the letter P (participant) and a number.

The research results were collated, synthesised and modelled to identify the green skills and their types, which farmers and related stakeholders need to be part of a circular society.

Results

1. Concept of a circular economy in the context of society

Circular economy principles are not only an area of research, or a way forward for a wide range of

stakeholders such as national and local authorities and business and agricultural organisations around the world, but also a policy-making tool to help achieve sustainability. Nonetheless, a theoretical framework for the circular economy and the practical skills of farmers have not been tailored to suit the agricultural domain, serving as a primary obstacle to its implementation in this sector. Additionally, existing literature lacks comprehensive studies assessing the suitability of existing circular economy knowledge and skills for the agricultural sector (Velasco-Munoz *et al.*, 2021). Finding synergies between different but interlinked education initiatives is therefore essential (Shallcross, Loubser, Le Roux, O'Donoghue, & Lupele, 2006). Promoting sustainable development through whole school approaches: an international, intercultural teacher education research and development project. A circular economy is defined ambiguously by different authors, including different aspects. According to Kirchherr, Reike, & Hekkert (2017), the circular economy is described as an economic model where business strategies replace the concept of “end-of-life” by minimising waste and maximising resource efficiency through practices such as reduction, reuse, recycling, and recovery. This approach affects various sectors of the economy, including the micro (individual products, companies, consumers), meso (eco-industrial parks), and macro (cities, regions, countries, etc.) levels, aiming to achieve sustainable development goals for the benefit of present and future generations. The circular economy is a socio-economic model that aims to minimise waste and resource depletion while maximising the durability and value of products, materials and resources. This concept contrasts with the traditional linear economy, where resources are extracted, transformed into products, used and discarded as waste. In a circular economy, resources are continuously reused, renewed and recycled, creating a closed-loop system (Padilla-Rivera, Russo-Garrido, & Merveille, 2020). According to Velasco-Munoz *et al.* (2021), enhancing efficiency in circular agricultural models entails optimising processes to minimise resource utilisation and prevent wastage.

However, Padilla-Rivera, Russo-Garrido, & Merveille (2020), noted that while sustainability is highlighted as a key objective of the circular economy - to provide benefits to the environment, the economy and society at large – it currently appears that the main beneficiaries of the circular economy are the political and economic actors implementing the system. In order to ensure that the benefits of the circular economy go beyond the political and economic actors that shape its principles, according to Jaeger-Erben *et al.* (2021), the circular economy model

needs to be complemented by the concept of ‘society’ in order to create an alternative paradigm that goes beyond growth, technology and market solutions. The addition of a societal component to the circular economy paradigm is linked to the idea that the shift towards to a circular economy is not possible without the commitment and participation of all members of society and their education. The concept of a circular economy society frames the transition to circularity as a profound socio-ecological-economic transformation to which society must not only contribute, but also benefit. According to Shallcross, Loubser, Le Roux, O'Donoghue, & Lupele (2006), transforming society sustainably is a complex task that requires immediate collective efforts and actions from all groups of society. It is not enough to teach sustainability-oriented values. It is important for all groups of society to have the capacity to act and experience those values in practice.

Corvellec, Stowell, & Johansson (2022) who are critical of the current circular economy paradigm, also point out that the circular economy ideology not only lacks a clear theoretical basis, being based only on technological processes and economic calculations, but is also difficult to implement in reality. One of the reasons for this is the failure to integrate social, cultural and political aspects into the circular economy paradigm, and they suggest that society's role in this paradigm should be strengthened both scientifically and practically. According to the critics, the circular economy deviates from its socio-economic assumptions and implications, without any reference to what a circular economy society might look like and what characteristics it should have.

In conclusion, the exploration of circular economy principles reveals a paradigm that extends beyond its origins in research and stakeholder engagement, evolving into a potent policy-making tool with global implications. Defined as an economic system aiming to replace the traditional “end-of-life” concept, the circular economy seeks to reduce waste and resource depletion while maximising the durability and the worth of products, materials, and resources, offering a sustainable alternative to the linear economy model (Kirchherr, Reike, & Hekkert, 2017; OECD, 2017; Padilla-Rivera, Russo-Garrido, & Merveille, 2020). However, concerns arise regarding the distribution of benefits, with the current perception suggesting that political and economic actors are the primary beneficiaries. To address this disparity, the circular economy paradigm must evolve to include a societal component, emphasising the necessity for the commitment and participation of all members of society in the transition to circularity (Jaeger-Erben *et al.*, 2021). Nevertheless, critics, such as Corvellec, Stowell, & Johansson, (2022), caution

against the circular economy's limitations, citing a lack of clear theoretical foundations and challenges in integrating social, cultural, and political aspects into its implementation. Strengthening society's role in the paradigm, both scientifically and practically, becomes paramount to align the circular economy with its socio-economic assumptions and implications. Thus, as the circular economy continues to shape sustainability discussions, acknowledging and addressing these challenges will be crucial for ensuring an inclusive and transformative transition toward a circular economy society. Wals (2019) points out that, like business as usual, education as usual is no longer a good option. The researcher argues that sustainability challenges are complex, value-laden, ambiguous, emotional, uncertain and emergent and that conventional forms of learning that focus on knowledge transfer are insufficient to engage learners in the sustainability challenges we face today.

In conclusion, the circular economy offers a promising path towards sustainability by minimising waste and maximising resource efficiency. However, current perceptions suggest that political and economic actors are the primary beneficiaries, highlighting the need for a more inclusive approach and wide education process. Integrating societal components into the paradigm is essential to ensure all members contribute to and benefit from the transition to circularity. Despite its potential, challenges remain, including the lack of clear theoretical foundations and difficulty integrating environmental, economic, social sustainability aspects. Strengthening society's role in the circular economy is crucial for aligning it with its socio-economic implications and ensuring a truly transformative transition. There is also a need for educational policies that support the crossing of boundaries, increase collective capacity building between formal and non-formal education institutions, incorporate reflective thinking into everyday practice, and increase opportunities for school participation in circular economy research.

2. Green skills definition

The changes and challenges experienced by the agricultural sector and the processes, phenomena, and problems experienced by the rural and regional populations show the need to know how to change "traditional" knowledge to more "green" knowledge for the development of a circular economy society. Various literature pays more and more attention to improving the definitions of green skills of the players. It is noteworthy that different authors, depending on what they focus on, emphasise the scientific context of these concepts, while others try to adapt those concepts in real life (e.g. at work). Several investigations (Baartman *et al.*, 2007; Wiek,

Withycombe, & Redman, 2011; Sørensen *et al.*, 2021) demonstrate broad green competencies, while others highlight skills related to sustainability. This underscores a linguistic ambiguity where the term "green skills" encompasses various concepts such as aptitudes, capabilities, qualifications, and others. As noted by Pavlova (2018), there persists both scholarly and practical discourse regarding the most effective means of delineating green skills.

Various forms of education and training within the realm of sustainable development (including formal, non-formal, and informal approaches) are examined as avenues for nurturing these skills across the lifespan, encompassing both individual and collective dimensions (Bianchi, Pisiotis, & Cabrera Giraldez, 2022). Transformative learning environments to encourage learners to become change agents who have the knowledge, means, willingness and courage to take transformative action for sustainable development (UNESCO, 2020), holistic and systemic thinking are vital for dealing with this complexity, and are required to innovate and integrate sustainable solutions (Leicht *et al.*, 2018) in all aspects of society education. The United Nations Economic Commission for Europe (UNECE) in its strategy for education for sustainable development from 2021 to 2030, defined and introduced the Whole Institutional Approach concept, which includes the environment of all levels of formal education and institutions providing formal, non-formal and informal education in the public and private sectors. This learning process is fundamental to quality education in all aspects: curriculum, management, infrastructure, communication with community and society (UNECE, 2022, p.12).

This transformational change can lead to an understanding of a greener economy as well as agriculture because it also concerns a value approach towards the environment. In addition, the need for skills transition in agriculture is important due to reaching more environmentally friendly actions and decisions implemented in this sector (e.g. types of production, patterns of consumption, etc.). It is essential to move towards environmentally friendly and circular lifestyles, work practices and business operations by learning and implementing a whole institution approach.

Debates on defining key skills in the circular economy society and agriculture are considered critical for shaping a specific society's perception of a sustainable future. The transition from traditional agricultural knowledge to modern society is influenced by a sustainable development approach.

According to ILO (2011), the absence of specific skills required to meet the demands of evolving and emerging occupations poses a challenge to the

Table 1

Defining green skills in the context of a circular economy society (by authors)

Author/source (year)	Definition
What are Green Skills? (2023)	The knowledge, abilities, values and attitudes needed to live in, develop and support a sustainable and resource-efficient society.
UN (2023)	These skills include technical knowledge, expertise and abilities that enable the effective use of green technologies and processes in professional settings.
Arthur (2022)	Transition to a low-carbon, resource-efficient economy requires systemic changes with deepening economic knowledge, environmental perception attitudes, that will result not only in new products and services but also in changes in production processes and business models what disclose the need for management skills.
Global Green Skills Report (2022)	Environmental protection skills, that can strengthen environmental sustainability of economic activities and values, they are the building blocks of the green transition and the key to unlocking the abilities of human capital that will power it.
Lodge <i>et al.</i> (2021)	Sustainability knowledge and research skills that are needed to support a sustainable society and recent research.
Nikolajenko – Skarbalė, Viederytė, & Šneiderienė (2021)	They are generally composed of three dimensions: knowledge, skills, and attitudes and / or values.
Pavlova (2018)	Needed skills are related to knowledge how to reduce the environmental impact and supporting economic restructuring with the purpose gaining more awareness and value attitude of attaining cleaner, more climate resilient and efficient economies that assure environmental sustainability principles and provide decent work conditions.
Pavlova (2014)	Include general knowledge, skills, attitudes and values and they are necessary for contributing to sustainable social, economic and environmental development in any job.
Cedefop (2012)	The knowledge, abilities, values and attitudes needed to live in, develop and support a sustainable and resource-efficient society.

promotion of green training and the cultivation of green skills. As highlighted by Bianchi, Pisiotis, & Cabrera Giraldez (2022), green skills empower learners to embody sustainability principles and understand complex systems, enabling them to take action to restore and preserve ecosystem health while promoting justice, and envisioning sustainable futures. This concept is significant as it emphasises the development of sustainability knowledge, skills, and attitudes in learners, enabling them to think, plan, and act with sustainability in mind and harmonise their lives with the planet.

Encouraging the acquisition of skills for green employment encourages investment in eco-friendly activities and expedites the transition to sustainability (ILO, 2011). Pavlova (2014, 2018) suggests that fostering generic green skills is essential for greening all sectors, as they help individuals to cultivate a green mindset and adopt general operational practices aimed at reducing environmental impact.

The United Nations (UN, 2023) analysed why green skills are important for youth, but in fact they

touched the issue of different generations, where the knowledge and experiences of different generations are very different, but participation in the green economy is very important for everyone. They focused on various forms of knowledge, values, and attitudes aimed at promoting environmentally sustainable decision making both in professional settings and personal life. Additionally, they stressed the importance of green skills being applicable to individuals of all ages, although they hold particular significance for younger generations who have the potential to contribute significantly to the green transition over the long term. Besides, as mentioned in the Global Green Skills Report (2022), most jobs requiring green skills are not traditional green jobs. Some specific concepts are provided in Table 1.

In summary, green skills encompass the diversity of knowledge, abilities, values, and attitudes in the fields of sustainable and resource-efficient activities and development, including economic, environmental and social domains of society which contributes to a green transition, higher levels of green consciousness, work

and living. These skills involve technical expertise for utilising green technologies in professional settings and contribute to a transition to a low-carbon, resource-efficient economy. Green skills also play a vital role in environmental sustainability, economic restructuring (e.g. new jobs, implementation of new circular business models, etc.) and the transition to the production and use of renewable energy resources, and the creation of cleaner and more climate-resilient economies. Comprising knowledge, skills, and attitudes, green skills are fundamental to supporting a sustainable society (e.g. individual green solutions - saving of water, soil conservation) and fostering social, economic, and environmental development across various job roles (e.g. green projects, creation of green working environment, green finances, circular activities in farm and territory, etc.).

3. Classification of green skills

A review of the above definitions of green skills shows that they are defined in very different ways and emphasised in different places. This suggests that green skills can be classified into different types. To this end, the following is an overview of the classification of green skills proposed by various authors, which is the basis for the classification of green skills used in the study.

Per Capita (2010) establishes the groundwork by presenting a compilation of fundamental green skills, also recognised as environmentally conscious practices, which are consistent across various sectors and associated with technological action dimensions: measurement and monitoring (of waste, energy, water); implementation of management systems (for waste, energy, water); procurement and selection processes; assessment of material usage and its impact; reduction of impact and usage; evaluation of impact; and risk management. This framework captures environmentally friendly processes that traverse diverse sectors, providing a basis for understanding sustainability practices.

Pavlova (2014) extends this classification by categorising green skills into cognitive, interpersonal, and intrapersonal skills (Fig. 2).

The aforementioned findings indicate that the green skills identified by Pavlova (2014) correspond with the essential skills recognised as vital for today's workforce. Importantly, these skills are distinguished by their emphasis on environmental consciousness and comprehension of sustainable development.

Engaging in circular economy practices typically demands a blend of manual and technological proficiencies, encompassing expertise in renewable energy, material repair, and reuse. However, the exigency extends beyond mere technical acumen; it underscores the necessity for advanced cognitive aptitudes in managerial roles, design processes, and the effective application of technology to facilitate such endeavours. Sumter *et al.* (2020) accentuate the pivotal role of cognitive skills in this context. Terzioglu & Wever (2021) posit a societal imperative to reshape public perceptions, attitudes, and behaviours concerning circular economy principles and repair practices, integrating them into citizens' daily lives as viable employment opportunities. Sanchez-Carracedo *et al.* (2021) argue that, in addition to technical and professional competencies, individuals in a circular society should have the ability to address issues related to social justice and sustainability. Lanz *et al.* (2019) promote the development of information and communications technology skills and problem-solving abilities among both organisations and consumers. They stress the significance of organisational and redesign capabilities in shaping innovative consumption behaviours within the context of ongoing learning approaches. So, the multifaceted demands of a circular economy underscore the necessity for a comprehensive green skill set encompassing technical, cognitive, and societal dimensions, emphasising the pivotal role of individuals, organisations, and society in fostering sustainable and resilient practices.

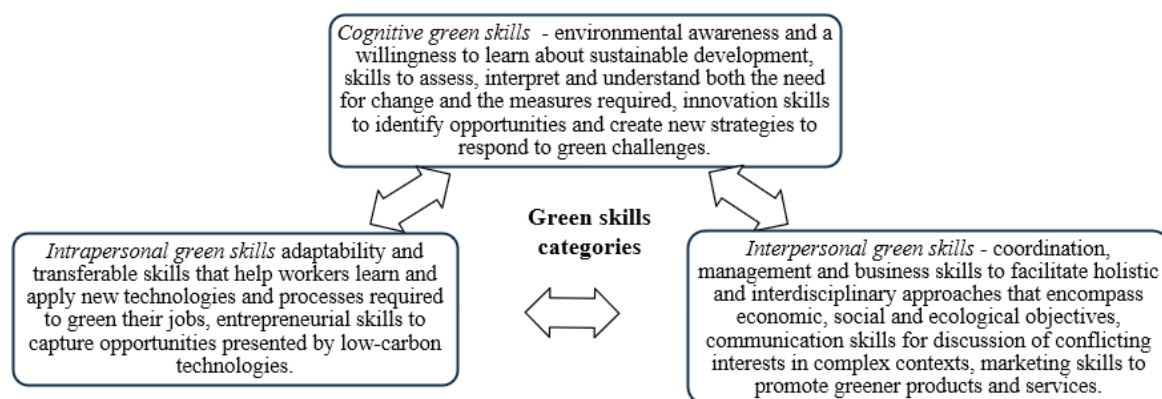


Fig. 2. Categorising green skills (made by authors following Pavlova, 2014).

Vona *et al.* (2015), Auktor (2020), and Arthur (2022) contribute to a broader understanding by classifying green skills into four categories:

- Engineering and technical expertise;
- Scientific competencies;
- Operational management abilities;
- Monitoring proficiencies.

Following the authors above, *Engineering and technical green skills* encompass a spectrum of hard skills related to the design, construction, and assessment of technology, typically mastered by engineers and technicians. This expertise is essential for endeavours such as eco-building initiatives, renewable energy design, and research and development projects focused on energy conservation.

Science green skills, derived from expansive bodies of knowledge, play a pivotal role in innovation activities and are particularly sought after at every stage of value chain and within the utility sector. These skills are crucial for providing essential amenities, including water, sewage services, and electricity. These green skills can be classified as cognitive green skills.

Operational management green skills encompass expertise in adapting organisational structures to support eco-friendly initiatives and maintaining an integrated view of the business through life cycle management, lean production, and collaboration with external stakeholders, including customers. These skills are particularly crucial for roles such as sales engineers, climate change analysts, sustainability specialists, chief sustainability officers, and transportation planners. These green skills can be classified as technological green skills.

Monitoring green skills involves a distinct focus on the technical and legal facets of business activities, diverging fundamentally from the domains of engineering or science. These skills are essential for evaluating compliance with technical criteria and legal standards. These green skills can be classified as action green skills.

In general, these categories cover a wide range of competencies crucial for various facets of sustainable practice.

The Arthur (2022) report about green skills showed that greening of the economy could inevitably change the skills required, and the tasks involved in many of the existing and future occupations. As the mentioned skills are considered to be increasingly important and relevant when making sustainability decisions, guaranteeing resilience of an area according to Arthur (2022) they also perceived as “*skills of the future*”.

Lodge (2021) introduces a dichotomy between hard and soft green skills, aligning with specific activities and functions. He detailed green skills which are required for organisations as part of circular economy society. Their division is associated with

specific activities and functions which operate in social reality. *Hard green skills*, such sustainability, environment health and safety, auditing, supply chain, finance, risk analysis, warehousing, pharmaceuticals, pumps, environmental, science are associated with technological and knowledges green skills group. *Soft green skills including* management, communications, planning, customer service, innovation, operations, leadership, sales, research, infrastructure pertain to social and action green skills group. Both types of green skills are relevant to the modern circular economy society, are in high demand, and are highly requested in specific activity fields. The mentioned green skills are in demand and tend to cover such activities that still seem to be unsustainable within the particular workplace or behaviour needs to be changed (Lodge, 2021).

Raberg (2022) expands the discourse to encompass ordinary consumers, presenting a classification that encompasses:

1. Manual proficiencies, which entail abilities like sewing and technical skills facilitating the repair and repurposing of materials.
2. Divergent thinking capabilities and the capacity for creative ideation, such as considering various uses for a specific item and adeptly questioning societal norms related to consumption.
3. Research and communication competencies, pivotal for engaged citizens seeking sustainable options and aiming to inspire others with humour and positivity to participate in the circular economy.
4. Organisational and prioritisation skills, revolving around effective time management, decision-making, and prioritising actions that can significantly reduce carbon footprint. Furthermore, when purchasing second-hand items, early search and anticipation of needs should be undertaken, while for rental options, needs should be foreseen and planned.
5. Household proficiencies, encompassing maintenance skills for household goods and clothing, culinary skills aimed at minimising food waste through creativity and planning, and recycling competencies involving the sorting of various waste fractions.
6. Skills acquired through experience, such as familiarity with different second-hand markets and the ability to discern the quality of materials and items, facilitating the adoption of circular practices.

In conclusion, Raberg’s (2022) comprehensive classification extends the discourse on green skills to encompass everyday consumers, highlighting the diverse set of abilities - from manual and divergent thinking skills to research, communication, organising,

Table 2

Green skills for a circular economy society classification (by authors)

Green skills types	The main purpose	Description	Authors
Cognitive green skills	UNDERSTAND	Comprehension of the environment, openness to learning about sustainable development and emerging technologies, are crucial competencies required for evaluating and comprehending the necessity for innovation and adaptation.	Arthur (2022), Raberg (2022), Sern (2021), Brundiers <i>et al.</i> (2021), Sumter <i>et al.</i> (2020), Auktor (2020), Pavlova, (2014), Wiek, Withycombe, & Redman (2011), Vona <i>et al.</i> (2015).
Social green skills	COMMUNICATE	These green skills that enable to hear and see what green activities others are doing, to share your experience, to gather communities for the implementation of green initiatives. It could be called environmental activism: the ability to engage in environmental advocacy, raise awareness, and advocate for policies that promote sustainability.	Raberg (2022), Terzioglu & Wever (2021), Lodge (2021).
Technological green skills	KNOW	These skills are related to knowledge of green, clean technologies, implementation of innovative production processes. Green skills comprise technical knowledge, expertise, and competencies that facilitate the proficient utilisation of green technologies and methodologies within professional environments.	Raberg (2022), Arthur (2022), Sanchez-Carracedo <i>et al.</i> (2021), Sern, (2021), Lodge (2021), Auktor (2020), Vona <i>et al.</i> (2015), Per Capita (2010).
Action green skills	APPLY	These encompass adaptability and transferable skills essential for individuals to assimilate and implement new green technologies, thus facilitating the transition to environmentally friendly practices in both professional and personal spheres. These skills include adaptability and transferable competencies crucial for workers to adopt and utilise new technologies and methodologies necessary for incorporating sustainability into their occupations, as well as entrepreneurial skills to seize opportunities arising from low-carbon technologies.	Raberg (2022), Arthur (2022), Lodge (2021), Auktor (2020), Vona <i>et al.</i> (2015), Per Capita (2010).

and household skills - that play a crucial role in fostering sustainable practices and active participation in the circular economy.

Sern *et al.* (2021) further enriches the discourse by providing an extensive list of specific green skills, encompassing problem-solving, interpretative, research, data collection, analytical, exploitation, management, design, and controlling skills. More precisely, these green skills encompass problem-solving abilities concerning environmental pollution, interpretive skills related to environmental phenomena, research proficiency in environmental matters, data collection capabilities, analytical skills, expertise in utilising green technology, management skills for natural resources, design abilities, pollution control skills, raw material

management expertise, energy conservation proficiency, recycling proficiency, and reuse competence. Curricula incorporating these green skill components are poised to cultivate individuals capable of fulfilling industrial requirements and contributing to economic, social, and environmental sustainability (Sern *et al.*, 2021). While discussing green skills (Skills..., 2021), it was identified that green skills should:

- be flexible and share best practices with a global community;
- develop skills while protecting workers, rather than jobs;
- enhance labour market mobility and flexibility;
- increase investment into workforce development should be amortisable.

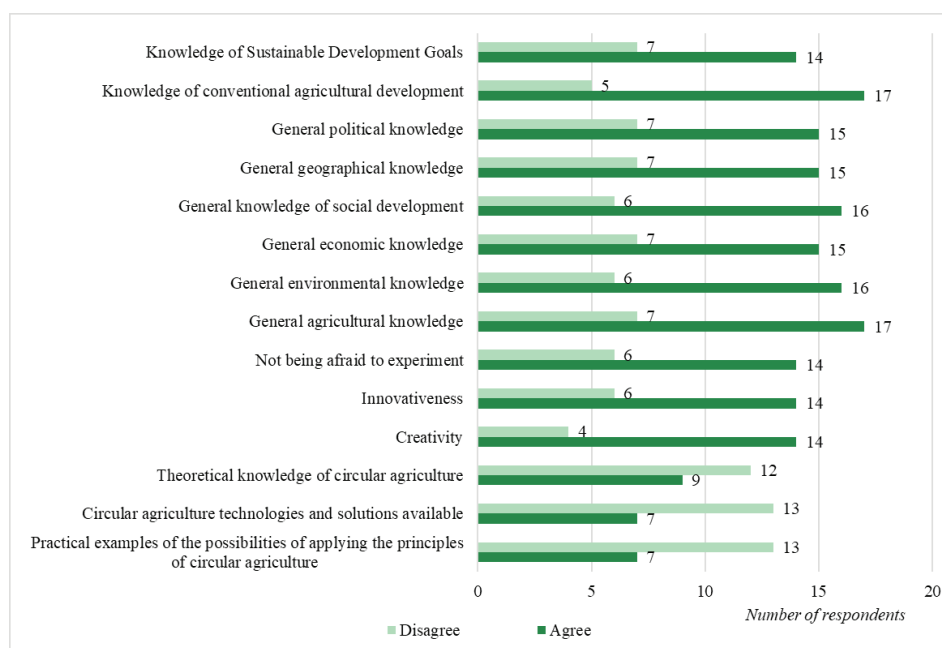


Fig. 3. Respondents' answers to the question "Do you think you have enough knowledge and competences to develop circular agriculture?".

In a comprehensive context, green skills refer to the abilities geared towards sustainability, encompassing technical expertise, knowledge, values, and attitudes essential for individuals to foster and maintain social, economic, and environmental wellbeing (McDonald, Condon & Riordan, 2012). According to the above-mentioned authors, green skills can be divided into the following types, which are shown in Table 2.

A review of the literature reveals that various authors define green skills as a set of knowledge, behaviours and competencies – rather than as the ability to perform certain tasks effectively. Therefore, the following definition of green skills is adopted in this paper – green skills are a combination of knowledge, abilities, values and behaviours that contribute to a successful circular economy society.

Overall, the classification of green skills into cognitive, social, technological, and action-oriented categories offers a comprehensive framework for understanding and cultivating the diverse competencies required for navigating the complexities of a circular economy society. As the global community increasingly embraces sustainable practices, fostering these green skills will be essential to achieving resilience and sustainability across economic, social, and environmental domains.

4. Farmers and related stakeholders research results about necessary green skills for circular economy society

A survey of farmers and related stakeholders revealed that, in order to be part of a circular economy society,

farmers and related stakeholders need all four types of the green skills identified in the theoretical section. While farmers were more focused on technological green skills, the survey and the classification of the survey results according to the classes of green skills revealed that farmers also need cognitive, social as well as action green skills. One of the important questions for the respondents was, "Do you think you have enough knowledge and competences to develop circular agriculture?" (Fig. 3). There were 14 possible responses and respondents had to evaluate each of them.

The given figure reveals that most respondents agreed that they have enough knowledge and competences related to "knowledge of conventional agricultural development" and "general agricultural knowledge". This discloses a quite common perception of agricultural knowledge not deeply focusing on specific green skills and competences. Moreover, despite the mostly mentioned statements, the respondents were aware of biggest part of the given options. There was not big part of respondents who disagreed with particular statements, but 13 missed knowledge about "circular agriculture technologies and solutions available" and "practical examples of the possibilities of applying the principles of circular agriculture". It should be pointed that the knowledge and competences to develop circular agriculture is known just a bit, without a clear understanding of how to apply them in agricultural activities.

Figure 4 describes and classifies green skills that farmers need as members of a Lithuanian circular

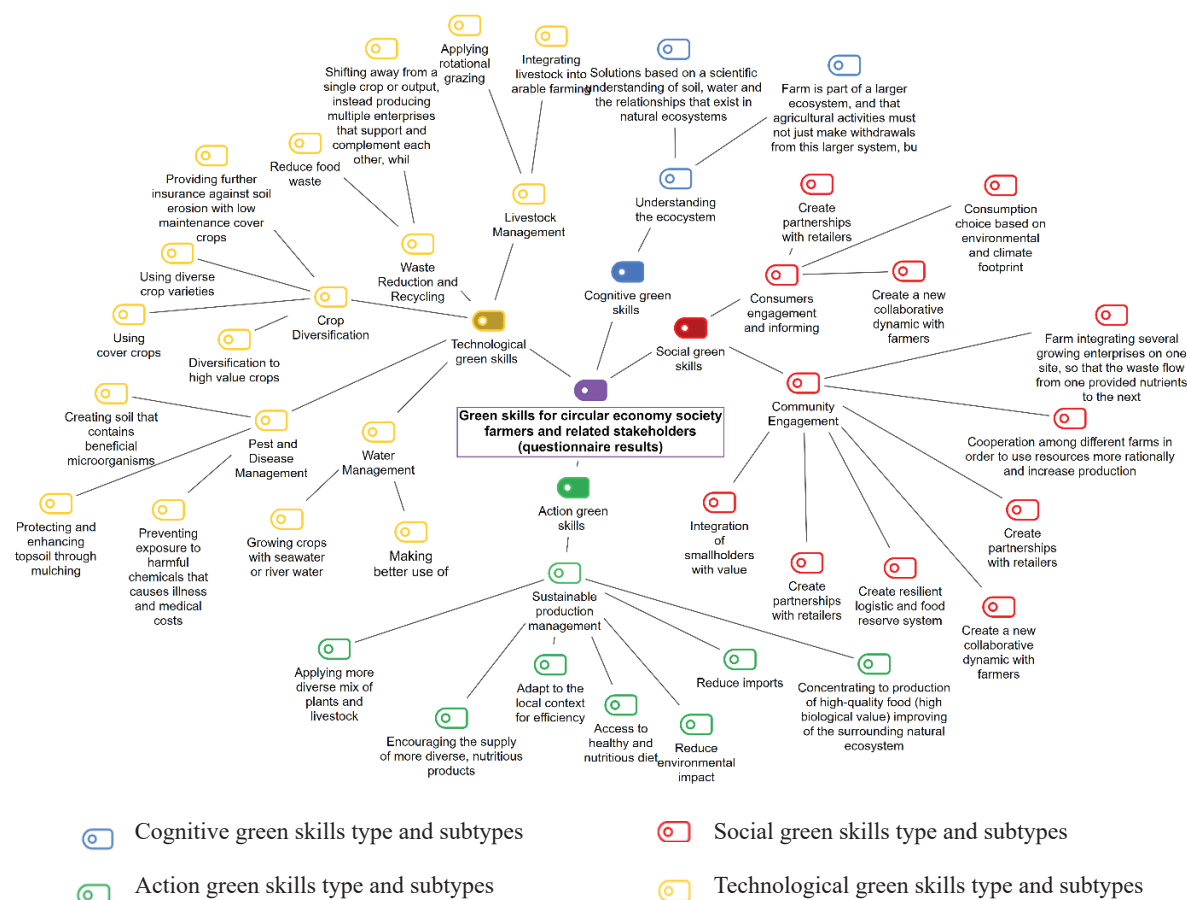


Fig 4. Respondents' (N=50) opinion about green skills, required for farmers and related stakeholders as a part of a circular economy society in Lithuania.

economy society. The types of green skills and their categories are visualised in different colours.

For farmers to know and apply green actions and technologies, they first need to have the *cognitive green skills* to understand their farm ecosystem, its characteristics and its role in the overall ecosystem. 17 respondents indicated that they possess and utilise skills to devise solutions rooted in a scientific comprehension of soil, water, and the interdependencies within natural ecosystems. 27 of respondents noticed that they have and apply skills of understanding, that ecosystem is larger than their farm and profession activity, and furthermore, agricultural activities should not only extract resources from this broader system but also contribute to it.

Only by having the right knowledge and being able to identify the needs and the possibilities to implement green actions, farmers and related stakeholders can decide which technological solutions are worth applying to their farms or professional activity. This requires:

Technological green skills, which often depend on the type of farm. However, the green skills identified in the harvesting process include the following:

- Farmers need these *crop diversification green skills*: Using diverse crop varieties – 37 of respondents know and 8 apply; Using cover crops – 33 of respondents know and 8 apply; Diversification to high value crops – 31 of respondents know; Providing further insurance against soil erosion with low maintenance cover crops – 28 of respondents know and 7 apply.
- Also, farmers need *pest and disease management green skills*: Preventing exposure to harmful chemicals that causes illness and medical costs – 37 of respondents know and 10 apply; Protecting and enhancing topsoil through mulching – 36 of respondents know and 8 apply; Creating soil that contains beneficial microorganisms – 34 of respondents know and 8 apply.
- The most known and recently applied *water management green skills* by farmers are: Growing crops with seawater or river water (natural water resources) – 39 of respondents know and 6 apply; Making better use of water – 35 of respondents know and 9 apply.

- The most needed for farmers' *waste reduction and recycling green skills* are: Reduce food waste – 32 of respondents know and 11 apply; Moving beyond reliance on a single crop or product, and instead cultivating multiple enterprises that mutually support and enhance one another, thereby diversifying revenue streams – 28 of respondents know and 11 apply.
- Known and applicable to some of the farmers *livestock management green skills* are: Applying rotational grazing – 29 of respondents know and 7 apply; Integrating livestock into arable farming – 33 of respondents know and 7 apply. It is important to note that the need for green technical skills depends on the type of farms farmers run. However, the survey focused on the general green technical skills that might be needed in farm operations.

With the green cognitive skills to understand and identify their farm ecosystem and its potential environmental impacts, and to select technical tools to manage these impacts, farmers also need to be able to exchange information with each other, cooperate, and network with other farmers and with stakeholders. This is a type of *social green skills*:

- The most known and applied social green skills for respondents in this survey are *community engagement skills*: Cooperation among different farms in order to use resources more rationally and increase production – 37 respondents; A farm that incorporates multiple cultivation ventures within a single location, ensuring that waste from one enterprise serves as nutrients for the next – 32 respondents; Integration of smallholders with value chains – 29 respondents; Create partnerships with retailers – 27 respondents; Create a resilient logistic and food reserve system – 26 respondents; Create a new collaborative dynamic with farmers – 25 respondents.
- Also, respondents noted, that they need consumer engagement and *informing green skills*, which are: Consumption choice based on environmental and climate footprint – 38 of respondents know it and 8 apply; Create a new collaborative dynamic with farmers – 19 of respondents know it and 25 apply; Create partnerships with retailers – 19 of respondents know it and 27 apply. Only by communicating with each other, with stakeholders and with consumers can the farmers find innovative ways of sustainable farming and technology and be a valuable part of a circular economy society.
- With the green skills to find and evaluate the knowledge about green farming, applying

green technologies and communicating and collaborating within it, farmers and related stakeholders can manage their production in a smart and green way or make the green decisions. In order to ensure the greenness of their production, the survey respondents considered that farmers need to have the following *green action skills*, related to sustainable production management: Applying a more diverse mix of plants and livestock – 39 respondents; Encouraging the supply of more diverse, nutritious products – 39 respondents; Adapt to the local context for efficiency – 36 respondents; Access to healthy and nutritious diet – 36 respondents; Reduce environmental impact – 35 respondents; Reduce imports – 35 respondents; Concentrating on production of high-quality food (high biological value) and improving of the surrounding natural ecosystem – 35 respondents.

The results of the survey of farmers and related stakeholders showed that 30 respondents were fairly familiar with the green skills presented in the questionnaire. However, 10 respondents know and apply them. Therefore, 40 respondents are aware of the above-mentioned green skills in circular farming. Only 10 have not heard of them. The most well-known green skills in circular agriculture are those related to sustainable water management, pest and disease management, crop diversification, livestock management. The most commonly used circular agriculture solutions are community engagement, sustainable production management and consumer engagement and information.

This shows that farmers and related stakeholders, as part of the green economy society, need cognitive, technological, social and action skills. However, this survey only focused on farmers' farming activities. In contrast, full members of a green economy society need to have skills that are necessary not only for farming, but also for their daily activities. Therefore, another research method was applied on the green skills needed by farmers and related stakeholders as members of a circular economy society.

5. Results from a focus group discussion about the necessary green skills that are required by farmers and related stakeholders as part of a circular economy society

In the focus group, which was consisted of 12 academics and 7 students, it was decided that to be a part of a circular economy society, farmers and related stakeholders first need to be given simple and basic knowledge that would be able to shape their attitude towards sustainable actions. Figure 5 represents the green skills from the academics focus group. With

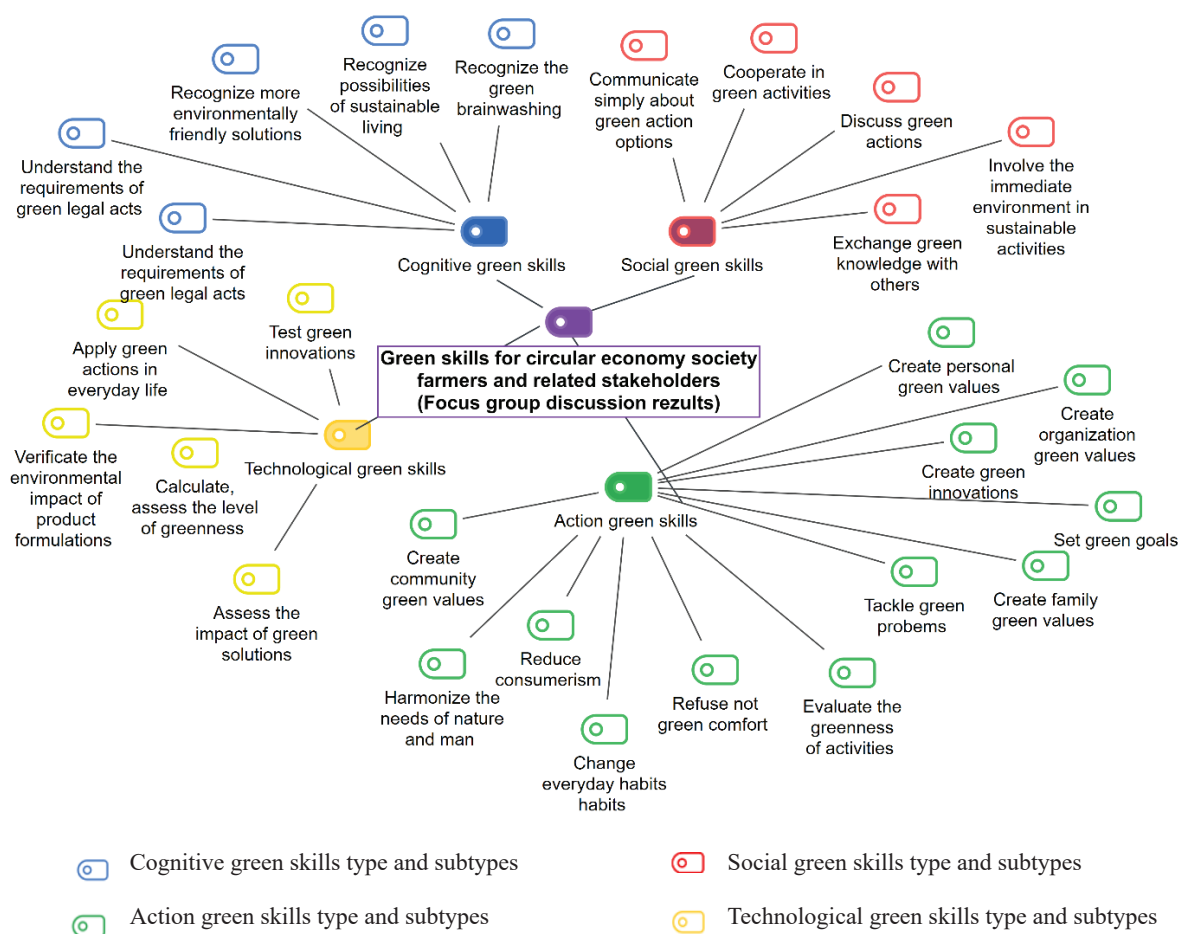


Fig 5. Green skills required by farmers and related stakeholders as part of the Lithuanian circular economy society, according to academic and students focus group (N=19) discussion.

background knowledge, people can acquire *cognitive green skills* that require a deeper understanding of green attitudes. These skills include understanding the requirements of green legal acts (e.g. focus groups participant P5 mentioned: “Knowledge of various national strategic documents, green requirements, politic actions”), recognising possibilities of sustainable living, more environmentally friendly solutions (e.g. focus groups participant P9 told: “To understand how we can reduce the negative impact on the environment, landscape, and water”) and recognise green washing (e.g. focus groups participant P3 said: “They need the competence to identify for themselves whether a product and activity is sustainable or not at all”). Only with basic knowledge, people can voluntarily choose to live in harmony with the environment and choose their level of sustainability.

Then, when people have basic green knowledge, recognise what is green and what is not, have their green position, then they will be empowered to use and

evaluate green technologies: apply green actions in everyday life (e.g. focus groups participant P11 said: “The first problem is that we do not sort. Knowing how to sort, how to clean”), assess the impact of green solutions (e.g. focus groups participant P4 told: “In reality, is anyone assessing whether they have succeeded or failed?”), test green innovations, calculate access the level of greenness, verify the environmental impact (e.g. focus groups participant M9 mentioned: “To understand how we can reduce the negative impact on the environment, landscape, and water:”). This is the second type of green skills – *technological green skills*.

Only people who understand and recognise sustainable requirements and apply green technologies, and take green actions in their everyday lives can have their own green position and communicate about it. The circular economy society members must cooperate in green activities, discuss green actions, exchange green knowledge (e.g. focus groups participant P12 said: “What we lack is communication and discussion, this

kind of joint discussion about how we understand certain phenomena.”), involve their immediate environment in green actions (e.g. focus groups participant P3 said: “Involve the immediate environment – family, children – in sustainable activities.”) and communicate simply with each other about them in the communities, organisations and families (e.g. focus groups participant P4 said: “And there is a lack of that debate in communities. We see that there is much to talk about today. As far as local communities, urban communities are concerned, there is a lack of discussion, but again, the question is, if we invited them, how many would come”). To do this, people need a second type of green skills: *social green skills*.

Also, the focus group participants mentioned that circular economy society members must not only to think green and apply green technologies, not only to communicate about their green position and actions, but also to behave green – to have and implement *action green skills*. It is not enough just to share green information, have a green position, and communicate about it. Real actions must also be implemented. So, every member of circular economy society must create their personal, family, organisational, and community

green values (e.g. focus groups participant P12 said: *It's about values. We need to clarify our values, not only to declare that we have them, but also to act on them. And in this way, we can succeed.*”), change their habits, refuse non-green comfort, reduce consumerism (e.g. focus groups participant P10 said: “We do these very simple, basic things and it feels like we’re doing green activities. But is it really enough? We are on such a very superficial path. It’s convenient for us. We should basically abandon some things.”), tackle green problems, set green goals, create green innovations, and harmonise the needs of nature and man (e.g. focus groups participant M9 said: *Is man a creature of nature or part of nature? Do we prioritise meeting the needs of nature or the needs of society?*”).

6. Results from the survey and focus group discussion about the necessary green skills that are required by farmers and related stakeholders as part of a circular economy society

A survey of the green skills needed by farmers and related stakeholders as part of a circular economy society found that they need cognitive green skills, technological green skills, social green skills, and action green skills not only in their farms’

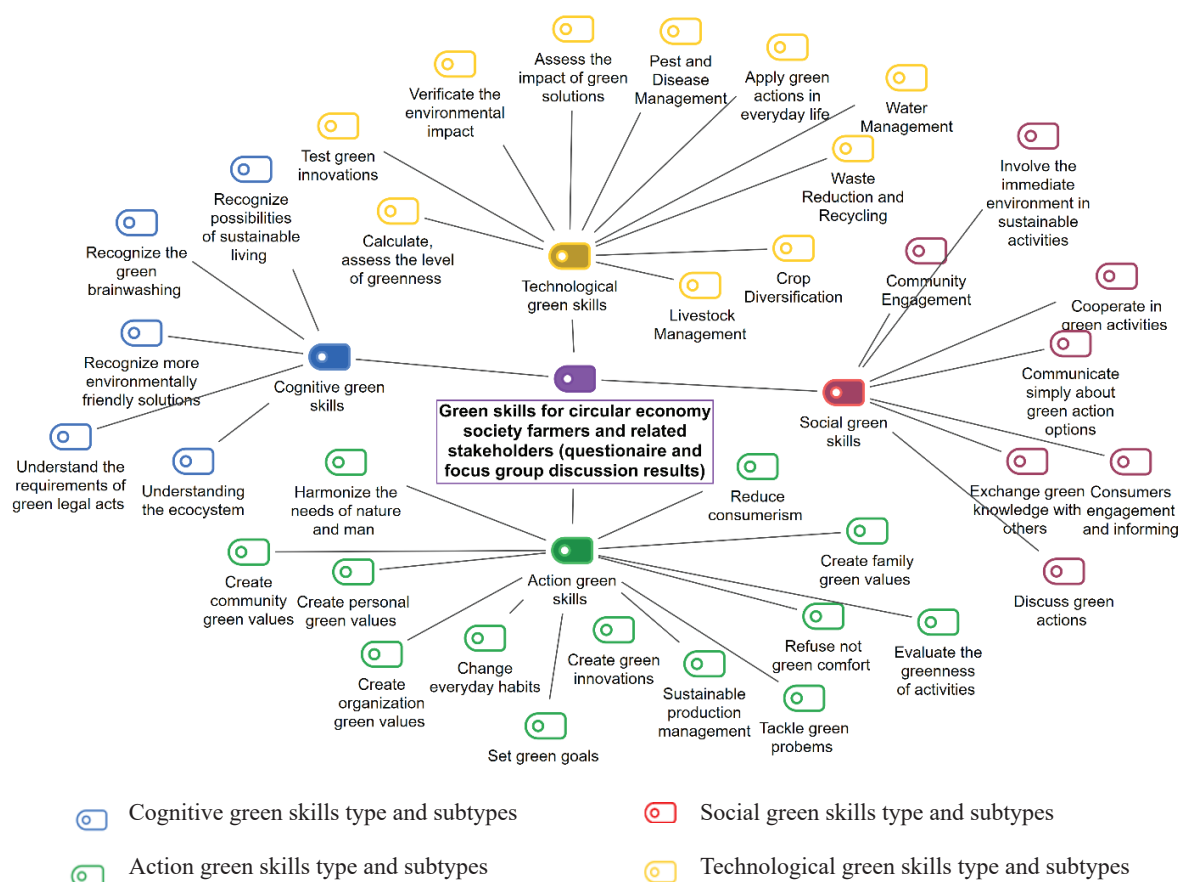


Fig. 6. Green skills required by farmers and related stakeholders as part of the Lithuanian circular economy society, according to questionnaire (N=50) and focus group (N=19) discussion results.

management, professional activities, but also in their everyday life (Fig. 6). The study not only revealed the same classification of green skills as identified in the literature analysis, but also extended it by identifying which cognitive, technological, social, and action green skills are needed by farmers as members of a circular economy society.

As part of the circular economy society, farmers and related stakeholders first need to have *green cognitive skills* that means *to understand and recognise* sustainable initiatives, actions and their impacts on the farm ecosystem, and also to create their own view of sustainability. Also, it is important for farmers and related stakeholders, as part of the circular economy society, to recognise sustainable washing, possibilities of sustainable living and farming, to understand the requirements of green washing and to be able to find more environmentally friendly solutions in everyday life and farming. Green cognitive skills for farmers and related stakeholders, as members of the circular economy society, are needed in everyday personal life, in their farm's management or professional activity.

Farmers and related stakeholders also need to be aware of and able *to apply* a range of green farming practices and technological knowledge – to be able to organise their farms and everyday lives according to green principles. So, they need *green technological skills*, which include the ability to assess the impact of green solutions, verify their environmental impact, test green innovations, calculate the level of greener, and apply water, pest and disease, waste reduction and recycling, crop diversification livestock management solutions and apply green actions not only in farming, but and in their everyday lives.

The survey showed that especially farmers and related stakeholders, as members of the circular economy society need *to communicate* with each other, with customers and with communities about sustainable actions, to initiate its implementation among all stakeholders, and to cooperate. For all these actions they need *green social skills*, which enable them to cooperate in green actions, involve communities and consumers, communicate about green actions in simple terms and involve intermediate environment in sustainable activities. Having and applying social green skills enables farmers and related stakeholders to become full members of a circular economy society, because the basis of society is communication and cooperation.

Farmers and related stakeholders, as part of the circular economy society need *to act* – to implement sustainable knowledge on their farms and their everyday lives. For this they need to have *green action skills*, which allow them to harmonise the need of man and nature, create personal, family, community,

farm or organisation green values, change everyday habits, set green goals, tackle green problems, refuse comforts that don't support green values, and develop production management in a sustainable way. The green action skills are the top-level skills that members of a circular economy society need in order to enable them to create green values and social, technological and other innovations, and to transform existing economic practices into greener ones.

Discussion

The results of the study correlate with the research reviewed in the literature review section on the need for green skills for farmers and related stakeholders as members of a circular society. Various classifications of green skills have been proposed by different authors, highlighting the diverse range of competencies that are crucial for fostering sustainable practices. In order to effectively transition towards a circular economy society, it is imperative to equip farmers and related stakeholders with the necessary skills and knowledge to embrace green practices.

The survey of farmers, academics, and students emphasises the importance of cognitive green skills, which entail understanding sustainable initiatives, recognising their impacts on the farm ecosystem, and fostering a sustainable worldview. Similarly, the researchers (Arthur, 2022; Auktor, 2020; Brundiers *et al.*, 2021; Pavlova, 2014; Raberg, 2022; Sern *et al.*, 2021; Sumter *et al.*, 2020; Wiek, Withycombe, & Redman, 2011; Vona *et al.*, 2015) working in this field also highlight the significance of understanding the environment and being willing to learn about sustainable development and new technologies. Both sources stress the need for farmers and related stakeholders to assess and understand the necessity for innovation and change. While the survey delves into the practical implications of green cognitive skills in everyday life and farm management, the literature provides a theoretical framework supported by various studies.

Both the survey and the literature review underscore the importance of technological green skills, which encompass knowledge of green technologies, and the ability to implement innovative production processes. Farmers and related stakeholders need to be equipped with the technical knowledge, expertise, and abilities to effectively utilise green technologies in their operations. The survey highlights the application of green technological skills in organising farms and everyday life according to green principles, while the scientists (Auktor, 2020; Arthur, 2022; Lodge, 2021; Per Capita, 2010; Raberg, 2022; Sanchez-Carracedo *et al.*, 2021; Sern *et al.*, 2021; Vona *et al.*, 2015) emphasise their relevance in professional settings. This alignment indicates a shared recognition of the

pivotal role of technology in advancing sustainability in agriculture.

Social green skills revolve around communication, community engagement, and environmental advocacy. The survey emphasises the need for farmers to communicate with various stakeholders and initiate sustainable actions, while the other researchers (Lodge, 2021; Raberg, 2022; Terzioglu & Wever, 2021) highlight environmental activism and the ability to raise awareness and advocate for policies promoting sustainability. The research underscores the importance of engaging communities and fostering collaboration to drive green initiatives. This convergence underscores the pivotal role of social cohesion in advancing sustainable agricultural practices within the broader context of a circular economy society.

The research and the literature review results emphasise the importance of action green skills, which involve applying green technologies, and adapting to sustainable practices. Farmers need to harmonise the needs of humanity and nature, set green goals, and develop production management in a sustainable manner. Similarly, the research by other scientists (Arthur, 2022; Auktor, 2020; Lodge, 2021; Per Capita, 2010; Raberg, 2022; Vona *et al.*, 2015) underscores the importance of adaptability and transferable skills in learning and applying new green technologies. Both sources stress the need for farmers and related stakeholders to actively engage in greening their work and lives, indicating a shared recognition of the transformative potential of action-oriented approaches.

The comparative analysis reveals significant alignment between the findings of the survey and the insights derived from the literature review. The research emphasises the multidimensional nature of green skills, encompassing cognitive, technological, social, and action-oriented competencies. Furthermore, they highlight the critical role of farmers in driving sustainability within the framework of a circular economy society. By equipping farmers and related stakeholders with the requisite green skills and knowledge, stakeholders can foster a transition towards more resilient and environmentally sustainable agricultural systems.

Conclusions

The green skills necessary for Lithuanian farmers and related stakeholders to successfully implement circular economy principles within the agricultural sector can be gained by applying a whole institution approach.

The society of circular economy will create a new value system and move from linear to circular

thinking and actions. The journey towards a circular economy society requires fundamental knowledge of sustainable development and the circular economy, developed through widespread public education initiatives and community engagement. The development of cognitive skills, encompassing critical and holistic thinking and self-determination, is essential for circular economy society farmers and related stakeholders to make informed green choices and embrace sustainability.

By understanding and recognising green requirements based on scientific research and green legislation, the circular economy society farmers and related stakeholders can choose and apply green technologies in their daily lives and work activities – applying technological skills.

These cognitive and technological foundational skills pave the way for the acquisition of social skills, fostering collaboration and communication among circular economy society farmers and related stakeholders for the effective development and implementation of green decisions, initiatives and technologies. As farmers and related stakeholders engage in constant knowledge exchange, discussions and creation of community understanding of circular economy, and cooperative actions, they contribute to the creation of a shared green consciousness. Finally, at the pinnacle of the green skills in the circular economy society lies action prowess, empowering farmers to not only use, but also to innovate green technologies. The highest echelon of green skills, marking a transformative shift in cognitive, social, and technological skills represents the ability to create green values and innovations, and cultivate a culture of sustainability.

The connections between green skills move in a circle: when cognitive green skills change, technological, social and action green skills also change. Changes in technological and action green skills lead to changes in cognitive green skills, because after starting to create and use new green innovations or solutions, personal values, experiences, and attitudes change, and personal perceptions and topics of communication about green solutions change. As a result, new ideas arise and new green solutions in the agriculture sector, inventions, and innovations are initiated – taking active green action in the farm and agriculture sector levels, and rural areas.

The research data showed that as a part of a circular economy society, it is necessary for farmers and related stakeholders to be “green” not only professionally and technologically, but also personally, to have their own green values, views and opinions in everyday life, and in agriculture and food supply chain, rural development management.

Moving forward, the research data advocates that it is needed to create a circular economy society and transformative learning environments where encouraged learners, farmers and related stakeholders become change agents. There is demand for farmers and related stakeholder's education initiatives, diverse communication channels, and universal the Whole Institutional Approach concept implementation to instil green knowledge and values, which would be orientated towards improving farmers' green skills.

The identified necessary green skills that are needed by Lithuanian farmers and related stakeholders can be useful for agricultural and rural development policy makers and implementers, entrepreneurs, farmers, representatives of educational and scientific institutions and other interested parties who seek to transition to circular agriculture and achieve sustainability.

During and after the research, the following limitations of the research emerged: this is a new topic that has been little analysed in the case of farmers and related stakeholders – they have little knowledge and skills. The research results can only be partially applied in other countries and other cultures. The results of the research can only be applied to the target group who participated in this survey.

References

- Arthur, Ch. (2022). *Green skills*. Retrieved 13 February 2024, from <https://www.unido.org/stories/what-are-green-skills>.
- Auktor, G.V. (2020). *Green Industrial Skills for a Sustainable Future*. Retrieved 13 February 2024, from https://www.unido.org/sites/default/files/files/2021-02/LKDFForum-2020_Green-Skills-for-a-Sustainable-Future.pdf.
- Baartman, L.K.J., Bastiaens, T.J., Kirschner, P.A., & Van der Vleuten, C.P.M. (2007). Evaluation assessment quality in competence-based education: a qualitative comparison of two frameworks. *Educational Research Review*. 2:114-129. DOI: 10.1016/j.edurev.2007.06.001.
- Bianchi, G., Pisiotis, U., & Cabrera Giraldez, M. (2022). *GreenComp – The European sustainability competence framework*. Bacigalupo, M., Punie, Y. (editors), Publications Office of the European Union, Luxembourg. ISBN 978-92-76-46485-3, DOI:10.2760/13286, JRC128040.
- Brundiers, K., Barth, M., Cebrian, G., Cohen, M., Diaz, L., Doucette-Remington, S., Dripps, W., Habron, G., Harre, N., Jarchows, M., Losche, K., Michel, J., Mochizuki, Y., Rieckmann, M., Parnell, R., Walker, P., & Zint, M. (2021). Key competencies in sustainability in higher education - toward an agreed-upon reference framework. *Sustainability Science*. 16(1), 13-29. DOI: 10.1007/s11625-020-00838-2.
- Burns, E. A. (2021). Regenerative agriculture: farmer motivation, environment and climate improvement. *Policy Quarterly*. 17(3), 54–60. DOI: 10.26686/pq.v17i3.7133.
- Cedefop (2012). *Green skills and environmental awareness in vocational education and training*. Luxembourg: European Commission. Retrieved 11 January 2024, from https://www.cedefop.europa.eu/files/5524_en.pdf.
- Corvellec H., Stowell A., F., & Johansson N. (2022). Critiques of the circular economy. *Journal of Industrial Ecology*. 26: 421–432. DOI: <https://doi.org/10.1111/jiec.13187>.
- Global Green Skills Report*. (2022). LinkedIn Economic Graph. Retrieved 23 February 2024, from <https://economicgraph.linkedin.com/content/dam/me/economicgraph/en-us/global-green-skills-report/global-green-skills-report-pdf/li-green-economy-report-2022.pdf>.
- ILO. (2011). *Greening the global economy the skills challenge*. Retrieved 23 February 2024, from https://www.ilo.org/wcmsp5/groups/public/@ed_emp/@ifp_skills/documents/publication/wcms_164630.pdf.
- Jaeger-Erben M., Jensen C., Hofmann F., & Zwiers, J. (2021). There is no sustainable circular economy without a circular society. *Resources Conservation and Recycling*. 168(2):105476, DOI:10.1016/j.resconrec.2021.105476.
- Kirchherr J., Reike D., & Hekkert M. (2017). Conceptualizing the circular economy: an analysis of 114 definitions. *SSRN Electronic Journal*. 127 (2017), 221-232, DOI: 10.1016/j.resconrec.2017.09.005.
- Lanz, M., Nylund, N., Lehtonen, L., Juuti, T., & Rattya, K. (2019). Circular economy in integrated product and production development education. *Procedia Manufacturing*. 33, 470–476. DOI:10.1016/j.promfg.2019.04.058.
- Leicht, A., Heiss, J., & Byun, W. J. (2018). *Issues and trends in education for sustainable development*. UNESCO Publishing. Vol. 5. <https://unesdoc.unesco.org/ark:/48223/pf0000261954>.
- Lodge, E. (2021). *What are Green Skills?* The Skills Network. Retrieved 22 February 2024, from <https://theskillsnetwork.com/insights-resources/blog/what-are-green-skills>.
- McDonald, G., Condon, L., & Riordan, M. (2012). *The Australian Green Skills Agreement: Policy and Industry Context, Institutional Response and Green Skills Delivery*. Australia, NSW: TAFE. Retrieved 20 February 2024, from <https://library.bsl.org.au/jspui/bitstream/1/3201/1/>

- The%20Australian%20Green%20Skills%20Agreement.pdf.
- Nikolajenko - Skarbalė, J., Viederytė, R., & Šneiderienė, A. (2021). The Significance of “Green” Skills and Competencies Making the Transition Towards the “Greener” Economy. *Rural Sustainability Research*. 46 (341), 53-65. DOI: 10.2478/plua-2021-0017.
- Nordina S. Md., Zolkepli I. A., Rizal A. R. A., Tariq R., Mannanam S., & Ramayahe T. (2022). Paving the way to paddy food security: A multigroup analysis of agricultural education on Circular Economy Adoption. *Journal of Cleaner Production*. 375, 134089, DOI: <https://doi.org/10.1016/j.jclepro.2022.134089>.
- OECD. (2017). *Green skills and the transition to a green economy, in Boosting Skills for Greener Jobs in Flanders, Belgium*. OECD Publishing, Paris. <https://doi.org/10.1787/9789264265264-3-en>.
- Padilla-Rivera, A., Russo-Garrido, S., & Merveille, N., (2020). Addressing the Social Aspects of a Circular Economy: A Systematic Literature Review. *Sustainability*. 12, 7912, DOI:10.3390/su12197912.
- Pavlova, M. (2014). Greening of skills in Asia: Agenda for green growth and challenges of skill gaps. In the 12th International Conference on Lifelong Learning: Continuous education for sustainable development, 30 May–1 June (p. 78-82) in St Petersburg, Russia, at Pushkin Leningrad State University (LSU). Retrieved 22 February 2024, from <https://cyberleninka.ru/article/n/greening-of-skills-in-asia-agenda-for-green-growth-and-challenges-of-skill-gaps/viewer>.
- Pavlova, M. (2018). Fostering inclusive, sustainable economic growth and ‘green’ skills development in learning cities through partnerships. *International Review of Education: Journal of Lifelong learning cities*. 64 (3), 339-354. <https://www.jstor.org/stable/44980024>.
- Per Capita. (2010). *International approaches to green skills and sustainability*. Slides presented at the Green skills research project presentation to the Industry Skills Councils (ISC) Conference, 1 June 2010. Retrieved 21 February, 2024 from <https://www.voced.edu.au/content/ngv%3A48794>.
- Raberg, M. (2022). *Citizens’ skills in the Circular Economy University*. Helsinki: University of Helsinki. Retrieved 21 February, 2024 from <https://helda.helsinki.fi/server/api/core/bitstreams/c613bec9-78d5-455d-af527fa66c11baac/content>.
- Sanchez-Carracedo, F., Moreno-Pino, F.M., Romero-Portillo, D., & Sureda, B. (2021). Education for sustainable development in Spanish university education degrees. *Sustainability*. 13(3), 1–24. DOI:10.3390/su13031467.
- Sern, L. C., Baharom, N., Foong, L. M., Wan Hanim Nadrah, W. M., Islamiah, R. D., & Ana, A. (2021). Integrating Green Skills into TVET Curricula in Polytechnics Malaysia. *Journal of Technical Education and Training*. 13(3), 15–19. DOI: <https://doi.org/10.30880/jtet.2021.13.03.002>.
- Shallcross, T., Loubser, C., Le Roux, C., O’Donoghue, R., & Lupele, J. (2006). Promoting sustainable development through whole school approaches: an international, intercultural teacher education research and development project. *Journal of Education for Teaching*, 32(3), 283-301.
- Sørensen, L.B., Germundsson, L.B., Hansen, S.R., Rojas, C., & Kristensen, N.H. (2021). What Skills Do Agricultural Professionals Need in the Transition towards a Sustainable Agriculture? A Qualitative Literature Review. *Sustainability*, 13, 13556. <https://doi.org/10.3390/su132413556>.
- Start. (2023). *What are Green Skills?* Retrieved 21 February, 2024 from <https://d2n2.startprofile.com/page/green-careers#skills>.
- Sumter, D., de Koning, J., Bakker, C., & Balkenende, R. (2020). Circular economy competencies for design. *Sustainability*. 12(4), 1–16. DOI:10.3390/su12041561.
- Terzioglu, N., & Wever, R. (2021). Integrating repair into product design education: Insights on repair, design and sustainability. *Sustainability*, 13(18), 1–21. DOI:10.3390/su131810067.
- The Adecco Group. (2021). *Skills for the Green Economy*. Retrieved 17 February 2024, from <https://www.adecco-jobs.com/-/media/project/adeccogroup/pdf-files/tag-skills-for-the-green-economy-paper.pdf?modified=20210125153357>.
- UN. (2023). *Why Are Green Skills Important for Youth?* Retrieved 11 August 2023, from <https://unfccc.int/news/why-are-green-skills-important-for-youth>.
- UNESCO. (2020). *Education for sustainable development: A roadmap*. Transforming Our World: The 2030 Agenda for Sustainable Development A/RES/70/1. Retrieved 11 January 2024, from <https://unesdoc.unesco.org/ark:/48223/pf0000374802>.
- United Nations Economic Commission for Europe (UNECE). (2022). *Framework for the implementation of the United Nations Economic Commission for Europe strategy for education for sustainable development from 2021 to 2030*. Retrieved 2 February, 2024 from https://unece.org/sites/default/files/2022-05/ece_cep_ac.13_2022_3_e.pdf.
- Velasco-Munoz J., Aznar-Sanchez, J. A., Mendoza J. M. F., & Schmid A. G. (2021). Circular economy

- implementation in the agricultural sector: definition, strategies and indicators. *Resources Conservation and Recycling*. 170. DOI: <https://doi.org/10.1016/j.resconrec.2021.105618>.
- Vona, F., Marin G., Consolin D., & Poll, D. (2015). *Green skills*. Cambridge US: National Bureau of Economic Research. NBER Working Paper No. 21116.
- Wals, A. E. J. (2019). *Sustainability-oriented ecologies of learning as a response to systemic global dysfunction*. In R. Barnett & N. Jackson (Eds.), *Learning ecologies: Sightings, possibilities, and emerging practices*, pp. 61–78. Taylor and Francis.
- Wiek, A., Withycombe, L., & Redman, C. L. (2011). Key competencies in sustainability: a reference framework for academic program development. *Sustainability Science*. 6(2), 203– 218. DOI: 10.1007/s11625-011-0132-6.

Acknowledgement

The preparation of this article was supported by the Project 2021-1-EL01-KA220-HED-000023289 “Strengthening Key Competences in Agriculture for Value Chain Knowledge” (SKILLS).