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## Special Issue: Opportunities and challenges of EU farm-to-fork strategy

### EDITORIAL

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### Abstract

In the context of the Farm-to-Fork strategy towards climate and natural resources neutralization, all players in agri-food value chain actors and stakeholders – citizens, consumers and business – cope with new challenges based on a better understanding of the complex interrelations between public health, ecosystems, value chains, consumption patterns, and planetary boundaries. From a managerial perspective, several dimensions appear crucial. The first one is circularity, i.e. the move from line to circular models which brings opportunities and threats in terms of quality management standards, procurements arrangements and skills for this circular turn. The second dimension is inclusiveness, with the renewed roles of farming systems as part of complete sustainable agri-food chains, with the core topic of social-environmental inclusivity within either existing agri-food companies or business models from scratch. The third dimension is path-dependency for conventional firms, with knowledge, technological and/or organizational lock-in, along with roles for newcomers and startups in this business model transformation, as well as the place and role of innovation ecosystems. The articles of this special issue offer contrasted view of these challenges.

**Keywords:** agribusiness, business models, farm-to-fork, food industry, rural development, R & D policy, system innovation

**JEL code:** L14, L21, L66, Q13, Q16

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The launch of the Farm-to-Fork (F2F) strategy by the European Commission on 20<sup>th</sup> May 2020 brings a new perspective for integrating agri-food systems. The strategy is a part of a worldwide project – European Green Deal – challenging to guide Europe towards building the climate-neutral continent.

Agriculture and food systems are key drivers of climate change and environmental degradation worldwide. This call aims to identify opportunities, challenges, and possible pitfalls of the F2F strategy for European agribusiness and food firms towards climate and natural resources neutralisation. The new approach is systemic: it involves all agri-food value chain actors and shareholders – citizens, consumers and business. The challenges are based on understanding the complex interrelations between public health, ecosystems, value chains, consumption patterns, and planetary boundaries. The foreseen integration gives rise to theoretical and empirical issues.

In this context from a business perspective, several dimensions appear crucial. The first one is *circularity*, i.e. the move from line to circularity which brings challenges in terms of quality management standards, procurements arrangements, governance, and skills (both human and technological) for this ‘circular’ turn. The second one is inclusiveness, with the renewed roles of farming systems as part of complete sustainable agri-food chains, with the core topic of *inclusivity* (community, social, ecological, biodiverse-oriented inclusivity) within either existing agri-food business or business models from scratch. The stakeholders’ issues mean the participation of consumers, citizens, third parties, in this innovative agri-food business models. The third one is *path-dependency* for conventional firms, knowledge, technological and/or organizational lock-in, roles for newcomers and startups in this business model transformation, place and role of existing innovation ecosystems.

This ‘IFAMA Europe Special Issue 2022’ of IFAMR provides various contributions, research articles as well as case studies from several European countries. It gives an overview of hot issues for both management scientists and agrifood managers in the context of the EU Farm-to-Fork Strategy. It shows, if needed, the interrelatedness of sustainability issues at different levels, firms, local territories, regions and States, pushes forward the need for systemic visions and disruptive innovation approaches for the European agribusiness and food sectors.

The article ‘Traceability issues of honey from the consumers’ perspective in Romania’ by Cristina Bianca Pocola, Peter Šedíkib, Alexandra-Ioana Glogovețanc and Ioan Sebastian Brumă, addresses the question of traceability in relation with European rules of protected origin. Indeed, the Romanian honey market is facing a problem related to traceability, especially when honey is produced in more than one country and its origin is indicated as a blend of EC and non-EC honeys. The increase of honey adulteration has consequences on both consumers and honey producers with considerable negative effects. The aim of the article is to identify the factors that influence honey purchasing behaviour and to evaluate consumers’ awareness related to honey adulteration in Romania among selected age segments. The results showed that the most important factors considered during the purchasing process by Romanian honey consumers were health factor and country of origin followed by producer reputation and ecological aspect, while the least important were discounts, promotion and brand reputation. Education in terms of honey authenticity and traceability will help consumers to choose local honey of high quality and to avoid adulterated products. This consumption and purchasing behaviour will discourage producers from honey counterfeiting.

The article ‘Collective smart innovations and corporate governance models in Italian wine cooperatives: the opportunities of the farm-to-fork strategy’ by Concetta Nazzaro, Marcello Stanco, Anna Uliano, Marco Lerro and Giuseppe Marotta, deals with the issue of technology in the context of agroecology transitions. European policies, especially the ‘farm-to-fork strategy’, address the challenge posed by the ecological transition in agriculture setting up a new technological paradigm. In this context, collective smart innovations may play a crucial role, enabling to meet current citizen-consumers’ needs as well as producing positive environmental and social externalities. Lately, wineries, in the attempt to improve the sustainability of production process and the creation of competitive advantages, reoriented their investments in research and development embracing

smart innovations. The latter, when supported by appropriate models of corporate governance, can facilitate business decisions and create shared value. This article aims to investigate the role played by collective smart innovations and corporate governance in the sustainable and ecological transition of wineries and, specifically, wine cooperatives. Results show that the collective smart innovation had impacts in terms of internal economies, such as increase in sales and costs reduction; and in terms of external social economies, such as local development and environmental protection.

The article ‘Are there any differences in rural development challenges within European countries? Social and economic contexts from EU rural leaders’ by Tomasz Kusio, Joanna Kudełko, Alexandra Borges, Anamarija Delic and Iulia Stroila addresses the question of rural development and entrepreneurship. Rural development has become a significant policy challenge in Europe. More employment opportunities have increasingly been concentrated in urban areas, leaving rural regions with ever-continuing down-fall in terms of population size and economic growth. In this context, rural entrepreneurship activity that positively influences rural communities is embedded in broader social or structural policies at the European level. The aim of the article is to investigate societal and economic challenges and their innovative solutions in five European rural regions. The comparative analysis reveals that most essential activities aimed at alleviating the development problems of rural areas include education of local communities, improvement of economic and digital infrastructure, activities supporting production and promotion of local products, promotion of cooperation between local communities and producers, and stronger orientation of local policy towards financial support of production enterprises and farms. The conclusions resulting from the study lead to formulating recommendations concerning rural policies in the context of developing entrepreneurship strategies in rural areas.

The article ‘Resilience in the food sector – environmental, social and economic perspectives in crisis situations’ by Justyna Franc-Dąbrowska and Nina Drejerska takes the starting point of resilience in agrifood sectors. Environmental, social and economic perspectives, derived from the sustainability approach and present within by the resilience concept, are integral parts of food systems. At the same time they are clearly articulated within the EU farm-to-fork (F2F) strategy referring to building up resilience to possible future crises as diseases and pandemics. The aim of this article is to investigate resilience in the food sector referring to its selected environmental, social and economic dimensions, which in fact rely on each other and cannot be separated, simply because of the character of food system itself (work with living organisms, soil, within natural environment, etc. done by people for business purposes). The issue of resilience in the food sector must be considered multidimensionally. In this approach, the basic direction of activities should be the one focused on the resilience approach, both in environmental protection and society. For a harmonious combination of these activities, it is also necessary to look at economic perspective of food system and entire rural livelihoods (e.g. income and employment diversification). Considering the last shocks discussed (COVID-19, war in Ukraine, drought, embargo on grain exports from Russia, rising inflation), a difficult situation on the food market can be expected in the nearest future, which makes the concept of resilience in the food sector even more relevant than it has been so far.

The article ‘Too much power or no power: When does intermediaries’ bargaining power result into better wine and happier farmers?’ by Orjon Xhoxhi, Drini Imami, Jon Hanf and Ekrem Gjokaj analyzes the trading relationship performance between farmers and intermediaries and the factors shaping it, with a focus on intermediaries’ bargaining power, based on a structured survey of vineyard farmers in Kosovo. Confirmatory factor analysis is employed to develop measures for the study latent variables, and OLS regression is used to test the hypothesis. To further validate the results, machine learning (i.e. random forest) is used to model the factors affecting the relationship performance between farmer and intermediaries. The results show that when the intermediary has considerable bargaining power, it leads to low trading relationship performance with farmers. Also, when the intermediary has low bargaining power, the relationship performance with farmers behaves in a similar way. The main contribution of this article is to further illuminate the debate of the role of power in business-to-business relationships, in that it points out an alternative explanation, stating that there is an optimal level zone that power needs to exist, in order to achieve above average trading

relationship performance. Outside this zone, either low or excessive high intermediary's bargaining power results in poor relationship performance.

The article 'Research and Innovation (R&I) challenges for better policies in food systems and bioeconomy transitions - evidence from Poland' by Paweł Chmieliński and Barbara Wieliczko analyses climate changes and depleting natural resources which call for the urgent sustainability transition of the economy. This also refers to food systems, which are a vital part of the economy directly linked to the nature. The first step in creating better forward-looking policies for the transition of food systems is identification of knowledge gaps to target R&D spending. The article focuses on the presentation and analysis of research directions that constitute future challenges for the transformation of research and development in Poland. The methodology of research applied in the study is based on participatory action research philosophy. The approach to determine the research challenges and needs included round tables and focus groups under the BIOEAST initiative. The results show that the most important weakness is low level of R&D expenditure in bioeconomy sectors, while the strength is a large number of new active entities for implementation of innovations, supporting bioeconomy and science-practice cooperation. The key recommendation is increasing the R&D spending and prepare national bioeconomy strategy to make use of the large potential of the Polish bioeconomy sector.

The article 'Operationalizing circular economy. Reflections on a bio-waste upcycling value chain construction in the brewing sector' by Gaëlle Petit, Samira Rousselière, Sibylle Duchaine, Emilie Korbel, Véronique Cariou, Sergey Mikhaylin and Luc K. Audebrand is focused on the concept of a circular economy as a response to the problems related to the limits of the dominant linear economic system in contemporary societies and of the finite resources of our planet. The transition from waste status to a raw material by reusing it makes it possible to modify its value for future users and thus to redistribute this value. This article considers the case of spent grain to illustrate the role of the circular economy in food transition. Bases on a series of interviews, the article discusses business modeling to operationalize sustainable development in the food sector and presents a discussion and conclusion on the advantages and limitations of the deployment of the circular economy in the brewing industry, taking into account and understanding the interests and constraints of various stakeholders.

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## Traceability issues of honey from the consumers' perspective in Romania

### RESEARCH ARTICLE

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### Abstract

The Romanian honey market is facing a problem related to traceability, especially when honey is produced in more than one country and its origin is indicated as a blend of EC and non-EC honeys. The increase of honey adulteration has consequences on both consumers and honey producers with considerable negative effects. The aim of the study was to identify the factors that influence honey purchasing behaviour and to evaluate consumers' awareness related to honey adulteration in Romania among selected age segments. An online survey was conducted between 2020-2021 on a sample of 1,233 respondents. The questionnaire covered aspects related to purchasing behaviour and honey adulteration, complemented with socio-demographic questions. The data were evaluated using descriptive, non-parametric and multivariate statistics. The results showed that the most important factors considered during the purchasing process by Romanian honey consumers were health factor and country of origin followed by producer reputation and ecological aspect, while the least important were discounts, promotion and brand reputation. The older respondents are more aware of honey adulteration and know better that crystallisation is an indicator of quality. This study provides important information for policymakers and the whole beekeeping chain in Romania. Education in terms of honey authenticity and traceability will help consumers to choose local honey of high quality and to avoid adulterated products. This consumption and purchasing behaviour will discourage producers from honey counterfeiting.

**Keywords:** honey authenticity, consumer behaviour, traceability, adulteration

**JEL code:** Q13, M31, P36

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## 1. Introduction

Food fraud is a topic of great debate and raised concern at present, since this unfair practice jeopardises food safety due to the possible health risks (Ahmad *et al.*, 2021). A feasible solution that could make a difference in fighting and alleviating this issue, is given by securing traceability and providing more assurances to stakeholders and customers all across the supply chain (Galati *et al.*, 2020). This may well be one of the best methods that has the potential of protecting consumers from the harmful effects of unfair trade practices in the market. Nevertheless, it is yet to be defined how much are consumers aware of the possibility to counterfeit certain foods and the impact of this practice upon their health (Rekha and Paul, 2018). Little of them know that, for instance, honey occupies the third position in the top most adulterated food products in the world (European Parliament, 2018). Honey adulteration has consequences on both consumers and honey producers with considerable negative effects. To understand better the concept, a definition of the traceable honey is brought by Menozzi *et al.* (2015): a honey with unique characteristics that can be used to identify it. For instance, information related to honey's producer, honey's production process (e.g. moisture content, bee pollen content, various additions), geographic origin, and a quality certification that guarantees that all this information is authentic. According to Menozzi *et al.* (2015), traceable honey can be related and traced back to the beekeepers.

Subsequently, the honey market is not exactly stable, and the beekeeping sector has more than its fair share of problems, especially issues related to the contradiction between the price of pure honey and that of adulterated honey (Arvane *et al.*, 2010). The most recent honey market report provided by European Commission (EC, 2021) shows that the EU self-sufficiency in honey is around 60% and the quantity imported from third countries like Ukraine, China, Argentina and Mexico was 177,650 tons in 2020. In the same year, the average price for imported honey was 2,05 EUR/kg. Imported honey is frequently cheaper than honey produced in the EU member states. According to the EU Council Directive 2001/110/EC (EC, 2001) 'the country or countries of origin where the honey has been harvested shall be indicated on the label'. However, there are some exceptions, including the situation when honey is produced in more than one country (EU/non-EU member state). In this case, the country of origin can be indicated as follows ('blend of EC and non-EC honeys'). Masking the geographical origin of honey decreases the traceability of this product and may be considered as a way of adulteration (García, 2018). In this context the transparency of the market is very important. In light of this, García (2018) recommends a re-evaluation of foreign trade rules, with the purpose of improving the traceability systems and to protect consumers. These aspects have been also discussed by Ahmad and Akhtar (2018) who stated that traceability represents a protective method against unfair market practices.

Romania is one of the main honey producers in the European Union (EC, 2021). According to the data provided by the Ministry of Agriculture and Rural Development (2020), honey trade balance is largely positive in Romania, with 45,826 tons of exported honey and 8,969 tons of imported honey between 2018-2019. Per capita consumption is still low compared to other EU countries, but there is an increasing trend of honey consumption due to its multiple benefits as food and medicine (Šedík *et al.*, 2019). Honey is perceived by Romanian consumers as a safe product, but there is a need to inform them about the risks of buying counterfeiting honey and the importance of making good choices during the purchasing process (Borodin *et al.*, 2013).

Studies on determination of honey authentication and quality in Romania are generally based on the analysis of the physicochemical parameters and chemometrics (Geana and Ciucure, 2020; Isopescu *et al.*, 2017; Oroian *et al.*, 2017; Pauliuc *et al.*, 2020). What we cannot find in the scientific literature on the honey authentication and traceability of honey are those elements related to the knowledge or awareness of Romanian consumers about these aspects. A better understanding of the main reasons behind honey purchase and consumption (food, medicine or cosmetics) together with an assessment of consumers' perception of honey adulteration could significantly make a difference. Accordingly, this insight could help launch educational and informative campaigns focused on training consumers to become aware of the importance of choosing quality products

for securing a healthy lifestyle and supporting pure honey producers. In this context, the purpose of the paper was to identify the factors that influence honey purchase behaviour and the consumers' awareness related to honey adulteration in Romania among selected age segments. Therefore, our research aims to answer the following research questions:

- RQ1: Which factors influence consumers buying decisions of honey in Romania?
- RQ2: What is the consumer's knowledge and awareness about honey traceability and authenticity in Romania?

The next section addresses the literature review, and it is divided into three subsections, namely: (1) factors influencing the honey buying behaviour; (2) consumers perception on the honey quality and adulteration; and (3) the relation between the sociodemographic features and honey consumption behaviour. The third section is dedicated to describing the methodology employed, while the fourth section comprises the main obtained results, their interpretation, and discussions on them. The final section tackles the concluding observations, the limitations of the study, practical implications, as well as features related to the originality of research.

## 2. Literature review

### 2.1 Factors which influence honey purchasing behaviour

The quality of honey, the geographical characteristics and the country of origin are elements of great interest for consumers. In addition, following the literature review, there were identified a series of factors influencing the honey buying behaviour. Yeow *et al.* (2013) tested the existence of some correlations between the honey purchasing behaviour and certain variables such as product quality, health condition of consumers, brand reputation, and price. The analysis revealed that the main factors influencing the honey purchasing behaviour are the following: product quality, consumers' health condition, and price. Same authors call the attention to the importance of honey certification both as guarantee of product quality and increased credibility of the product for consumers. Roman *et al.* (2013b) also points out the importance of honey certification for consumers, and not forgetting about brand and logo in the equation of buying decision since these elements ensure that honey comes from a safe source. At the same time, the consumers' trust level regarding the benefits of honey consumption can be elevated by appropriate product labelling (Yeow *et al.*, 2013). Batt and Liu (2012) identify the following factors as most influential for honey buying decision: brand reputation, origin, and quality-price ratio. Pocol and Bolboacă (2013) pinpoint age, education, and occupation as key influencing factors of the honey buying decision.

Roman *et al.* (2013a) finds that economic factors such as level of family income and honey price are of great importance in the purchasing process. In addition, the honey buying decision is strongly swayed by the consumers' knowledge of honey value and benefits on health (Roman *et al.* (2013a). As part of a study conducted by Cosmina *et al.* (2016) it is shown that consumers are interested in honey origin, price, and liquidity state in the buying decision. When analysing the willingness to pay and purchase honey, Vapa-Tankosić *et al.* (2020) identify the consumers' concern with organic certification. Furthermore, there are a series of factors influencing the honey purchasing behaviour such as level of family income, consumption needs, the existence of one or more children in a family (Vapa-Tankosić *et al.*, 2020). Murphy *et al.* (2000) reached the conclusion that, in the case of consumers, the most important factors for honey purchasing decision are price, texture, colour, and packaging. Ćirić *et al.* (2015) highlight the relevance of honey quality in consumers' purchasing decision which leads to the consumers' preference for buying honey directly from beekeepers as a guarantee of quality and lower prices than those found in supermarkets or specialised shops. Guziy *et al.* (2017) note that the main factors lying at the basis of the honey purchasing process are represented by the country of origin, taste, price, and features related to packaging, namely its dimensions and design. The consumers preference for local honey is also underlined by Kallas *et al.* (2019). Gyau *et al.* (2014) point out the factors that influence consumers in the purchasing decision as well as the education level (minimum secondary education) and being part of a family. Bršćić *et al.* (2017) assess the key factors

of honey purchasing decision and observe that taste, flavour, smell, type of honey, and medical benefits are the major concerns of the young buyers.

Žak (2017) highlights the main factors taken into consideration by young consumers when buying honey, namely its price and the sensorial features. On assessing the factors influencing the honey-purchasing process of the alleged millennial generation, Blanc *et al.* (2021) single out perceptions that are firstly concerned with sustainability, preserving resources and environment. Further, they evaluate a series of features that have the final say when buying honey such as ecological footprint which contributes significantly to the development and support of a healthy lifestyle (Blanc *et al.*, 2021). Table 1 centralises the main intrinsic and extrinsic factors influencing the honey buying behaviour.

## 2.2 Consumer perception of honey quality and adulteration

Through the lens of honey being the third-most-faked food in the world, this section of the literature review focuses on the analysis of consumer awareness about counterfeit honey and on their capacity to identify the authenticity of this product. Therefore, it is under examination the consumers degree of awareness about adulterated honey and also their capacity for identifying pure honey. As part of a study conducted by Fairchild *et al.* (2003) it was found that there is an increasing need among consumers to learn more about the origin and processes undergone by the food products, honey included. Ahmad *et al.* (2021) point out that consumers are aware of the existence of the adulterated honey market and, still, some of them choose to buy and consume it. This is due to the consumption needs of this segment of consumers that favour fake honey since it has a lower price and it is available in almost any store or supermarket (Ahmad *et al.*, 2021). Accordingly, even if consumers are knowledgeable of the presence of adulterated honey on the market, this does not affect their intention of buying it (Ahmad *et al.*, 2021).

Concurrently, Addam *et al.* (2017) reveal that some consumers test the purchased honey at home by applying different techniques to make sure that it is pure. According to Soares *et al.* (2017) some consumers associate crystallised honey (incorrectly informed) with low quality honey or sugar-adulterated honey. Yet, a large part of consumers is starting to become aware of the health hazards associated with certain toxic substances found in food and favour those labelled as organic (Soares *et al.*, 2017). Although honey labelling comes to the support of consumers to increase their level of trust in the process of purchasing and consuming, there are consumers who are yet wary of these quality guarantees (Addam *et al.*, 2017). A common feature emerges in

**Table 1.** Overview of studies on factors influencing honey purchasing behaviour.

Authors	Contribution / factors influencing honey purchasing behaviour
Murphy <i>et al.</i> (2000)	Price, texture, package, colour
Batt and Liu (2012)	Brand reputation, origin, quality-price
Yeow <i>et al.</i> (2013)	Quality, medical condition, brand reputation, price
Roman <i>et al.</i> (2013a)	Consumer needs, level of income, price
Roman <i>et al.</i> (2013b)	Brand, logo and certification
Pocol and Bolboacă (2013)	Education, occupation and age
Gyau <i>et al.</i> (2014)	Education, family
Čirić <i>et al.</i> (2015)	Quality, trust in beekeepers,
Cosmina <i>et al.</i> (2016)	Origin, liquid state of honey, price
Guziy <i>et al.</i> (2017)	Country of origin, taste, type, price, size of packaging, design of packaging
Bršćić <i>et al.</i> (2017)	Flavour, smell, honey type, colour, medical benefits
Žak (2017)	Price, sensory characteristics.
Kallas <i>et al.</i> (2019)	Origin
Vapa-Tankosić <i>et al.</i> (2020)	Certification (organic), family income, presence of a child in the family
Blanc <i>et al.</i> (2021)	Environmental sustainability aspects, ecological footprint

the honey assessing behaviour adopted by consumers, namely they prefer buying directly from beekeepers and thus be certain of the purchase quality (Addam *et al.* 2017; Ćirić *et al.*, 2015).

The young consumers lack the trained capacity for distinguishing between local honey produced by a local beekeeper and imported honey, capacity based on sensorial assessment (Šedík *et al.*, 2018a). The same authors raise the question of information need and education of consumers about the features of pure honey (Šedík *et al.*, 2018a). It is shown that the consumers informed about the negative effects of fake honey have a higher demand for locally produced honey (Wu *et al.*, 2015). This aspect is also underlined by Jones Ritten *et al.* (2019) who pointed out that consumers in possession of honey laundering information are more willing to pay a higher price for local pure honey. Jones Ritten *et al.* (2019) emphasise the importance of educating consumers by beekeepers on matters such as honey adulteration and effectiveness of labelling which guarantee the product quality. Accordingly, beekeepers can increase their income and bring a significant contribution to reducing food fraud (Jones Ritten *et al.*, 2019). For this purpose, Runzel *et al.* (2021) suggest implementing a smart agricultural system focused on honey traceability as a solution for honey adulteration. This system could be based on the following key elements subjected to constant checks and tests such as production (volume and type of honey), validation of distribution chain, and honey testing at the sale stage to the end consumer (pollen signature) (Runzel *et al.*, 2021).

### 2.3 Relation between socio-demographic characteristics and honey consumption behaviour

In what concerns the socio demographic features, the literature shows that despite the lack of a standard profile of the honey consumer, the factors positively influencing the consumption are as follows: age, gender, level of education and income (Pocol, 2012; Pocol and Ványi, 2012). Moreover, it is shown that consumers with higher studies who are part of 2-4 member families register a high consumption of honey (Ćirić *et al.*, 2020). Arvanitoyannis and Krystallis (2006) also confirm the fact that the consumers who have a family register a higher honey consumption behaviour. Testa *et al.* (2019) note that income is a key factor for high honey consumption. From the perspective of multiple sociodemographic factors analysed and their influence on the honey consumption behaviour, it was noticed that age is one of the best predictors of honey consumption.

According to a study conducted by Ćirić *et al.* (2020), consumers over 50 years old are regular consumers of honey. This is also corroborated by Pocol and Boloacă (2013) that showed that consumers over 50 with average and higher studies and consumers over 50 with maximum 10-year education are prone to daily honey consumption. At the same time, there is a daily honey consumption at the level of consumers under 50 years old with higher studies and living in small towns (Pocol and Boloacă, 2013).

The class of young consumers (25-34) is either not interested in honey consumption or registers very low levels of consumption (Krystallis *et al.*, 2007). This is also corroborated by Šedík *et al.* (2019) who underline the fact that younger consumers (18-30) rarely eat honey (up to 1 kilo per year) especially when their health condition is not at their best, in certain alcoholic drinks, or during wintertime, in the evening. The socio-demographic factors also influence the location where consumers buy the honey. Therefore, consumers over 45 years old prefer buying honey directly from beekeepers or from open markets/fairs (Kowalczyk *et al.*, 2017). Persons whose age ranges between 16 and 30 years old generally have little or no knowledge of the nutritional value of honey. The same happens in the case of those with lower education who prefer buying honey from the supermarket (Kowalczyk *et al.*, 2017). The female persons with higher education and knowledge about the health benefits choose to buy honey from specialised shops, generally health food stores (Kowalczyk *et al.*, 2017).

## 3. Materials and methods

An online survey was conducted between August 2020 and May 2021 on a sample of 1,233 respondents. The questionnaire contains aspects related to purchasing behaviour and honey adulteration, complemented with socio-demographic questions. For a certain number of questions the Likert scale was used, with grades from 1

to 5 where 1 means ‘completely unimportant’ and 5 stands for ‘very important’. The first section, addressing the purchasing behaviour, includes the following courses of directions: buying frequency, factors influencing purchase (such as health concern, organic certification, origin, brand, price, place of purchase, family budget, presence of children in a family, discounts, promotions), place of purchase (including honey purchase during vacations), quantity of purchased honey, influence of sanitary crisis triggered by COVID-19 on the quantity of honey purchased. The second section is dedicated to honey adulteration and focuses on the perception and information of consumers about counterfeit honey. The final section comprises the sociodemographic features of the respondents which are shown in Table 2. The age segments were established according to previous findings on honey consumption behaviour in Romania (Šedik *et al.* 2019). The authors of these studies defined the similar age groups.

30.3% of the respondents are male, while 69.7% are female. The main age categories, where a significant number of respondents (25%) are found, are above 34 and under 44 years old. Most respondents have higher education both in terms of licence and master’s degree or PhD (34.7%). The majority of participants are either students (19.9%) or employees (56.7%). The income is under 820 Euros in the case of 26.6% of the total respondents and above 820 Euros for most participants in the questionnaire (40.4%). Some of them

**Table 2.** Socio-demographic characteristics of the sample.<sup>1</sup>

Variable	Definition	Percentage (%)
Gender	Male	30.3
	Female	69.7
Age	18-24 years	24.7
	25-34 years	18.3
	35-44 years	25
	>44 years	32
Education	Maximum 8 years of schooling	0.6
	Professional school	2.4
	High school	17.8
	Post high-school	3.1
	Higher education (license)	41.4
	Higher education (master, doctorate)	34.7
Socio-professional category	Housewife	4.1
	Student	19.9
	Retired	5.9
	Unemployed	1.5
	Employee	56.7
	Freelancer	6
	Business owner	5.6
	Other	0.3
Family income (Euros) <sup>2</sup>	≤820	26.6
	821-1,640	40.4
	1,641-3,074	13.6
	>3,074	4.5
	I don’t know / I don’t answer	14.9
Residence	Rural	32.2
	Urban area, small town	15.5
	Urban area, residence/municipality	52.3

<sup>1</sup> In August 2020-May 2021, 1,233 respondents provided this information.

<sup>2</sup> Exchange rate (the average value for August 2020-May 2021): 1 Euro = 4.8791 RON (Romanian Leu).

(14.9%) did not provide information about their monthly income. Most respondents (52.3%) live in the urban area, in big cities that are either municipalities or county capitals.

Obtained data were processed and evaluated by using descriptive, nonparametric and multivariate statistics. The analysis was carried out in XLSTAT, version 2021.1. (Addinsoft Inc, New York, NY, USA) and in IBM SPSS 25 software (IBM Corp., Armonk, NY, USA). Nonparametric test such as Friedman test was applied in order to identify differences in evaluation among factors which are statistically significant. In addition, Nemenyi's procedure was used to determine among which factors exist these statistically significant differences. The 5-points scale (1-not at all important, 7-very important) was used for evaluating the importance of the following factors during honey purchase: health factor (F1), ecological aspect (F2), country of origin (F3), brand (F4), producer reputation (F5), place of purchase (F6), family budget (F7), price (F8), discounts (F9) and promotion (F10). Categorical principal components analysis with varimax and Kaiser normalisation was further applied in order to reveal the existence of latent factors. Differences among age segments towards selected questions regarding honey adulteration were examined by using chi-square test of independence.

#### 4. Results and discussion

The survey showed that respondents purchase honey if necessary (55.7%) or once a month (26.5%). When comparing this result to those of older studies, it must be pointed out that Menozzi *et al.* (2015) is highlighting that those consumers who frequently purchase honey presented an increased preference for traceable honey. The majority of respondents stated that they buy honey directly from beekeepers and from friends. A similar conclusion was reached by other researchers who highlighted that consumers prefer to purchase honey directly from beekeepers, whose products are of high quality, a better taste and flavour (Ćirić *et al.*, 2015; Popescu and Guresoaie, 2019). Short supply chain offers consumers more confidence in the honey authenticity and quality. This is consistent with what has been found by Roman *et al.* (2013b), Šedík *et al.* (2018b), and Thoma *et al.* (2019). On the one hand, honey is mostly purchased from beekeepers situated at markets, fairs or direct delivery. On the other hand, purchase via Facebook, website or along roadside is executed rarely or never. Rare frequency of purchase was indicated also in case of supermarkets, specialty shops, neighbours and relatives. Popescu and Guresoaie (2019) have also shown that supermarkets are not preferred by Romanian consumers in the case of honey purchase.

Honey is rarely purchased during holidays at touristic places by Romanian consumers. Contrary to these findings, Li and Ryan (2018) have revealed that in other parts of the world, honey is one of the most popular souvenirs for tourists, being considered a natural and clean product. Most respondents confirmed that the presence of children in the family often influences the willingness to purchase honey. The findings are directly in line with previous findings obtained by Menozzi *et al.* (2015) and Vapa-Tankosić *et al.* (2020). Arvanitoyannis and Krystallis (2006) have also demonstrated that one of the main dimensions of honey purchasing motivation is related to the ethical character of this product, which includes its suitability with children's diet. In the last 3 years, the quantity of honey bought for family has mostly stagnated (49%) or increased (39.9%). During the sanitary crisis caused by COVID-19, the quantity of honey consumed by the whole family has mostly remained constant (56.6%) or increased (34%). A different conclusion was reached by Eftimov *et al.* (2020) who analysed the consumption patterns during the pandemic crisis, in 24 countries. Their findings show a decrease of honey consumption during the quarantine.

Furthermore, the present study examined the importance of selected factors which are considered during purchase of honey (Table 3). Friedman test supported with post hoc test – Nemenyi's procedure – confirmed that respondents evaluated selected factors in different way. The most important factors considered during purchase were health factor and country of origin followed by producer reputation and ecological aspect. The least important were discounts, promotion and brand followed by price and family budget (Table 4).

A similar pattern of results was obtained in other studies which suggest that health benefits and country of origin represent important incentives for honey consumption (Blanc *et al.*, 2021; Kowalczyk *et al.*, 2017;

**Table 3.** Consumer attitudes towards factors considering during honey purchase.<sup>1</sup>

Factors	Mean	Standard deviation
F1 Health factor	4.29	1.06
F2 Ecological aspect	3.72	1.24
F3 Country of origin	4.18	1.08
F4 Brand	2.78	1.34
F5 Producer reputation	3.75	1.23
F6 Place of purchase	3.56	1.29
F7 Family budget	2.97	1.32
F8 Price	3.09	1.25
F9 Discounts	2.62	1.33
F10 Promotion	2.64	1.35

Mean=3.35, standard deviation=0.62, Friedman's test  $\leq 0.0001$

<sup>1</sup> The honey consumers evaluated the importance of selected factors on a 5-point scale from 1 (not at all important) to 5 (very important).

**Table 4.** Nemenyi's procedure.<sup>1</sup>

Factors	Mean of ranks	Groups <sup>2</sup>
Discounts	3.83	A
Promotion	3.92	A
Brand	4.10	A
Family budget	4.62	B
Price	4.88	B
Place of purchase	5.89	C
Ecological aspect	6.29	D
Producer reputation	6.35	D
Country of origin	7.43	E
Health factor	7.69	E

<sup>1</sup> Nemenyi's procedure = a post-hoc test of Friedman's test.

<sup>2</sup> Factors with different letters were evaluated differently from statistical point of view.

Roman *et al.*, 2013a; Yeow *et al.*, 2013). The importance of ecological aspects in the honey purchasing process was also highlighted in previous studies (Blanc *et al.*, 2021; Sîrbu *et al.*, 2016; Vapa-Tankosić *et al.*, 2020).

In addition, categorical principal components analysis revealed two latent components (Table 5). First components were titled as 'monetary factor' includes promotion, discounts, price, family budget while factors such as health factor, country of origin, producer reputation, ecological aspects and place of purchase comprise the second component entitled as 'factor of authenticity'. Approximately 69% of respondents consider Romanian honey as a honey of higher quality in comparison to imported honey from other countries. Crystallisation of honey is perceived as a sign of authenticity by 72.6% while only 7.8% thinks that it represents a sign of adulteration.

Honey belongs to the most adulterated food world-wide due to the strong economic motivation (Jaafar *et al.*, 2020). Only 51.4% of respondents are aware of adulteration and they suppose that honey is mostly counterfeit by table sugar and glucose syrup. Moreover, around 48% have been in a situation where they realised that honey was counterfeit.

**Table 5.** Rotated components loadings.

Factors	Dimension 1	Dimension 2
F1 Health factor	0.815	0.124
F2 Ecological aspect	0.725	0.214
F3 Country of origin	0.879	0.095
F4 Brand	0.514	0.437
F5 Producer reputation	0.785	0.170
F6 Place of purchase	0.727	0.207
F7 Family budget	0.269	0.807
F8 Price	0.249	0.834
F9 Discounts	0.123	0.920
F10 Promotion	0.106	0.908

Next questions were oriented on how consumers are protecting themselves from honey adulteration. On the one hand, the majority of them do not perceive the country of origin as a clue regarding the counterfeiting and higher price as a guarantee regarding honey's authenticity. On the other hand, the most respondents (56%) consider a very low price for a clue regarding the counterfeiting of honey. In general, respondents indicated that in order to distinguish authentic honey from counterfeit honey they have never used the following methods: napkin test, water cup test or fire test. A different conclusion was reached by Addam *et al.* (2017) who show that some consumers test the purchased honey at home by applying different techniques to make sure that it is pure.

Nevertheless, the majority of them consider the selected criteria (consistency, taste and degree of crystallisation) as an appropriate method for distinguishing authentic honey from counterfeit honey. The degree of crystallisation (or the liquidity state) was also mentioned by Cosmina *et al.* (2016) as an important element in honey purchasing decision. The chi-square test of independence confirmed statistically significant differences in answers towards questions with honey adulteration among age segments. Results showed that respondents belonging to age segments between 35-44 years and more than 44 years are more aware of the fact that honey is among the easiest and most often counterfeited food items (Table 6). The same results were obtained regarding the statement which claims that honey and other bee products from Romania are of higher quality than those from other countries. However, these segments do not know whether country of origin represents a clue regarding the counterfeiting of honey. The youngest segment (18-24 years) has the lowest percentage for assuming the honey crystallisation is a sign of its quality and the highest percentage for a sign of honey inauthenticity. The majority of all age segments think that very low price represents a clue regarding the counterfeiting of honey.

## 5. Conclusions and implications

The importance of authenticity in the food market is currently increasing due to many food scandals and adulteration of various food products. Similar situations have occurred in the honey market where raw honey is assumed to be the third most adulterated food in the world (Garcia and Phipps, 2017). Recent scandals with adulterated honey have created some doubts about declared quality, origin and authenticity (Zhou *et al.*, 2018). Our study brings original consumer research oriented on consumer attitudes toward honey adulteration as well as it examined the importance of several factors which are being considered during purchase of honey in the Romanian market.

The research showed that Romanian people purchase honey mostly from beekeepers or from their friends. In general, health aspect and country of origin are considered as the most important factors followed by producer reputation, ecological aspect and place of purchase. All aforementioned factors belong to latent



**Table 6.** Consumer attitudes towards honey adulteration among age segments.

Questions	Answers	18-24 years	25-34 years	35-44 years	>44 years	P-value <sup>1</sup>
Do you feel that honey and other bee products from Romania are of higher quality than those from other countries?	yes	63.61%	58.85%	72.08%	76.90%	0.000**
	no	10.16%	10.62%	5.84%	5.33%	
	I do not know	26.23%	30.53%	22.08%	17.77%	
Did you know that honey is among the easiest and most often counterfeited food items?	yes	38.36%	40.71%	56.49%	63.71%	0.000**
	no	51.48%	43.81%	30.19%	20.56%	
	I do not know	10.16%	15.49%	13.31%	15.74%	
In your opinion, the crystallisation of honey is:	A sign of its quality	57.05%	72.12%	79.87%	79.19%	0.000**
	A sign of its inauthenticity	14.75%	9.73%	3.90%	4.31%	
	I do not know	28.20%	18.14%	16.23%	16.50%	
Do you think that the country of origin represents a clue regarding the counterfeiting of honey?	yes	32.79%	26.99%	21.75%	25.63%	0.018**
	no	34.10%	34.96%	32.14%	31.47%	
	I do not know	33.11%	38.05%	46.10%	42.89%	
Do you think that a very low price represents a clue regarding the counterfeiting of honey?	yes	58.03%	55.75%	57.79%	55.84%	0.096
	no	26.23%	28.32%	21.10%	21.57%	
	I do not know	15.74%	15.93%	21.10%	22.59%	

<sup>1</sup> \*\*indicates statistical significance at the 5% by applying chi-square test of independence.

factor entitled as ‘factor of authenticity’. Less important factors were price, family budget, promotion and discounts. All of them belong to the second latent factor entitled as ‘monetary factor’. In addition, research provided interesting insight into issues related to honey adulteration and its awareness among consumers. The majority of respondents are aware of honey adulteration and nearly a half have personal experience with fake honey. Honey produced in Romania is perceived as honey of higher quality in comparison to honey imported from other countries. The most respondents have never applied authenticity tests for honey (napkin test, water cup test and fire test) however, they consider very low price of honey as a clue regarding the counterfeiting of honey. The overall awareness of honey adulteration is higher in case of respondents who were 35 years and older. The more interesting is the fact that honey crystallisation is considered ‘a sign of quality’, however the youngest segment (18-24 years) had the lowest percentage for this answer and the highest percentage for ‘I don’t know’ and ‘it’s a sign of honey inauthenticity’.

Honey market of European Union including Romania is flooded with cheap imported honey with unknown country of origin (‘blend of EU and non-EU honeys’). This cheap honey exerts pressure on market prices in Romania and many beekeepers suffer from this situation. This study provides important information for beekeepers but mainly insight into purchasing behaviour of Romanian consumers and their attitudes towards honey adulteration. Beekeepers should focus more on components included in ‘factor of authenticity’. Highlighting health factor, country of origin, reputation and ecological aspect of their product can increase the value of domestic honey in consumers’ minds. All these components should be seen as added value.

Furthermore, policy makers should inform people about possible honey adulteration and its consequences on consumers in order to avoid inexperienced consumers from purchasing counterfeit honey which is only sweetener without any added value (healing effect, nutritional value). Beekeepers should educate their consumers about honey crystallisation as a sign of its quality especially to target younger segments because their awareness is the lowest.

The country of origin represents an important factor for Romanian consumers during the purchasing process of honey. Their trust in the high quality of Romanian honey should represent an important element for producers and distributors in order to increase their competitive advantage on the honey market. Traceability of honey should be in the attention of policy makers in order to protect consumers against low quality and cheap honey with unknown country of origin.

The main limitation of this study is related to the research sample, especially its structure which is not representative on a national level. This limitation exists due to COVID-19 pandemic which allowed only to distribute the questionnaire in online environment by using the snowball method. Further research should be addressed in order to investigate the consumer attitudes towards honey adulteration and authenticity in other countries of the European Union.

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*Special issue: Opportunities and challenges of EU farm-to-fork strategy*

## **Collective smart innovations and corporate governance models in Italian wine cooperatives: the opportunities of the farm-to-fork strategy**

### **CASE STUDY**

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### **Abstract**

European policies, especially the ‘farm-to-fork strategy’, address the challenge posed by the ecological transition in agriculture setting up a new technological paradigm. In this context, collective smart innovations may play a crucial role, enabling to meet current citizen-consumers’ needs as well as producing positive environmental and social externalities. Lately, wineries, in the attempt to improve the sustainability of production process and the creation of competitive advantages, reoriented their investments in research and development embracing smart innovations. The latter, when supported by appropriate models of corporate governance, can facilitate business decisions and create shared value. Despite its relevance, literature on the topic is still scarce. This study aims to investigate the role played by collective smart innovations and corporate governance in the sustainable and ecological transition of wineries and, specifically, wine cooperatives. The case study methodology was adopted investigating the collective innovation ‘I mille per l’Aglanico’ implemented by the Italian wine cooperative ‘La Guardiense’. Results show that the collective smart innovation experienced by ‘La Guardiense’ had impacts in terms of internal economies, such as increase in sales and costs reduction; and in terms of external social economies, such as local development and environmental protection.

**Keywords:** innovation, sustainability, cooperatives, governance, value creation

**JEL code:** Q13, Q16, Q18

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## 1. Introduction

Agri-food sector adversely impacts the environment for two main reasons: firstly, it leads to over exploitation of natural resources (e.g. water, soil, etc.), it is also responsible of more than 10% of greenhouse gas emissions (GHG) in the atmosphere (Climate Watch, 2017). The effects reflect on people's health, climate change and biodiversity loss, resulting in social, environmental and economic costs. Accordingly, it is increasing significantly citizen-consumers' awareness towards environmental issues, lifestyles and consumption habits (Demirtas, 2018; Marotta and Nazzaro, 2012; Rezai *et al.*, 2012; Rhein and Schmid, 2020).

Recently, food system is playing a central role in the European debate to become the first climate-neutral continent by 2050. More specifically, the 'farm-to-fork strategy', which represents the core of the European 'Green Deal', addresses the sustainability of food system. It aims to create a fair, healthy and environmentally-friendly food system, emphasizing the link between healthy people, societies and planet. The new 'Biodiversity strategy' also goes in this direction, preserving nature and contrasting the ecosystems' degradation. Consequently, the European Commission is looking at new green business models to renew the social pact with the agri-food sector (European Commission, 2020).

The common agricultural policy (CAP) addresses these issues as well. It promotes ecological and digital transition in agriculture setting three key objectives: (1) promoting a smart and resilient agricultural sector; (2) supporting care for the environment and climate action; (3) stimulating growth and employment in rural areas. The European Union (EU) aims for a more sustainable agriculture pursued through innovation and technology (European Commission, 2017).

Companies become socially responsible by embracing social and environmental issues in their economic activities also engaging sustainable innovations (Borsellino *et al.*, 2020; Gaito, 2008; Marotta *et al.*, 2017; Medaets *et al.*, 2020; Pulina and Timpanaro, 2012; Topp-Becker and Ellis, 2017). To this extend, environmental protection may represent a competitive lever that – through the introduction of collective sustainable innovations (Stanco *et al.*, 2020) – enables to meet the current citizen-consumers' needs while producing positive environmental and social externalities (Grolleau *et al.*, 2007; Iakovou *et al.*, 2014; Marotta and Nazzaro, 2012, 2020).

The wine sector, which represents a leading sector in the Italian and European economy, both in terms of sales and product quality (Rizzo and Bonuzzi, 2008; Stanco and Lerro, 2020; Vecchio *et al.*, 2018), it is currently experiencing innovative production processes, that are smarter and greener, along with renewed organizational and managerial models (Dries *et al.*, 2013; Fiore *et al.*, 2017; Nazzaro *et al.*, 2016).

In particular, wine cooperatives are orienting their investment in research and development, improving the sustainability of production processes through the adoption of smart innovations (e.g. precision agriculture) (Doloreux and Lord-Tarte, 2013; Figueiredo and Franco, 2018; Lerro *et al.*, 2019; Raimondo *et al.*, 2020). The latter, are able to support business decisions, create shared value and increase competitiveness (Alves *et al.*, 2007). These effects are enhanced when cooperatives members are actively involved in business decisions through contractual relations and governance model that guide collective innovations.

In the current European policy scenario, cooperatives can – better than other institutions – address citizen-consumers' social and environmental instances. In addition, developing collaboration networks, both horizontally and vertically, cooperative model can secure rural environments and promote traditional food products, generating positive externalities for the community, in line with the 'farm-to-fork strategy'. More deeply, the cooperative model leads to positive effects, producing public goods and social wealth, encouraging environmental conservation and local development as well as countering the depopulation of rural areas (Vitale, 2019). Lastly, cooperatives, by involving the whole supply chain, can facilitate the transition to green economy models that require, to be effective, a collective participation.

The role of cooperation and innovation in the ecological transition to green economy models is still unknown in literature. Literature on innovation in the agri-food sector is mainly oriented to the farm rather than on the whole supply chain, focusing, especially, on the identification of the determinants that encourage its dissemination (Avermate *et al.*, 2004; Capitanio *et al.*, 2010; Grunert *et al.*, 1996, 1997; Triguero *et al.*, 2018). This study investigates the innovation process along the whole supply chain, according to a collective model and in relation to governance mechanisms. When innovation is driven by governance models, it enables to spread, along the supply chain, the value created (Karantininis *et al.*, 2010). Further, governance becomes a determining factor in the process of innovation and value creation (Gosh and John, 2005; Menard, 2004). It also represents the strategic factor for the success of collective smart innovations, allowing the sharing of value created and the establishing of trust between the actors of supply chain (Martino, 2007, 2010).

This study focuses on the Italian wine cooperatives, in terms of collective smart innovations and supply chain governance, in order to investigate how they support the sustainability and ecological transition of agri-food sector. More specifically, the study poses the two following research questions:

- RQ1: How do collective smart innovation create value for wine cooperatives and territories?
- RQ2: How do governance models contribute to a fair distribution of the value created between the cooperative and its members?

## 2. Theoretical background

### 2.1 Literature review

European food products are well recognized, globally, as safe, nutritious and of high quality. Currently, they are also becoming a global standard for sustainability. Indeed, pursuing the ‘farm-to-fork strategy’, European Union aims to accomplish six main objectives: (1) ensuring the sustainability of food production; (2) providing food supply chain security; (3) stimulating sustainable practices in the whole food sector (i.e. from wholesale to retail); (4) promoting sustainable food consumption, facilitating the transition to healthy and sustainable food; (5) reducing food losses and waste; (6) contrasting food fraud in the food chain (European Commission, 2020).

The European ‘Green Deal’ represents an opportunity for the agri-food sector to encourage the choice of healthy and sustainable food regimes, by the adoption of smart innovations.

Smart innovations are considered as part of Agriculture 4.0, which derives from the concept of Industry 4.0. It embraces the adoption of digital technologies to create a value chain integrating customers and other stakeholders (Hrustek, 2020; Sott *et al.*, 2020).

It is possible to distinguish between precision agriculture and smart agriculture. Precision agriculture is a ‘discipline characterized by the collection, storage, processing, and sharing of digital data from various sources with clearly defined objectives’ (Hrustek, 2020: 4). It represents the area in which technology can be used in order to manage agriculture by understanding the temporal and spatial changes in soil, crop, production, and management through the use of innovative techniques (Salam and Shah, 2019). This term was used, for the first time, in 1990 (Oliver *et al.*, 2013) and later was related to the concept of smart agriculture. The latter, starting from precision agriculture, includes the implementation of software systems with integrated digital components, supporting the conversion of raw data into useful information for the agricultural production process (Bucci *et al.*, 2019; Hrustek, 2020).

Innovation represents the cornerstone of precision and smart farming. There are innovations concerning crop, input, and resource management, but also organization, marketing, and distribution. New technologies, such as sensors, decision support systems (DSS), automation and robotics, collected data, traceability, and blockchain are available to farmers for supporting agricultural activity along with improving their sustainability (Adamashvili *et al.*, 2020, 2021; Galati *et al.*, 2021; Lombardo *et al.*, 2018; Sarri *et al.*, 2020).



There are several benefits related to the adoption of smart agriculture. Smart technologies, in fact, are able to increase yields and reduce inputs of production (Rose *et al.*, 2021). Furthermore, they may improve the environment increasing the production on the cultivated land, eco-efficiency (Schieffer and Dillon, 2015) and sparing further land use (Balmford *et al.*, 2019; Phalan *et al.*, 2011).

Smart agriculture also helps to fight climate change and take long-term decisions (Nguyen *et al.*, 2017). It can help to face all the threats related to crop, fish or animal production by avoiding diseases, risks of pest attack and other soil and environmental factors. It also preserves natural resources and the environment, representing one of the key tools for achieving sustainability. In recent years, internet of things (IoTs) accomplished relevance in daily lives, extending our perceptions and ability to modify the environment around us. In particular, the agri-food sector applies IoTs in both diagnostics and control (Muangprathub *et al.*, 2019; Rehman *et al.*, 2022). Further, it provides information to consumers about the origin and properties of products consumed (Talavera *et al.*, 2017).

Another concept widespread in literature is represented by climate-smart agriculture (CSA). The Food and Agriculture Organization of the United Nations (2010) defines CSA as ‘agriculture that sustainably increases productivity, enhances resilience, reduces GHGs, and supports the achievement of national food security and development goals’. It aims to achieve food security and other development goals in a context of climate changing and increasing food demand (Lipper *et al.*, 2014; Ngcobo and Chitakira, 2021; Nyagumbo *et al.*, 2022; Totin *et al.*, 2018).

The application of smart agriculture in viticulture is relatively recent (Arnó Satorra *et al.*, 2009). Viticulture is largely responsible of GHG emissions due to the production and application of chemicals, irrigation, pruning, tillage, soil emissions, and crop residue management (Recchia *et al.*, 2018; Sarri *et al.*, 2020). Specifically, mechanization in viticulture represents more than 60% of the total warming of wine production (Aguilera *et al.*, 2015). Accordingly, it is important to apply smart agriculture in viticulture to improve economic, environmental, and social sustainability (Sarri *et al.*, 2020). More deeply, it may reduce GHG emission enacting on: (a) the enhancement of the soil’s ability to operate as carbon stock reserve (Angers and Eriksen-Hamel, 2008; Khan *et al.*, 2007); (b) the reduction of fuel consumption due to less in-field operations (Sarri *et al.*, 2020); (c) the decreasing of inputs for the agricultural field operations (Sarri *et al.*, 2020). These practices optimizing the agricultural inputs, produce higher or equal yields with a lower cost, reducing also the carbon footprint of the process by one-quarter (Belafoutis *et al.*, 2017). A further benefit is given by the added value recognized by citizen-consumers for the protection of natural and social environment (Bekmezci, 2015; Marotta and Nazzaro, 2012; Van Evert *et al.*, 2017). Therefore, the application of smart agriculture in viticulture allows to enhance the environmental, economic, and social sustainability of the production process (Sarri *et al.*, 2020).

## 2.2 Conceptual framework

The ‘farm-to-fork strategy’ enables the ecological transition in agriculture that requires a new technological paradigm (i.e. low environmental impact with zero emissions), embracing an efficiency-oriented technology (e.g. cost reduction and profit maximization), and a technology geared to citizen-consumers’ needs (e.g. health, environment and ethics). In agriculture, this technological paradigm is addressed through smart agriculture. The latter, to be effective, requires a collective approach to innovation, involving public and private actors in the food value chain and rethinking the governance models (Schebesta *et al.*, 2020; Stanco *et al.*, 2020). Indeed, since it relies on the behavior adopted by the actors in the food supply chain, the main risk lies behind their opportunistic behaviors. In the cooperative sector the implementation of innovations may be critical due to potential divergence in the innovation objectives set by the cooperative and its members. For instance, members may strive to increase the production whilst the cooperative to improve the quality in order to better compete on the markets. As a result, members’ involvement represents a condition for an effective innovation process in a cooperative. The latter requires a collective approach based on integration strategies (i.e. vertical and horizontal) and on coherent and synergistic behaviors of all economic actors involved (Stanco *et al.*, 2020: 3,4).

The effectiveness of smart collective innovations in the agri-food value chain depends on: (1) the structural characteristics and internal skills of the supply chain; (2) the degree of integration among the various stages of the supply chain and the cooperation between its actors with Universities, research institutions and other stakeholders in the territory; (3) the governance of the supply chain; (4) policies (Stanco *et al.*, 2020; Triguero *et al.*, 2018: 51). The Italian agri-food sector results highly fragmented, with the prevalence of small and medium enterprise (SME) with limited R&D capability and in which integration is a resource to establish smart collective innovations. In this context, cooperation with companies in other sectors and with the research institutions (e.g. Universities) may unlock knowledge and technologies of smart innovations to the agri-food chains.

The implementation of smart innovation requires a collective strategy led by a leading company (e.g. a cooperative and/or agri-food company). The positive effects of this approach are twofold. Since the leading company is the economic player closer to the market, it is able to catch citizen-consumers' needs. Moreover, it ensures the coordination of the supply chain to reduce transaction costs and share equally the value created by innovation.

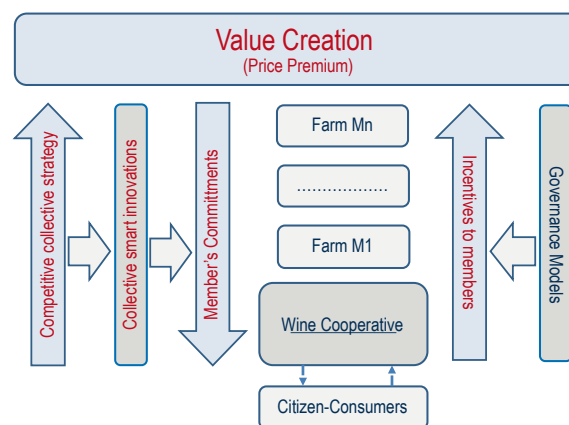
This study identifies as leading company of the proposed conceptual framework, the cooperative that is able to intercept the current citizen-consumers' needs by implementing the smart innovations in the whole production process (i.e. in field and winery) (Figure 1).

The leading cooperative defines a competitive collective strategy involving several members (i.e. wineries) (Farm  $M_n$ ) in the collective smart innovations. To encourage farms in the implementation of smart innovations, the competitive collective strategy has to apply fair governance models. The latter involve contracts that encourage members' commitment paying a price premium and, they establish the sharing of the value created by the sale of the 'smart' products among the different actors in the wine supply chain (Farm  $M_1$ , Farm  $M_n$ ).

To sum up, governance becomes a strategic driver in the implementation and management of collective smart innovations, regulating the relationship in the supply chain, reducing transaction costs (Williamson, 1985), ensuring the success of the innovation and, determining the sharing of the value created.

### 3. Materials and methods

The case study methodology was applied in the study as this methodology enables to analyze an emblematic case (Harling and Misser, 1998; Siggelkow, 2007; Yin, 2009), highlighting its distinctiveness and uniqueness, within a specific socio-economic context (Stake, 2005).



**Figure 1.** Collective smart innovations and governance models.

The case study investigates as collective innovation process ‘I mille per l’Aglianico’ implemented by the Italian wine cooperative ‘La Guardiense’. The latter was chosen as it represents an emblematic case of a cooperative engaged in the implementation of many sustainable and smart innovation projects – both in the vineyard and in the cellar – aiming at improving the environmental sustainability of the whole supply chain and producing high quality wines.

The study relies both on primary and secondary data. The primary data were collected with face-to-face interviews, administering a semi-structured questionnaire to the cooperative management and few members. The questionnaire addressed three main objectives: (1) the smart innovations applied in vineyard and in cellar; (2) the degree of involvement of the cooperative’s members; (3) the internal and the external effects of the implemented collective smart innovations. As for the smart innovations, the questionnaire detected the initiatives put into place by the cooperative to improve product quality and pursue the sustainability goals (i.e. environmental, social and economic). Another section of the questionnaire revealed the commitment required to the cooperative members to implement the smart innovations in vineyards, as well as the incentive received. Lastly, the interview unveiled the resulting impacts of smart innovations adopted in terms of internal economies, such as increase in sales and costs reduction; and in terms of external social economies, such as local development and environmental protection.

The secondary data were collected analyzing the cooperative website, published reports and, the cooperative financial data.

## 4. The case study

### 4.1 The cooperative

‘La Guardiense’ founded in 1960 in Guardia Sanframondi, in Sannio area, is one of the greatest wine cooperatives in Southern Italy. It counts more than 1000 members producing approximately 200,000 quintals of grapes per year and 150,000 hectoliters of wine, with a turnover of about 15.5 million euros in 2020. The wine cooperative holds 1,500 hectares of vineyards over the 10,000 total hectares of the province of Benevento, with an average of 2 hectares per winery. Cooperative members cultivate three native vines, namely Aglianico, Falanghina and Piediroso (both protected designation of origin (PDO) and protected geographical indication). ‘La Guardiense’ produces approximately 4 million bottles per year, divided into four production’s lines (i.e. Janare, Fremondo, Aicon, and Classica), and the sparkling wine produced with both the Charmat/Martinotti method and the classic one.

All the wines are certified SQNPI Sustainable Quality, a certification conceived by the Italian Ministry of Agricultural, Food and Forestry Policies, in which the wine is obtained from grapes treated with integrated cultivation practices (e.g. limited use of chemicals on grapes).

Since it was founded, ‘La Guardiense’ has always looked for improving the quality of wines through process and product innovations. As a consequence, the cooperative was able to face increasingly competitive markets, becoming a real symbol of technological progress for its territory. All the innovations implemented are aimed at preserving environmental sustainability. Indeed, the cooperative promotes the adoption of sustainable agronomic practices, as well as the experimentation of smart agriculture to improve the efficiency of natural resources, reduce the use of chemicals and preserve soil fertility. In the cellar, instead, the contribution to the environmental sustainability explicit in: (1) self-producing most of the electricity needed in the production process; (2) using technologies to reuse and purify waste water; (3) experimenting new fermentation processes that limit the use of chemistry.

#### 4.2 'I mille per l'Aglianico': a project of collective smart innovation

'La Guardiense', over the last few years, implemented several products and process innovations, to achieve the aims set by the 'farm-to-fork strategy', and realize the transition process toward sustainable and smart agri-food sector. These innovations contributed to its growth and to the creation of shared value. Previous studies (Drucker, 1985; Jacobides *et al.*, 2006) pointed out that innovation is central for value creation for consumers, producers and for individuals not directly involved in the production process. The concept of value extends beyond the economic one, focusing more and more on the immaterial aspects related to the realization and diffusion of innovation. In this context, it becomes essential to act in the perspective of smart agriculture, through sustainable and responsible collective innovation, in order to generate positive consequences in the context in which the company operates.

The collective smart innovation project called 'I mille per l'Aglianico' was launch in 2009 to respond to a market crisis that hit Aglianico, one of the most important indigenous grape varieties of Sannio. It takes its name from the number of cooperative members (i.e. 1000) involved.

The main objective of the project was to relaunch the Aglianico wine on the market: (1) improving the quality of the grapes produced, by reducing the production of grapes per vine; (2) encouraging the adoption of more sustainable agronomic practices and smart innovations; (3) implementing more efficient and environmentally friendly transformation processes, excluding chemistry in cellar.

About 110 producers were involved in the experimental phase of the project accounting for over 70 hectares, located between 200 and 400 meters above sea level and facing south-southwest of the Sannio wine area. Such a large experiment, with the involvement of a large number of members, took place for the first time in Italy. The experimentation also represented a great challenge for the cooperative as Aglianico is a complex vine that requires specific care, especially with regard to quantitative management.

The success of the experimental phase of 'I mille per Aglianico' project led 'La Guardiense' to extend the collective smart innovation process to the whole production area of the Aglianico PDO grapes cultivated by the cooperative members.

The project carried on the market a new type of wine with 'smart' attributes. As a consequence, a new label was adopted to distinguish it from the classic Aglianico wine sold by the cooperative.

##### ■ *The innovations in vineyard*

First of all, the project concerned the experimentation of a cultivation protocol based on the application of sustainable agronomic practices aimed at the natural reduction per hectare of the grapes produced, from 120 qls<sup>1</sup>/ha (enabled by Aglianico PDO's disciplinary) to a maximum of 70 qls/ha. The protocol was designed by a committee of agronomists of the cooperative coordinated by the well-known oenologist Riccardo Cotarella. More specifically, in order to reduce the yield, the cultivation protocol provides different operations:

- targeted pruning. A maximum of 20 buds are left on the plant and the quantity of shoots is reduced;
- green pruning (gem selection). Only the largest buds are left on the plant;
- no fertilization in vineyard. In order to avoid the increase in production and preserve sustainability;
- grassed vineyard. Weeding and the passage with tractors are abandoned, letting the spontaneous grass grow;
- green manure. It is a sustainable agronomic practice which consists in the sowing of an herbaceous crop with pure or known essences – to be totally buried or chopped – as a fertilizer;

<sup>1</sup> qls = quintals.

- thinning of the bunches. The purpose of this practice is to remove any damaged bunches from the plant both in the veraison phase (i.e. the phase in which the bunch begins to ripen), and just before the harvest, to avoid that these can compromise the quality of the wine produced;
- targeted phytosanitary treatments. Phytosanitary treatments are carried out only if strictly necessary and based on plant health. The vines of each farm are, in fact, kept constantly under control through vegetative maps.

The cultivation protocol also plans to recover up to 50 q.l.s of grapes<sup>2</sup> per hectare of thinned grapes. The latter, due to their acidity (as they are removed from the plant before they reach maturity), become an excellent basis for the production of sparkling wine.

The winegrowers involved in the project were also able to count on the constant technical assistance provided by the committee of agronomists who, in addition to carrying out inspections in vineyard, also took care of organizing periodic events to spread best practices.

To mechanize phytosanitary treatments, 'I mille per l'Aglianico' project experimented collective smart innovations, introducing mechatronics in vineyard. Experimentally, the cooperative adopted multi-parametric control units set on quads that periodically cross the rows of the vineyards to detect plant health. Data collected by the multi-parametric control units were sent in real time to a database updating a vegetative map. The latter were then used by smart tractors which, retracing the same rows, recognized the plant releasing a sufficient amount of nutrients based on the plant health. Lately, to further preserve environmental sustainability, and reduce the use of natural resources and soil erosion, the quads were replaced by drones, while the smart tractors by a smart fertilization and irrigation system, still under test today.

#### ■ *The innovations in cellar*

Once the grapes reached the cellar, to preserve the quality of the final product, they are processed with soft holds. It maintains the integrity of the skins, reducing the presence of harmful particles in the fermentation mass, and containing the development of harmful organisms in the bottle. Moreover, during fermentation, the operation of refrigerators allows to limit the use of chemicals in wine, reducing both the environmental impacts of wine production, and the costs of chemicals. The maintenance of low and constant temperatures during the fermentation also enables to drastically reduce the quantity of sulphites adopted into wine production.

Finally, to preserve the environment and save energy, 'La Guardiense' installed a photovoltaic plant that occupies an area of 950 square meters, with a power of 130 Kw picco and an annual production of 176,000 Kwh. Noteworthy, there is also an industrial water treatment plant, that facilitate the internalization of water resources and, along with the use of photovoltaic, reduce the impact of production on the environment.

#### *4.3 The governance model introduced by 'I mille per l'Aglianico' project*

The success of the collective smart innovation provided by 'I mille per l'Aglianico' project was the governance model adopted by the cooperative. The latter created a climate of widespread trust among the cooperative members, which enabled to achieve shared and participatory results (Martino, 2007, 2010).

'La Guardiense' to encourage members to follow the rules set out in the cultivation protocol and adopt the smart innovations, it set up contracts that pay up to a maximum of 120 q.l.s/ha (maximum production enabled by Aglianico PDO's disciplinary), even if the maximum amount of grapes vinified, is 70 q.l.s/ha. As for the 70 q.l.s/ha vinified, the cooperative recognizes the market price for Aglianico PDO grapes increased by 50%.

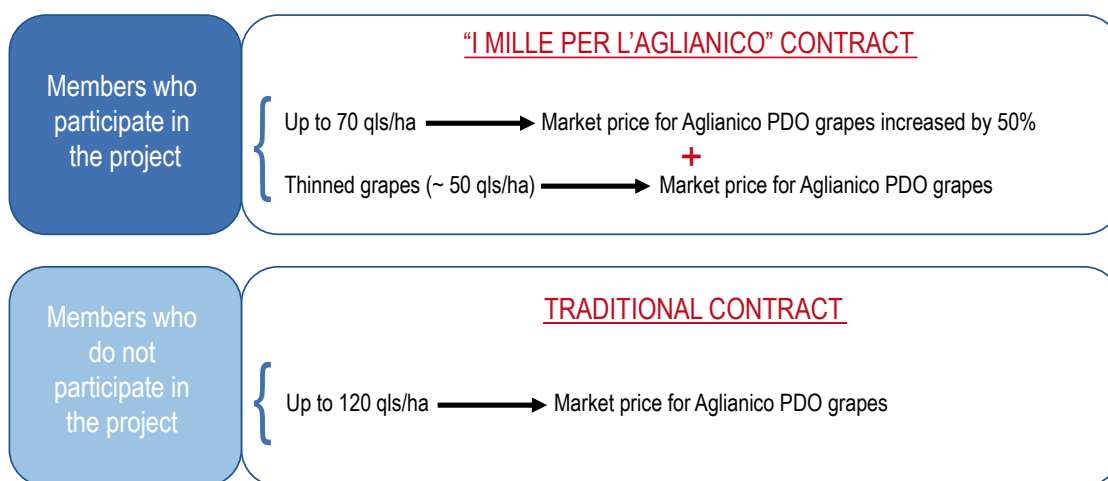
<sup>2</sup> They represent the difference between the 120 q.l.s/ha enabled by Aglianico PDO's disciplinary and the maximum 70 q.l.s/ha provided by the cultivation protocol of 'I mille per Aglianico'.

As regards the approximately 50 q.l.s/ha of grapes obtained from thinning and used as a sparkling wine base, the cooperative recognizes the expected market price for Aglianico PDO grapes (Figure 2).

Therefore, the members benefit of a price premium per quintal of grapes produced of about 30% more than the market price. The contract, which in the experimental phase were stipulated only with a limited number of members, is currently extended to all members involved in the cultivation of Aglianico PDO grapes.

### 5. Results and discussion

To answer to the first research question, the study analyses the impacts generated by the adoption of the collective smart innovations by ‘La Guardiense’. Specifically, the study findings show that the collective smart innovations establish both internal (i.e. internal economies) and external (i.e. external social economies) impacts. The formers reflect in sales increase and in the improvement of the production process due to the reduction of costs management in vineyard and the use of chemical products. The new wine produced by the cooperative granted, from 2015 to the present, a significant increase in sales and turnover going from about 12.8 million euros in 2015 to about 15.5 million euros in 2020, with an increase of over 21%. Literature widely acknowledges the economic impact resulting from the implementation of innovation in the agri-food sector. More deeply, scholars agree on the role played by innovation in improving competitiveness and market position (Capitanio *et al.*, 2010; Nazzaro *et al.*, 2019; Roucan-Kane *et al.*, 2011). As for the external social economies, the collective smart innovations enhanced the sustainability of the production process as well as the development of the territory. More deeply, it, firstly, limited the negative externalities of production on the environment; secondly, it enabled the characterization of the wine in terms of typicality and promotion of the Sannio wine area. In other words, the collective smart innovations increased the economic value created as well as preserved the environment and local development, contributing to the growth of both the Cooperative and the territory. The Cooperative also promoted the innovative aspects, the high quality and the environmental sustainability of the new wine through three publications in the magazine ‘La Civiltà del Bere’. Further, in 2013, the wine ‘I mille per l’Aglianico’ won a prestigious international award recognized every year for the best wine produced among those participating in the competition, namely the ‘Oscar del vino’. In addition, this award contributed to the development of the territory as well as its distinctive identification at national and international level. These findings are in accordance with previous studies highlighting the relevance of collective smart innovations for the revamping of inner areas in economic and social terms (Pancino *et al.*, 2019; Stanco *et al.*, 2020).



**Figure 2.** Governance model of ‘I mille per l’Aglianico’.

As for the second research question addressed in the study, the case study reveals the value created by the smart collective innovations and the role of the governance models in its distribution between the cooperative and its members. The collective smart innovation ‘I mille per l’Aglanico’ led to the launch on the market of a new wine with ‘smart’ attributes. The new wine was first released in December 2013 with a price tag of around €15.00 for a 0.75 liter bottle. Subsequently, the ‘I mille per l’Aglanico’ wine was withdrawn from the market to be launched definitively in January 2015. The wine Aglianico PDO ‘I mille per Aglianico’ was sold on the market with a price tag of €25.00 for a 0.75 liter bottle. Compared to a bottle of medium quality Aglianico PDO produced by the same cooperative, that is sold at a price of €8.00 for a 0.75 liter bottle, there is a price difference of about €17.00 per bottle. It represents the value created by the collective smart innovation ‘I mille per l’Aglanico’ which is shared with all the cooperative members due to the governance model implemented. Indeed, cooperatives’ members benefited of a price premium per quintal of grapes produced of about 30% more than the market price of Aglianico PDO; whilst the cooperative, since the launch of the new wine on the market, showed an increasing in its turnover year by year. The benefit for the members is due to the twofold mechanism of incentives put into place by the wine cooperative (Figure 2). The cooperative, instead, was able to increase the turnover and reposition its products on the market, producing a wine in line with the current citizen-consumers’ instances.

Literature well recognizes the importance of governance models for the distribution of the value created by the innovation as well as for the creation of stable relationship among the different actors of the supply chain (Martino, 2010). Moreover, it is central for avoiding opportunistic behavior by the actors involved in the innovations (Karantininis *et al.*, 2010; Zilberman *et al.*, 2019).

Currently, ‘La Guardiense’ extended the collective smart innovations to the whole production area of the Aglianico PDO grapes cultivated by the cooperative members. Lastly, given the success achieved by the previous project and the restored confidence of members towards innovation, due to the adoption of the governance model, the cooperative proposed a similar project for its white wine (i.e. Falanghina) namely ‘I mille per la Falanghina’.

## 6. Study implications and limitations

The study findings provide useful implications for both decision makers and practitioners, as they contribute to the debate on the sustainability and ecological transition in the agri-food sector. In particular, the study highlights the central role of collective smart innovation and its resulting effects in terms of internal and external social economies.

The first implication of the study is related to the policy for the agri-food sector that should support mainly strategic development plan able to foster innovation in the supply chain. Indeed, as the case study highlighted, the benefits of collective smart innovations affect the actors involved in the food supply chain along with the territory. European Union is already set to meet the arising instances of the agri-food sector in terms of innovation. More specifically, the ‘farm-to-fork strategy’, which represents the core of the European ‘Green Deal’, addresses the sustainability of food system by the innovation point of view. Moreover, the forthcoming Common Agricultural Policy 2023-2027 will put into place a bundle of funds aimed at encouraging innovation in the agri-food supply chain. A further implication of the study regards governance models. Specifically, the study uncovered that the effectiveness of the collective smart innovation relies on the adoption of new governance models able to share the value among the actor involved. Therefore, practitioners should pay more attention to the governance models to implement in the agri-food supply chain.

The study limitations are mainly related to the use of the case study methodology that limits the generalization of the results observed. However, such methodology well fits the aim of the study that focuses on the role of collective smart innovations and the governance models adopted.

Future studies should investigate deeply new governance models able to facilitate innovation and the distribution of shared value. Further, they may explore different supply chains and territories, in order to corroborate the role of collective smart innovations in the sustainability and ecological transition pursued by European policies.

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*Special issue: Opportunities and challenges of EU farm-to-fork strategy*

## **Are there any differences in rural development challenges within European countries? Social and economic contexts from EU rural leaders**

### **RESEARCH ARTICLE**

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### **Abstract**

Rural development has become a significant policy challenge in Europe. More employment opportunities have increasingly been concentrated in urban areas, leaving rural regions with ever-continuing down-fall in terms of population size and economic growth. In this context, rural entrepreneurship activity that positively influences rural communities is embedded in broader social or structural policies at the European level. The aim of the article is to investigate societal and economic challenges and their innovative solutions in five European rural regions: Croatia (Slovenia), Germany (Münsterland, Saxony-Anhalt), Poland (Małopolska), and Portugal (Alto Minho). This study follows a multi-case method which investigates the diversity of challenges and solutions in selected European rural areas. The comparative analysis reveals that most essential activities aimed at alleviating the development problems of rural areas include education of local communities, improvement of economic and digital infrastructure, activities supporting production and promotion of local products, promotion of cooperation between local communities and producers, and stronger orientation of local policy towards financial support of production enterprises and farms. The conclusions resulting from the study lead to formulating recommendations concerning rural policies in the context of developing entrepreneurship strategies in rural areas.

**Keywords:** economics, entrepreneurship, rural development, social innovations

**JEL code:** O1, Q01, L26, L31, R11, R23, R58

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## 1. Introduction

Sustainable economic growth, employment opportunities, decent workplaces and the general well-being of European countries are still diversified despite many years of efforts to harmonise and minimise disparities. The most common challenge of rural areas is related to depopulation, particularly the migration of young adults to urban areas. However, there are many exceptions of rural communities that survive external challenges and develop in a growing pattern. It seems that rural residents, with their entrepreneurial attitude, knowledge, capability, willingness and resolutions have successfully developed new economic activities to respond to potential (urban) market demand. These communities often go through a social management transformation from individual to a more collective-based system. In this process, communication and dialogue among individuals are improved, and collaboration between different stakeholders also becomes more intense. Therefore, the social capital of rural regions becomes a significant issue. Rural residents are willing to establish and maintain effective interactions with the external environment and regional stakeholders who provide access to financial and political capital that can have beneficial development outcomes (Li *et al.*, 2019) and serve as the possible solution to overcome challenges in their communities.

In this context, policymakers at the regional, national and European level have been working towards improving a business climate with a view to reducing disparities between rural and urban development opportunities. The European Cohesion Fund, the European Regional Development Fund, and the European Social Fund are examples of such rural development policies and programmes initiated by the European Union to tackle rural development challenges at the national and regional level (Van der Ploeg *et al.*, 2017). Still, there is a general lack of rural strategies focused on entrepreneurship, particularly in ageing and depopulated rural areas.

A traditional activity undertaken in rural areas is the production of agricultural goods for the purpose of direct consumption or for the needs of the agriculture and food industries. This activity remains a significant function performed by rural areas, and it is indispensable to maintaining food security. However, as a result of social and economic changes, rural areas are no longer associated exclusively with agriculture and the food sector. Presently, rural areas perform a number of non-agricultural functions, allowing their residents to seek employment in more lucrative economic sectors. Empirical studies show that the diversification of economic activities increases household incomes (Gautam and Andersen, 2016; Hoang *et al.*, 2014). Some development economists have still argued that agriculture is the key to rural development (Irwin *et al.*, 2010), others have argued that it is only by industrialising rural areas that growth can ultimately be achieved, which could also be compared to rural urbanisation as generally referred to the transformation of a rural area into an urban one (Liu *et al.*, 2010). Other modern rural development initiatives include landscape management, the conservation of new nature values, agritourism, organic farming, and high quality and region-specific products. Other activities, increasingly adopted by family farms, include innovative forms of cost-reduction, direct marketing, and new activities such as integrating care activities into the farm. Involvement in this type of undertakings results in new forms of social cohesion, and, in many cases, a variety of activities are combined in an integrated way (Van der Ploeg *et al.*, 2017).

Yet, the most successful development strategy is the one that creatively benefits from synergies between regional stakeholders by developing a strong business ecosystem and enhancing rural entrepreneurial spirit (Berglund *et al.*, 2016). This underlines and refers to the idea of rural development embedded in entrepreneurship (Barrett, 2015; Fortunato, 2014; Markey *et al.*, 2010) through stakeholder engagement and life-long entrepreneurial learning (Brandt *et al.*, 2018; Hercz *et al.*, 2021; Leonidou *et al.*, 2020). Rural entrepreneurship can be defined as all forms of entrepreneurship which take place in areas characterised by large spaces and a small population in terms of national characteristics (Korsgaard *et al.*, 2015). Territorial issues have a lot of weight in defining rural entrepreneurship. However, the key role in the development of entrepreneurship in rural areas is played by synergies between various regional stakeholders such as higher education institutions, rural businesses, public authorities, rural residents, and rural entrepreneurs. The engagement and collaboration of these people and characteristics of their activities constitute the essence of the discussion on rural entrepreneurship. This is because regional stakeholders have the best understanding

of local social problems, and rural entrepreneurship is strongly rooted in the local social context. While nurturing rural entrepreneurship plays a vital role in reaching new horizons in sustainable economic growth and well-being (Muñoz and Kimmitt, 2019; Sá *et al.*, 2018), it is necessary to have a better understanding of how entrepreneurship can revitalise rural regions in the EU's perspective.

To address this gap, this study aims at investigating social and economic challenges and innovative solutions in five European rural regions: Croatia (Slovenia), Germany (Münsterland, Saxony-Anhalt), Poland (Małopolska), and Portugal (Alto Minho). This will allow for a better understanding of rural development possibilities as well as the establishment of public policies and recommendations to stimulate this development. Specifically, this study addresses the following issues:

- What challenges can be identified in rural regions in Croatia, Germany, Poland, and Portugal?
- What are the similarities and differences between European regions?
- What are possibilities for bridging existing development gaps in rural areas?

This study follows a multi-case method (Yin, 2009) which investigates the diversity of challenges and solutions in selected European rural areas. One focus group was organised in each region to identify and discuss specific challenges and solutions. Approximately 20 representatives from higher education institutions, rural businesses, public authorities, and rural residents were included in each focus group. As a result, it was possible to obtain information from individuals who have the best knowledge on the economic and social challenges of rural areas and who are genuinely interested in developing best practices aimed to meet them.

This paper offers important contributions to arousing academic and practical interest in rural entrepreneurship by identifying similarities and differences in challenges and solutions of European rural areas. The paper is organised as follows: its introductory part presents a theoretical contextualisation of the rural challenges and development directions. Then, it presents the adopted methods aimed to conduct the study. The next step is the presentation and discussion of the results. Finally, it presents conclusions and suggestions for future research.

## 2. Literature review

Being a topic undertaken in literatures since the early 1980s, rural development is still a major concern of all EU countries. Rural regions face major challenges – emigration of young people to urban areas, population with lower levels of formal education, older age structure and limited access to financial capital (Deller *et al.*, 2019), rapid decline in employment, dominant agricultural sector, poor socio-economic environment, and distance to market and services (OECD, 2006). In this context, rural entrepreneurs face different challenges. Dabson (2001) emphasised that many rural communities are remote and geographically distant from major business networks, leading rural entrepreneurs to create deep social capital (Wilkinson, 1991). Local demand is limited in rural areas with limited population and density; therefore, it is extremely difficult for rural entrepreneurs to achieve economies of scale. Since the local economy is dominated by one industry or agriculture, sector-specific risks are higher (Goetz, 2006). Rural communities, due to their remoteness, often have limited financial opportunities, which are critical for start-up survival, but also limited access to human resources and institutional support mechanisms for small and medium enterprises (SMEs). Innovation blends with traditional values and norms (Lichtenstein and Lyons, 1996). Artz (2003) stresses that brain drain is a major problem for rural areas as young and well educated people tend to seek better-paid employment in urban areas. This creates a power asymmetry where local workers feel ‘economically disadvantaged’ and helpless about their own careers (Fortunato, 2014: 393). Entrepreneurs in rural areas are mainly involved in the service, retail and construction sectors (Henderson, 2002). They are also found in agriculture and extractive industries. Since rural areas have fewer high-growth businesses and rural incomes are 31% lower compared to urban areas (Henderson, 2002), the need for supporting activities and policies seems to be a must. Also, there is a strong and deepening difference between urban and rural growth.

Earlier policies and strategies that focused on attracting investment from urban areas were unsuccessful in addressing these challenges. In the 1960s, the policies directed investment to the rural areas to organise

production, ensuring food supply in EU countries. Investments were mainly used for opening new enterprises, relocating businesses and improving the infrastructure. However, the expected increase in business and reinvestment of profits in agriculture were not always implemented. The recession in the 1970s led to the closure of many enterprises. In the early 1980s, this model of rural development could not yield the expected results in economic terms. However, at that time the successful economic development of such areas as Tuscany and Emilia-Romagna attracted public attention because a high concentration of specialised small and medium enterprises was not affected by the industrial crisis (Patarchanova, 2012). Firms have abandoned models based on economies of scale and vertical integration and increasingly opt for more flexible patterns of organisation (Van der Ploeg *et al.*, 2017). Through their flexibility, in terms of quality and quantity of supply, SMEs are better suited to trade in dynamic and volatile markets than large firms. Due to their experience, the rural development model was shifted to promote local businesses, increase local capacity, local initiatives, and economic diversification. This new model assumes that local development is created primarily by local impulses, based on the greater degree of local resources (Patarchanova, 2012).

Many studies have concluded that a more comprehensive analytical concept for rural development is required. Many policy objectives for rural regions are still oriented towards classical 'growth' objectives; however, a much wider application of new perspectives and a more targeted answer to societal challenges is suggested (Dax and Fischer, 2018). The specific character of rural areas within the EU is determined by their social and cultural identity. Every rural area has a unique geographical location, natural resources, history, ethnic composition of the population, religion and traditions, urban network and economic potential. They feature a distinctive way of life, closer relationships between people, direct contact with nature, which is a symbol of a healthy living environment. Understanding their nature includes views on multifunctional agriculture, economic diversification of the farm for environmental protection, landscape conservation and preservation of their cultural heritage as well as customs and traditions (Patarchanova, 2012). Sustainability, ecological modernisation, public goods, multifunctionality, rural restructuring, networks and globalisation, endogeneity and circular economy are important aspects of the challenges in rural development policies. Consequently, it is more important to propose alternative guidelines for future options of rural strategies: well-being of the regional population, potential of migrants, newcomers and returning people, significant changes in the role of spaces (e.g. towards living space and regions for leisure experience), a renewed identity implying the creative use of social innovation changes and, in general, the capacity to innovate for regions, leading to increased regional attractiveness (Dax and Fischer, 2018).

Researchers, as well as policymakers, shifted their focus to rural entrepreneurship (Drabenstott and Henderson, 2006). Rural entrepreneurship can be defined as all forms of entrepreneurial activities in rural areas – local enterprises that employ local people, use and provide local services, and generate income in rural areas (Korsgaard *et al.*, 2015; Pato and Teixeira, 2016). The interest in this area increased due to changes and crises in rural society (Wortman, 1990), which raised awareness of this issue. It was found that entrepreneurship can raise the level of employment in rural areas, but also secure welfare (Chun and Watanabe, 2012). Besides that, Van der Ploeg *et al.* 2000) found out that entrepreneurship started all development activities in rural areas. Nevertheless, rural entrepreneurship theory is still in its infancy (Fuller-Love *et al.* 2006; Kulawczuk, 1998; Pato and Teixeira, 2016; Vaillant and Lafuente, 2007), without a proper research agenda. The empirical literature on rural entrepreneurship mainly refers to developed countries such as the United States, Spain, Finland and Greece (Pato and Teixeira, 2016), neglecting the situation in less developed countries, especially underdeveloped ones. Rural enterprises need to extract new values from traditional resources, but also combine them with local specificities (Anderson, 2000). Rural entrepreneurship may be significantly different from entrepreneurship in urban areas, but there is little consensus on this (Fortunato, 2014). Creating innovative regions has never been on the agenda of rural entrepreneurs. Their goal is simply to improve the quality of place and life (Korsgaard *et al.*, 2015).

Recently, literatures have associated entrepreneurship with immigrant businesses (Fortunato, 2014). According to research conducted in the United States, immigrants have revitalised rural areas through their ventures. Immigrants are 30% more likely to start a business than non-immigrants (Fortunato, 2014). The results of

this study are particularly important for all European countries facing the largest flows of migrants. Another important finding is that rural entrepreneurs earn significantly more than urban workers (Yu and Artz, 2019), but also that individuals who choose rural residency are more likely to become entrepreneurs. Rural entrepreneurship stimulates the local economy by creating jobs, providing various products and services, but also by increasing the quality of life in rural areas (Yu and Artz, 2019).

The need for citizens who contribute to service delivery is in rural areas more urgent than in metropolitan areas because of changes such as (expected) depopulation, ageing, digital exclusion, school closures, unemployment, under-employment, high mobility costs and changing consumption demands. Therefore, the knowledge of the contributions of community-led development, social entrepreneurship and citizens' initiatives to service delivery is important (Haan *et al.*, 2019). Moreover, being rural does not cause poverty, but it has the effect of exacerbating the related conditions that increase vulnerability and limits opportunities to escape poverty. A distance from markets and limited resources creates disadvantages whilst relative isolation and dispersed populations may also lead to neglecting problems caused by social and economic distance. Therefore, rural areas seem to be an appropriate context for social enterprise because entrepreneurial solutions offer opportunities to create positive changes (Andersen and Lent, 2019). A study of two Scottish rural areas shows (Steiner and Teasdale, 2019) that social enterprise could represent a way to face the local challenges of sustainable economic development, suggesting the withdrawal of public services and promoting community cohesion. The authors explain that social enterprises can create locally responsive services, but it may be necessary to go beyond traditional policy options that separately address economic development, community cohesion and public services, as national policies do not always translate into practice at the national rural level. Collaboration between groups of social enterprises and between social enterprises and public authorities can lead to economies of scale, particularly where strong trust-based relations are built up.

Some studies have shown that particularly in rural areas citizens' initiatives have the potential to replace pressurised services and foster the resilience and empowerment of these rural communities (Haan *et al.*, 2019). However, despite all the shortcomings of rural areas, lifestyle entrepreneurs, internet nomads and social entrepreneurs have discovered rural areas as ideal places for their ventures. Their main goal is to combine the desire to pursue their own desires and ideas with the quality of life. This shift from traditional industries to services has been good for rural areas (Acs and Armington, 2006). Many rural entrepreneurs are less concerned with profit than with pursuing their own ideas, desires, or goals (personal, social, or cultural). They are willing to compromise on the financial development of their business in order to achieve their goals (Achtenhagen *et al.*, 2010). They will maximise locally available resources and create new value from traditional resources by combining the characteristics and uniqueness of place in providing services or products (Anderson, 2000).

The involvement of all local stakeholders should not be neglected in rural development models. The stakeholder's role in the innovation processes is very significant (Fiore *et al.*, 2020) because the use of external knowledge makes innovation easier and faster for firms despite their size and industry environment (Giacomarra *et al.*, 2019). Therefore, both internal and external stakeholder relationships should be managed in order to attract and share knowledge, to achieve both social responsibility goals and sustainable innovation outcomes (Giacomarra *et al.*, 2019). In a rural development context, empirical studies highlighted that cooperation and organisation between stakeholders created new chances for smart social innovations. Moreover, in farming all the stakeholders (farmers, processors, transporters, distributors, retailers, consumers, officials, and policymakers) are crucial in handling food-safety risks (Fiore *et al.*, 2020). The diversity of knowledge and values of the rural community must be taken into consideration, and it is necessary to ensure that there is stakeholder participation in decision-making processes and implementation. The involvement of stakeholders makes it possible to seek their views and identify how each of them can contribute to meeting the identified challenges. However, the implementation of rural development projects is inherently complex, partly due to the need to satisfy multiple stakeholders (Usadolo and Caldwell, 2016). Different stakeholders might differently perceive and evaluate the co-benefits of collaboration, and neglecting these differences may lead to conflict, and thus to policy resistance mechanisms (Giordano *et al.*, 2020). Henceforth, to be successful, a process in which stakeholders engage in collaboration and coordination for mutual benefit



should be initiated by the stakeholders themselves and supported by the public administration and other knowledge structures (Messely *et al.*, 2013).

### 3. Research methods

This study follows a multi-case method (Yin, 2009), which investigates the diversity of challenges and solutions in selected European rural areas.

The case study analysis is considered one of the most adopted qualitative methods in organisational (Eisenhardt, 1989) and organisation and management studies (DeMassis and Kotlar, 2014). As Yin states (1981), the empirical inquiry can be both single or multiple, which means drawing generalisable conclusions from patterns across contexts.

Conducting a comparative study of rural areas in a regional context is present in the literature (Štastná *et al.*, 2020), considering the importance of rural development prospects. It is significant to consider the development of rural areas because of the ongoing transformation, according to which not only the nature of these areas is changing from agricultural-economic to cultural-touristic (Soma *et al.*, 2021). The professional characteristics of the rural population are also subject to change to an increasing extent because their work is undertaken for the support of urban areas.

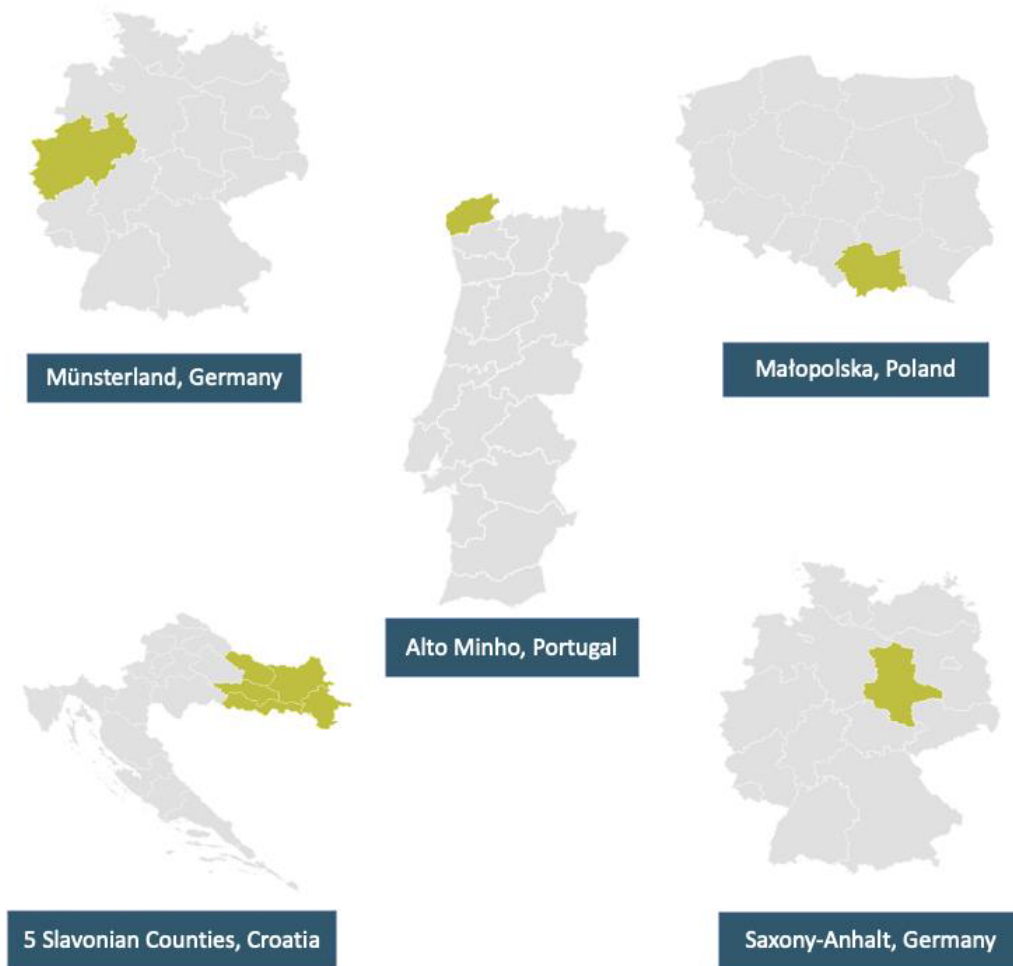
In order to achieve the objectives of this study, a comparative analysis of the selected regions was carried out in a first empirical phase from the perspective of basic characteristics such as population, area, population density, or access to the Internet and the level of unemployment. Conducting the analysis serves to obtain information on the level of comparability of selected socio-economic characteristics of the areas in question.

The analysis is based on the case of selected EU regions: Croatia (Slavonia), Germany (Münsterland, Saxony-Anhalt), Poland (Małopolska), and Portugal (Alto Minho) (Figure 1), where during the last two years observations have been conducted for the purpose of identifying developmental challenges.

The selection of the analysed areas is not accidental. It was our intention to choose areas from different EU regions. Also, the analysed entities are diversified in terms of their development level as well as their landscape and socioeconomic conditions. This diversity allows for answering the question whether the development problems and challenges of rural areas characterised by different locations and development problems are similar or not.

The observed similarities concerning development opportunities and barriers led to the decision to conduct an in-depth analysis of different European regions from the perspective of the specificity of rural development. The regions presented in Figure 1 are characterised below:

- Münsterland – a region located in the western part of Germany, corresponding to NUTS2 level in the Eurostat territorial unit statistics;
- Saxony-Anhalt – a region located in the eastern part of Germany, corresponding to the NUTS2 level in the Eurostat territorial units statistics;
- Małopolska – a region located in the southern part of Poland, corresponding to the NUTS2 level in the Eurostat territorial units statistics;
- Slavonia – a region situated in the northeast of Croatia, comprising five units corresponding to NUTS3 level in the Eurostat territorial units statistics (Viroviticko-podravaska zupanija, Pozeško-slavonska zupanija, Brodsko-posavska zupanija, Osječko-baranjska zupanija, Vukovarsko-srijemska zupanija);
- Alto Minho – a region located in the northwest of Portugal, comprising five units corresponding to the NUTS3 level in Eurostat's statistics of territorial units.



**Figure 1.** Graphical presentation of considered regions ([www.ruralentrepreneurs.eu](http://www.ruralentrepreneurs.eu)).

The regions above are analysed if they are diversified in terms of size and economic specificity and the level of socio-economic development. In turn, the preliminary comparative analysis provides a cross-sectional picture of the challenges faced by the local rural communities of the analysed regions.

The second empirical phase refers to the research material collected from the brainstorming of focus groups of experts, members of rural councils, whose task – during workshops held in selected EU countries – was to identify and discuss the challenges in the areas where they live and work.

Approximately 20 people were included in each of the five rural councils. In each of the regions, qualitative research was conducted in groups of experts using the focus group method. The experts met in a specially organised workshop, separately in each of the surveyed regions. The purpose of the discussion was to identify and discuss development problems and challenges in the rural areas where they live and work. During the focus group meetings proposals were also developed regarding recommendations for actions that would serve to mitigate the identified problems. The selection of experts was based on ensuring representation of science, business, public administration, but also NGOs and participation of social leaders. As a result of workshops with experts held over a similar period of time, which in some cases were preceded by a preliminary questionnaire survey, it was possible to identify those challenges for selected EU rural areas which, in the opinion of experts, are most important and which should be addressed as a priority in the implementation of the regional development strategy. As a result of the brainstorming in the selected regions, the cases were selected which, from the perspective of comparability, were adequate for analyses.

The second phase of the empirical part is based on a case study method. The method explores single objects and draws general conclusions for entire populations. It analyses one case in detail for the purpose of gaining a full understanding of this case. The selected case does not necessarily confirm universal phenomena. The authors aimed to answer the following research questions:

1. What rural development problems were identified in the analysed regions?
2. Are rural development problems similar or different in these regions?
3. What are the possibilities for bridging existing development gaps in rural areas?

Qualitative analysis methods were used to examine the case studies. The next stage of the second part of the empirical study presents a comparative analysis of the results obtained in the five examined regions of the European Union. It leads to drawing conclusions regarding the development problems of rural areas and the ways of overcoming them in various European regions. An attempt was made to find analogies and differences between them. The qualitative research was carried out from January to June 2020.

## 4. Results and discussion

### 4.1 The diversification of analysed regions in terms of socio-economic determinants

Among the analysed regions, Münsterland in Germany has the highest level of development. In 2019, gross domestic product (GDP) per capita was 33,270 EUR (Table 1). The region is very densely populated (379 persons per 1 km<sup>2</sup>), which proves its attractiveness for population settlement. It is characterised by a relatively low level of unemployment (unemployment rate was 4.5%). There is a relatively large number of medium and large enterprises, representing about 14% of all companies in the region. When it comes to tourism, the Münsterland region is architecturally characterised by many churches, monasteries and castles, some of which are still very well preserved. Due to a relatively flat terrain, especially in the northern and western parts, bicycles are a common means of transport. Mechanical engineering and agriculture are the most prominent sectors. For years, the R&D expenditure of companies in Münsterland has been lower than the national average. One reason for this is the medium-sized sector structure in which R&D activities are often owner-driven and not institutionalised in R&D departments of science, and research activities in the Münsterland region are initiated by the Westfälische Wilhelms-Universität Münsterland, the Münsterland University of Applied Sciences, and the Westfälische Hochschule. These three universities alone have more than 62,000 students. The propensity to start a company is lower in rural Münsterland than in densely populated regions. This is also due to the current labour market situation. In Münsterland, there were 3.9 start-ups per 1000 inhabitants aged between 18 and 64

**Table 1.** Variables describing socio-economic determinants in the analysed regions in 2019.

Region, country	Münsterland, Germany	Slavonia, Croatia	Alto Minho, Portugal	Malopolska, Poland	Saxony-Anhalt, Germany
Total area (km <sup>2</sup> )	6,819	12,486	2,219	15,182	20,454
Population density (persons per 1 km <sup>2</sup> )	379.2	56.7	104.1	221.3	107.9
GDP per capita at current market prices (euro) <sup>1</sup>	33,270	7,672	15,547	11,935	27,972
Unemployment rate (% of population in the labour force)	4.5	20.3	8.9	4.1	7.1
Share of small companies (% of enterprises)	85.9	98.3	99.9	99.3	97.0
Population with access to internet (% of the population)	82.0	18.7	85.2	93.2	88.0
Life expectancy (years)	78.2	78.2	80.2	79.2	79.5

<sup>1</sup> Data for 2018 (based on [www.ruralentrepreneurs.eu](http://www.ruralentrepreneurs.eu)).

years. Although there are very few start-ups in Münsterland, the probability of success is slightly higher than the country's average. In 2015, 41.6% of companies founded in 2010 were still active in the market.

Among the studied entities, the second German region – Saxony-Anhalt – also stands out positively. The value of GDP per capita achieved there was high and amounted to 27,972 EUR, although it is a much less populated area than Münsterland (107.9 persons per 1 km<sup>2</sup>). It is also somewhat disadvantaged in terms of employment, as evidenced by the relatively high unemployment rate (7.1%). Also, the region has fewer medium-sized and large companies, representing 3% of the total number of enterprises. In 2019, it was visited by 3.6 million tourists. Besides the Harz Mountains as the most important holiday destination, Saxony-Anhalt is the state with the highest density of UNESCO World Heritage sites in Germany. The chemical and plastics industry, plant engineering and construction, the food industry, automotive supplies, renewable energies and logistics are the most important economic sectors. Saxony-Anhalt is one of the most concentrated German research landscapes with Martin-Luther University in Halle, and the Otto von Guericke University of Magdeburg, four universities of applied sciences and numerous extra-university research institutions, including five research institutions in the Leibniz-Gemeinschaft, the Max Planck Institute, six Fraunhofer facilities, two facilities of the Helmholtz Gemeinschaft, and one facility of the Robert Koch Institute, closely cooperating with Saxony-Anhalt's enterprises on their way to leadership in innovation. The start-up scene is located in the cities of Magdeburg and Halle. With the Weinberg Campus, Halle has a large technology park. Start-ups in Magdeburg and other cities can also build on a modern infrastructure through resident (university-based) incubators. According to the Regional Innovation Scoreboard 2019, Saxony-Anhalt belongs to a group of 'strong innovators', and has held that position since 2008.

Compared to the two Germany sites, Alto Minho in Portugal is characterised by an average/mediocre level of development, taking into account the GDP per capita indicator – 15,547 EUR. However, it should be noted that it is the smallest of the analysed areas. Minho, on the other hand, stands out positively in terms of the longest life expectancy – 80.2 years. This indicator is an important determinant of the quality of life of residents. On the other hand, the labour market situation is unfavourable. The unemployment rate is relatively high at 8.9%. When it comes to tourism, almost 30% of its territory was classified as Natura 2000, and Alto Minho is the first NUT III in Portugal Continental that has its territory fully awarded by the European Charter of Sustainable Tourism, a certificate awarded by EUROPARC – the European Federation of National and Natural Parks. It has more classified national monuments than any other subregion in Northern Portugal, and 10 historical centres of excellence for visitors. It also integrates the main routes of St. James Portuguese Way. From the industrial development perspective, automotive components, metalworking and shipbuilding and repair have a considerable weight in the industry of Alto Minho. Apart from this renowned regional network of technology, innovation and research are present in the region. The Technology and Knowledge Transfer Office (OTIC) of the Polytechnic Institute of Viana do Castelo (IPVC) is a platform to support the development of a new culture of higher education aiming, on the one hand, at the economic valuation of research and its results and, on the other hand, the approximation of the IPVC to the business fabric. It is intended that this OTIC is a determining agent of business innovation in the region through the provision of high quality services geared to the need of companies. An institutional network, constituted by the Alto Minho CIM, IPVC, Alto Minho Business Confederation (CEVAL), Incubator of Innovative Business Initiatives (In.cubo), Integrated Rural Development Association of the Lima Valley (ADRIL) and Integrated Rural Development Association of the Minho Valley (ADRMINHO), aims to stimulate an integrated platform for mobilising resources, people, agents and ideas that promote the entrepreneurial spirit and culture in Alto Minho and contribute to the process of creating and implementing entrepreneurial initiatives in the region. IPVC is a school with the widest range of courses in the Alto Minho higher education network. In addition to professional higher technical courses (CTeSP), it offers higher education courses, including undergraduate, postgraduate and master's courses (in cooperation with various foreign and domestic universities) through its six colleges. With a school population around 4,250 students, 946 students graduated from IPVC in 2018. IPVC conducts, shares and transfers applied research, supported by a national and international network of partners, relevant to the region's cultural, social, economic and business tissues, financially sustainable and included in an IPVC training offer.

Compared to the other examined regions, Małopolska in Poland stands out positively in terms of low unemployment (the unemployment rate is 4.1%) and a very high level of internet access (93.2%). However, these positive phenomena do not translate into an overall level of development as measured by GDP per capita, which is much lower than in the regions discussed above, at only 11,935 EUR. Medium-sized and large enterprises in this region represent only 0.7% of the total number of registered companies. The region is a leader among tourist destinations in Poland with unusual landscapes and beautiful nature, an impressive number of monuments and a unique atmosphere. The Tatra mountains, the Krakow-Czestochowa Upland, castle ruins, historical towns, wooden churches, spas with mineral waters, thermal baths, cultural events, still alive tradition and delicious cuisine – these are just some of the attractions that wait here for tourists. The region has well-developed high tech, automotive, tourism and business service sectors thanks to its high scientific, research and educational potential, availability of qualified engineering staff and labour force, and convenient natural and climatic conditions. The gross domestic expenditure on R&D (GERD) indicator in 2017 was at the level of 1.85% (Poland – 1.03%). Employment in the R&D sector is growing (in 2015, it amounted to 14,500 EPCs). The research projects in Małopolska represent the following fields: technical sciences and energy, biological and medical sciences, agricultural sciences, physical and engineering sciences, and digital research infrastructure. Małopolska is characterised by a high level of entrepreneurship. In 2018, 9.0% of Polish entities were located in this region. In the last decade, the number of business entities has significantly increased in relation to the population – the indicator expressing the number of entities per 1000 inhabitants in 2018 was 115. Around 10% of Polish startups come from Krakow, which places the regional capital on the 3<sup>rd</sup> place in the country. Małopolska is one of the most important academic centres in Poland with more than 150,000 students. It has 106 accredited research laboratories, and 3,100 other laboratories (807 are located in scientific units – universities, institutes of the Polish Academy of Sciences, and research institutes).

Taking into account the analysed indicators, the weakest level of development is recorded in Slavonia, Croatia. The region is sparsely populated (56.7 persons per 1 km<sup>2</sup>). Also, the value of GDP per capita is low – only 7,672 EUR. The unemployment rate is very high, reaching 20.3%. The region is in a very disadvantaged position in terms of internet access. Only 18.7% of the population has internet access. As for tourism, this part of Croatia is best known for its spacious and fertile fields, big rivers and marshlands, forests, old cities, wine production and joyful people with rich traditions. Agriculture, the food industry and wood processing are the most prominent sectors. The science and research landscape in 5 Slavonian counties includes the Josip Juraj Strossmayer University of Osijek, the College of Slavonski Brod, the Polytechnic in Požega, the Virovitica College, and the College of Applied Sciences ‘Lavoslav Ružička’ in Vukovar. The higher education institutions had more than 19,200 students in 2018/2019. In 2017, the R&D expenditure stood at 65.7 EUR per capita compared to 49.3 EUR per capita at the national level. For a number of years, the level of activity in starting business ventures has been lower than the national average: 6.6 and 9.6%, respectively (2018). The GEM research also indicated regional differences in attitudes towards entrepreneurship: in 2018, it was at the lowest level (46.7%).

#### *4.2 Development problems of rural areas in the studied regions*

Synthetic conclusions resulting from the focus group discussions in the studied regions, referring to the main development problems identified in rural areas, are presented in Table 2.

They raise various issues. The problems were presented in a non-uniform manner. In order to systematise the obtained information and enable its comparison, the identified development problems were grouped under six thematic areas:

- unfavourable demographic situation;
- low quality of human capital and social capital;
- financial barriers to development of enterprises;
- poorly developed economic and social infrastructure;
- legal and administrative impediments;
- low effectiveness of the implemented development policy.

**Table 2.** The main development problems of rural areas in the studied regions (elaboration based on [www.ruralentrepreneurs.eu](http://www.ruralentrepreneurs.eu)).

<b>Münsterland, Germany</b>	<b>Slavonia, Croatia</b>	<b>Alto Minho, Portugal</b>	<b>Malopolska, Poland</b>	<b>Saxony-Anhalt, Germany</b>
<ul style="list-style-type: none"> <li>• Poor labour market situation.</li> <li>• Percentage of rural unemployment and of population migrating to urban areas has increased considerably.</li> <li>• Bureaucracy is shifting innovation in the region.</li> <li>• Collapses of SMEs due to unprecedented lockdown.</li> </ul>	<ul style="list-style-type: none"> <li>• Shortage of knowledge.</li> <li>• Complicated regulatory framework.</li> <li>• Too much administrative work.</li> <li>• Low attractiveness of agriculture for young people.</li> <li>• Lost identity of rural regions.</li> <li>• Subsidies not connected with the incomes.</li> <li>• Lack of centres for smart agriculture production.</li> <li>• Still no accepted strategy for agricultural production.</li> <li>• Too strong importing lobby.</li> <li>• Some cultures are exported before the crops are ripe.</li> </ul>	<ul style="list-style-type: none"> <li>• Reduced numbers of inhabitants in the rural areas.</li> <li>• An ageing population.</li> <li>• Excessive bureaucracy.</li> <li>• Accessibility and access to services.</li> <li>• Young people are not motivated.</li> <li>• Not enough business opportunities.</li> <li>• Low development of a local/regional economic model.</li> </ul>	<ul style="list-style-type: none"> <li>• Lack of interest in local products.</li> <li>• Lack of adequate interest and demand for local products.</li> <li>• Egotism and mental barriers, and their insufficient or inadequate promotion.</li> <li>• Lack of stable logistic systems for sale of manufactured products.</li> <li>• Insufficient development of material and financial infrastructure.</li> <li>• Systemic risk related to financing of specific projects.</li> <li>• Reduction of socio-economic and financial activity due to pandemic situation.</li> <li>• Social activity and readiness to undertake actions for the common good are still relatively rare.</li> <li>• Lack of local leaders who have the ability to integrate the local community around a common goal.</li> </ul>	<ul style="list-style-type: none"> <li>• Lack of good accessibility of the centres, young families do not want to move to the region, lack of companies due to the lack of skilled workers.</li> <li>• Ageing society that is increasing the demand for infrastructures that accommodate the needs of the elderly.</li> <li>• High proportion of school dropouts.</li> <li>• Outward migration.</li> <li>• Decreasing number of pupils.</li> <li>• Deteriorating density of medical care.</li> </ul>

The development problems of rural areas identified in the studied regions were assigned to separate thematic groups and their occurrence in the studied regions was determined (Table 3).

The analysis shows that the most common development problems of rural areas are related to the unfavourable demographic situation and the existing financial barriers to business development. These two issues were indicated in four out of five studied regions. They concern both highly developed regions and those with a lower level of development.

The unfavourable demographic situation was presented as a rural development problem in four regions: Slavonia in Croatia, Münsterland in Germany, Alto Minho in Portugal and Saxony-Anhalt in Germany. There is a noticeable decrease in the number of inhabitants in rural areas and an aging population in Alto Minho. This is related to the lack of motivation of young people to live in rural areas. Also in Slavonia there is an outflow of young people, for whom the work in agriculture is not very attractive. Similarly in Saxony there is visible aging of population. Young families are not willing to live in rural areas and migrate to cities or abroad. This situation generates a lack of skilled workers and consequently is a barrier to the development of companies in rural areas. Similarly, Münsterland is witnessing an increase in the number of people migrating to cities.

The second very common problem of rural development is the existing obstacles to business development. Such types of difficulties were identified in four analysed regions: Slavonia in Croatia, Münsterland in Germany, Alto Minho in Portugal and Małopolska in Poland. In most of the regions, barriers to business development are associated with financial and demand barriers. In Alto Minho, insufficient financial resources significantly limit business opportunities. In Slavonia an important problem is the inappropriate system of subsidies for business activity, which is not linked to the income of enterprises. An additional impediment is the excessively strong import lobby and the lack of centres for intelligent agricultural production. In Małopolska, the reasons for the weak development of companies are the lack of consumer interest in local products and the low level of demand for them. This exacerbates the risks associated with financing specific projects. In addition, there is a lack of stable logistic systems to sell manufactured products. The situation in Münsterland is also difficult for the development of companies, many SMEs have closed down, which has resulted in a bad situation on the labour market and a significant increase in unemployment in the countryside. Important development problems in rural areas also include: low quality of human capital and social capital, underdeveloped economic and social infrastructure and existing legal and administrative barriers. Problems

**Table 3.** The occurrence of rural development problems in the studied regions.

Development problems	Slavonia, Croatia	Münsterland, Germany	Alto Minho, Portugal	Małopolska, Poland	Saxony- Anhalt, Germany
Unfavourable demographic situation	x	x	x		x
Low quality of human capital and social capital	x			x	x
Financial barriers to development of enterprises	x	x	x	x	
Poorly developed economic and social infrastructure			x	x	x
Legal and administrative impediments	x	x	x		
Low effectiveness of the implemented development policy	x		x		

belonging to these categories were reported in three different examined regions. Also, these issues concern both highly developed regions and those with a lower level of development.

Barriers due to low levels of human and social capital were found in Slavonia in Croatia, Małopolska in Poland and Saxony-Anhalt in Germany. An important problem in Saxony-Anhalt is the declining number of students associated with high dropout rates. What is a barrier to development in Slavonia is lack of sufficient knowledge on how to run a business in rural areas. Additionally there is a problem of loss of regional identity of rural societies, which hinders their integration and cooperation. The voivodeship of Małopolska voivodeship has also indicated mental barriers, limiting social activity and readiness to undertake actions for common good as well as the lack of local leaders, who have the ability to integrate the local community around a common goal.

There are deficiencies in economic and social infrastructure in the rural areas of the regions investigated. These were identified in the regions: Alto Minho in Portugal, Małopolska in Poland and Saxony-Anhalt in Germany. In particular, in Małopolska there is insufficient development of physical infrastructure. The main problem of Alto Minho is poor availability of social services. In Saxony-Anhalt it is especially visible weak accessibility of medical care facilities.

A significant obstacle to the development of rural areas are the existing legal and administrative barriers. Such problems were reported by experts from the following regions: Münsterland in Germany, Slavonia in Croatia and Alto Minho in Portugal. The complicated legal framework and excessive bureaucracy were mentioned as obstacles for the development of enterprises in all regions mentioned.

Except for the discussed development problems of rural areas, concerning most of the surveyed regions, ineffectiveness of the implemented development policy was also among the reported development barriers. However, this was a problem occurring only in two regions: Slavonia in Croatia and Alto Minho in Portugal. Slavonia lacks an established agricultural production strategy. While Alto Minho does not have a developed local development model. It should be noted that the problem of inefficiency in the execution of development policy did not refer to the regions with the highest level of development, i.e. German regions.

#### *4.3 Recommended actions aimed at alleviating existing rural development problems*

The structured guidelines resulting from the focus group discussions in the surveyed regions relating to the recommended actions for reducing the problems in rural areas are presented in Table 4.

The experts' guidelines were presented in a heterogeneous way, and, for the purpose of a comparative analysis, grouped – as in the first part of the comparative study – under six thematic areas:

- education;
- local products;
- medical care;
- policy improvements;
- cooperation;
- infrastructure and digitalisation.

What is noteworthy at this stage is the fact that the characteristics of the recommended areas are similar to the identified problems, which seems to be a natural direction of the conclusions of workshop participants.

The actions to be considered as recommended in the studied regions were assigned to separate thematic groups (Table 5).



**Table 4.** The presentation of actions to be considered as recommended in terms of regional development (elaboration based on [www.ruralentrepreneurs.eu](http://www.ruralentrepreneurs.eu)).

<b>Münsterland, Germany</b>	<b>Slavonia, Croatia</b>	<b>Alto minho, Portugal</b>	<b>Malopolska, Poland</b>	<b>Saxony-anhalt, Germany</b>
<ul style="list-style-type: none"> <li>• Stimulating willingness to set up a company.</li> <li>• Strengthening entrepreneurial potential.</li> <li>• Encouragement of rural entrepreneurship.</li> <li>• Better promotion of entrepreneurial education within the region where ‘classic’ images of entrepreneurship need to be challenged.</li> <li>• Identification of competencies for the future under the new ‘normal’.</li> <li>• Supporting access to finance, information, and market.</li> <li>• Enhancing attitudes in rural entrepreneurs which are different compared to urban ones.</li> </ul>	<ul style="list-style-type: none"> <li>• Stronger engagement of rural resources and people – rural strengths.</li> <li>• More effective use of eu membership possibilities.</li> <li>• Focusing on young entrepreneurs.</li> <li>• Stronger triple-helix model utilisation within rural areas.</li> <li>• Focusing on good practice examples in circular economy, revivification of the rural areas.</li> <li>• Supporting formation of centres for education in agriculture.</li> <li>• Joining agro-clusters.</li> <li>• Supporting improvements in food production.</li> <li>• Utilising different approaches towards big and small agricultural family farms as having different problems.</li> </ul>	<ul style="list-style-type: none"> <li>• Keeping people engaged and interested in rural development.</li> <li>• Engagement of policymakers in solving remote villages’ problems.</li> <li>• Better distribution of local products.</li> <li>• Taking action to encourage people to return to the territory.</li> <li>• Enhancing quality/diversity of local products.</li> </ul>	<ul style="list-style-type: none"> <li>• Commercialization and promotion of local products and services provided by social organizations and households.</li> <li>• Increase in the level of knowledge on financing opportunities.</li> <li>• Increasing the ability to raise funds.</li> <li>• Building attitudes of local economic patriotism.</li> <li>• Increased knowledge of the benefits of purchasing local products and services for the local community and economy.</li> <li>• Promoting the purchase of local products/services.</li> <li>• Stimulating local community activity and promoting cooperative attitudes.</li> <li>• Financial resources should be re-allocated to support local micro entrepreneurs and not just local businesses but also social organizations which offer local products and services that are not well promoted and offered.</li> </ul>	<ul style="list-style-type: none"> <li>• Increasing mobility and building good infrastructure – prerequisites for the attractiveness and future viability of the region considered as a residential and business location.</li> <li>• Supporting educational activity.</li> <li>• Providing lifelong learning possibilities, knowledge transfer, digital education and (individual) support, cultural education, and solutions for cases where face-to-face teaching is not possible.</li> <li>• Increased digitalization as the possibility of networking, proximity, local anchoring, dynamics, independence, and taking new paths.</li> <li>• Providing solutions for increasing demand for access to medical care.</li> </ul>

**Table 5.** The areas of activities considered as recommended in the development of studied regions.

Recommended actions	Slavonia, Croatia	Münsterland, Germany	Alto Minho, Portugal	Malopolska, Poland	Saxony- Anhalt, Germany
Education	x	x		x	x
Local products	x		x	x	x
Medical care					x
Policy improvements	x	x	x		
Cooperation	x		x	x	
Infrastructure and digitalisation		x	x	x	x

In the identified areas experts give special attention to education. As for the educational direction being one of the most important factors serving the development of rural areas, this indication was missing only in one case. A similarly high level of similarity in terms of the desired directions of development was observed in the area related to regional products. The experts unanimously perceive the development of production, distribution and promotion of these products as the possibility of increasing the significance of rural areas. This consensus should in fact be applied to all of the analysed European areas, as it was less clearly articulated in only one of the analysed areas (Münsterland). However, when considering other important directions of development identified in this area, there was a strong reference to entrepreneurship, which could indirectly refer to the management of local resources,

Infrastructure and digitalisation is another area with the strongest identified similarity when it comes to identifying activities for rural development. Among the expert indications concerning the need for activities in this area, only Slavonia lacked a direct reference. On the contrary, it can be concluded that the issue of the need for activities in the field of infrastructure development and digitalisation is largely the domain of national and regional policies.

The need for policy action in this case is another highlighted area of comparative analysis. The clear indications for action in this area were identified in three out of the five analysed cases. A high level of intensity of activities in this field is shown by the Croatian region, and it can be argued that there is an indirect reference to the area of infrastructure and digitalisation, bearing in mind the factor referred to as ‘more effective use of EU membership possibilities’.

Another positively verified area in terms of the consistency of expert indications and recommended actions ‘cooperation’. Similarly to the previously discussed ‘need for policy action’, this is not an area with the strongest indication – only three out of five areas identify the need for action. Nevertheless, the factor of cooperation for rural development purposes is perceived as important by experts. On the other hand, it may be concluded that it has been indirectly recognised in Munsterland, taking into account the identification of the measure ‘strengthening entrepreneurial potential’, which refers to strengthening, inter alia, the social capital as a result of cooperative activities.

The exception to be verified as negative is the area of medical care, which was found in one of the five European regions (Saxony-Anhalt). Although it is suggested that there is an indirect reference to the area of policy improvement in terms of health policy, it seems that the specificity of the homogeneity of this area is too distant and, therefore, there is no reason for a direct reference and correlation with the area of policy improvement.

Summing up the arguments presented in the above discussion in relation to similarities between the recommended actions, it can be concluded that the level of similarity is high. In relation to 50% of the compared areas, the concordance of expert indications was 80%, in relation to 40% of the areas the coefficient was

60%, and only in 20% the coefficient did not exceed 50% (a 20% similarity level). The experts recommend taking very similar measures in different and socio-economically diverse European regions in the context of their development.

The results of the research presented in the paper reflect similar problems in all the analysed despite their specific challenges and goals. The conducted research also reveals the existence of common problems and development challenges, regardless of the location of the rural area: unfavourable demographic factors, low quality of human and social capital, financial barriers to entrepreneurship development, poorly developed infrastructure, legal and administrative burdens, and low effectiveness of the implemented development policies. The comparative analysis of the identified challenges and recommended actions shows a high level of similarity. According to the results of the study, there are six thematic areas for policies and specific actions: education, development of local products, better medical care in rural areas, policy improvements, cooperation and infrastructure, and digitalisation. Education is considered, according to all stakeholders, as the most important area for improvement, especially education in the field of entrepreneurship.

The obtained results are based on the direct analyses of rural communities and the practical experience gained by local stakeholders, well-acquainted with the existing conditions and economic environment, and committed to making necessary improvements.

The study was simultaneously conducted in rural areas in several European regions characterised by different socioeconomic factors and development levels. Despite these differences, the obtained results are similar, which confirms the universal character of problems and challenges faced by rural areas.

The results of the study are consistent with the findings of other authors. They confirm the findings of Deller *et al.* (2019), who state that one of the major barriers to rural development is related to demographic factors and the inadequate quality of human capital resulting from lower levels of education in rural areas. Also, it is confirmed that another obstacle is the quality of social capital and that one of the major challenges is the necessity of cooperation between entrepreneurs and other stakeholders. Other authors point to the necessity of creating cooperation networks (Berglund *et al.*, 2016), engaging all stakeholders (Brandt *et al.*, 2018; Hercz *et al.*, 2021; Leonidou *et al.*, 2020; Messeley *et al.*, 2013), as well as engaging local communities in developing local entrepreneurship (Anderson and Lent, 2019; Steiner and Teasdale, 2019). A significant conclusion is the identification of the challenge related to developing rural entrepreneurship supported by the specificity of products offered by a given region. Some other cited authors also stress the need for stimulating and developing rural entrepreneurship (Berglund *et al.*, 2016; Muñoz and Kimmitt, 2019; Sá *et al.*, 2018; Yu and Artz, 2019) as well as the significance of grassroot initiatives (Haan *et al.*, 2019).

## 5. Conclusions and recommendations for future research

The problem of rural development has been on the EU agenda for many years, but there is no simple answer or universal policy that can solve it. While some researchers and policymakers argue that agriculture is the solution for all the problems in rural areas, others strongly support the idea of strengthening business ecosystems in rural areas and residents' entrepreneurial activities. Proposed actions are very different, and it seems that there is no consensus among researchers and policymakers.

Stimulating social and economic development in rural areas is an important problem for all European Union countries. Rural areas are less attractive for inhabitants and entrepreneurs than cities, which results, *inter alia*, from the fact that they struggle with problems related to adverse demographic changes, limited access to capital or unfavourable structures of their economies. A serious challenge for communities and local authorities is to create conditions for boosting development and improving the quality of life of rural residents.

The main goal of this study was to identify development problems in rural areas and to offer recommendations for actions that would make it possible to overcome them. The research was carried out in selected regions

of the European Union, with diverse levels of socio-economic development. The research questions were as follows: (1) What rural development problems were identified in the regions? (2) Are rural development problems similar or different in the analysed regions? (3) What are the possibilities for bridging existing development gaps in rural areas?

The analysis reveals that the most common development problems of rural areas are related to the unfavourable demographic situation and the existing financial barriers to business development. Important development problems in rural areas also include the low quality of human and social capital, underdeveloped economic and social infrastructure, and existing legal and administrative barriers.

The analysis reveals that the nature of the problems is not mainly affected by the level of social wealth in a given rural region, which points to the phenomenon of the homogeneity of rural areas in terms of development needs. The major development problems of rural areas concern both highly and less developed regions.

Further studies of rural regions point to a high level of convergence in terms of the recommended actions aimed to resolve their development problems. The education of local communities, the development of economic infrastructure and digitalisation as well as the manufacture and promotion of local products are regarded as the most important tasks. Other frequently recommended measures include cooperation between local communities and producers, and more attention given by local policies to the financial support of production companies and farms. Both business and social initiatives are important. However, social undertakings supported by local leaders are perceived more favourably by rural residents.

The conducted research demonstrates the existence of some common problems and development challenges specific to rural areas, regardless of their location in different regions and countries of the European Union.

The results of the study can be applied in practice. They allow for offering recommendations concerning rural area policies aimed to raise development levels.

It is advisable to develop entrepreneurship development strategies at the level of regions and municipalities. Such strategies should identify major development goals. Undoubtedly, one of them is the lifelong and continuing education of society, including education in the area of entrepreneurship. A significant role is also played by the identification of the local potential and the sources of competitive advantage (services and unique products) – a given region's strengths which contribute to building and increasing local brand recognition. Entrepreneurs' economic activities should be supported by legal, financial and organisational assistance. Importantly, opportunities offered to inhabitants and entrepreneurs should encourage them to carry out their operations in rural areas. Moreover, local manufacturers should be encouraged to engage in cooperation programmes through educating them in the possible benefits of such cooperation and simplified formalities. Cooperation between local stakeholders, apart from entrepreneurs, should also incorporate inhabitants, institutions and public administration representatives. However, the willingness to cooperate implies building mutual trust and ensuring effective communication.

The question arises if it is possible to tackle those problems with the same policies, without consideration given to local specificities, development levels and ecosystems. The presented results point to common priority recommendations – stakeholders in all the analysed EU countries identified similar problems and similar ways of resolving them. However, at an operational level, different solutions should be implemented in achieving propriety goals, giving consideration to local specificities, landscape and natural characteristics, existing economic structures, experience in economic activities and the uniqueness of local products.

The conducted research contributes to the theory of sciences which analyses the processes and determinants of rural development. It seems that apart from a positive verification of the results achieved by other authors, the value of this work also lies in the fact that it confirms the universal character of specific problems and

challenges faced by rural areas, regardless of their location (country or region), development levels or socioeconomic conditions.

The authors are aware of certain limitations of the presented study. Issues related to development problems and challenges in rural areas represent a vast research area. The presented considerations are based on several case studies. The proposed conclusions, but also the research study itself, are limited by the characteristics of the countries in the sample as well as by the chosen methodological approach. Although the analysed rural regions represent different levels of development, none of them can be referred to as underdeveloped. Therefore, recommendations and conclusions do not reflect the needs and requirements of underdeveloped countries. This study makes use of focus groups because its objective was to collect opinions and reflections from stakeholders in the observed countries. Thus technique allows for analysing socially acceptable opinions expressed by a certain type of participants. Since the focus analyses were conducted by different moderators in particular countries, we could not control the process itself and had a limited ability to guide it. Therefore, these limitations should be considered in analysing the collected data.

The conclusions of this research open the way for further in-depth analyses. Future directions could be supplemented by other case studies and comparisons of other regions of the European Union. Another area of future research could be an analysis of development changes in rural areas over longer periods of time. A valuable contribution to this field of study could be made by conducting comparative analyses of the development of European and other rural areas in the world.

The conclusions of different focus groups in different countries provide material for further research in the field of rural development. Recommendations were clustered around six areas, but they are too broad and cannot be used in the process of policymaking. Furthermore, there is a need to connect all identified areas in harmonised policies and concrete action plans. Finally, the results of the proposed policies and recommendation could be a basis for further research based on quantitative tools and methods.

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*Special issue: Opportunities and challenges of EU farm-to-fork strategy*

## **Resilience in the food sector – environmental, social and economic perspectives in crisis situations**

### **RESEARCH ARTICLE**

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### **Abstract**

Environmental, social and economic perspectives, derived from the sustainability approach and present within by the resilience concept, are integral parts of food systems. At the same time they are clearly articulated within the EU farm-to-fork (F2F) strategy referring to building up resilience to possible future crises as diseases and pandemics. The aim of this paper is to investigate resilience in the food sector referring to its selected environmental, social and economic dimensions, which in fact rely on each other and cannot be separated, simply because of the character of food system itself (work with living organisms, soil, within natural environment, etc. done by people for business purposes). The issue of resilience in the food sector must be considered multidimensionally. In this approach, the basic direction of activities should be the one focused on the resilience approach, both in environmental protection and society. For a harmonious combination of these activities, it is also necessary to look at economic perspective of food system and entire rural livelihoods (e.g. income and employment diversification). Considering the last shocks discussed (COVID-19, war in Ukraine, drought, embargo on grain exports from Russia, rising inflation), a difficult situation on the food market can be expected in the nearest future, which makes the concept of resilience in the food sector even more relevant than it has been so far.

**Keywords:** resilience, food system, biodiversity, finance, labor, inflation

**JEL code:** G00, J21, O13, Q10

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## 1. Introduction

The issue of a sustainable approach to production processes in agriculture has been studied for many years. It has already been proven that an intensive economy leads to an imbalance in nature (Foster and Clark, 2018). Many animal species have become extinct, others are threatened with extinction (Ceballos *et al.*, 2010). The growing population and uneven geographical distribution of food demand contribute to the intensification of production processes with increased mortality due to hunger and poverty at the same time (Lappé *et al.*, 1998). In this context it seems reasonable to refer to the holistic perspective of resilience encompassing the complexity of food systems operating at many scales (Tendall *et al.*, 2015). Another argument for the need to re-evaluate the human approach to its activity and directing actions towards it in accordance with the laws of nature is the COVID-19 epidemic problem that caused the epidemic crisis. It proved that one should return to primal processes of nature and disrupting them has much wider effects than we can predict. Environmental changes, social norms and institutions, and, consequently, the linkage of biology, information and society cannot be detached, also from their further financial consequences in all areas of human activity (Peters and Jandrić, 2021).

Environmental, social and economic reasons, derived from the sustainability approach and present within by the resilience concept, are integral parts of food systems. At the same time, they are clearly articulated within the EU farm-to-fork (F2F) strategy referring to building up resilience to possible future crises as diseases and pandemics (European Commission, 2020). That is why, the aim of this paper is to investigate resilience in the food sector referring to its environmental, social and economic dimensions, which in fact rely on each other and cannot be separated, simply because of the character of food system itself (work with living organisms, soil, within natural environment, etc. done by people for business purposes).

This article consists of 5 sections. After the introduction, the second part includes a literature review, investigating the resilience concept taking into account environmental, social and economic perspectives. It is difficult to discuss them separately, but the narration from environmental, through social to economic issues is proposed. However, it should be noted that it is impossible not to refer to some economic issues while discussing environmental dimensions (e.g. monoculture and industrialized agri-food system), as well as to refer to some social aspects without discussing their economic role (e.g. income diversification). The research methodology is presented in the third section. The fourth section contains the research results with the same narration from environmental, through social to economic issues. The fifth section presents conclusions, limitations and recommendations.

## 2. Analytical framework and methods

### 2.1 Methodology of the literature review

The methodological two-fold approach intends to form a framework based on the integrative literature review and analysis of time series of selected indicators (secondary data). The literature review was applied to identify resilience in the food sector and its wide background. The term of the resilience is not a completely new one, beginning of 21<sup>st</sup> century has brought an increasing interest in this topic, resulting for example in rising number of scientific publications. Results for Web of Science Core Collection prove the increase during the last ten years, from 4,930 in 2012 to 21,279 in 2021. This increase was gradual, year by year, but the COVID-19 epidemic put the resilience concept in one of the most important research areas, especially regarding the food sector. With the pandemic background, the paper can be treated as addressing emerging issues, investigated in different scientific fields, which justifies the application of an integrative literature review (Torraco, 2005).

The review started from searching the Web of Science Core Collection with the key word 'resilience', then the key word 'crisis' was added, and adjectives such as: economic, social and environmental. Afterwards, it was developed with other sources as current publications led to different types of information relevant to

the topic as for example policy briefs. Complexity of the investigations led also to snowballing application, such as using the reference list and key concepts of a paper to identify additional sources appropriate for the study. The number of citations of the items was taken into account (although it does not always determine the weight of the article), hence the expert evaluation of the literature was also used. Detailed qualitative and quantitative notes were prepared without use of special software dedicated to bibliometric analysis. Main stages of the process included identification of the topic, justification literature review as the accepted methodology, searching the literature, its analysis and synthesis. The synthesized knowledge from the state of the art supported by analysis of time series of selected indicators allows to propose a new, more comprehensive, perspective on the topic of resilience in the food sector.

## 2.2 Statistical data sources

The literature review is supported by the presentation of time series describing issues pointed out within the literature review. Generally, we studied 27 EU countries as joined by the common approach of the EU F2F strategy (e.g. data on harmonized indices of consumer prices and employment in agriculture analyzed within this approach) but selected issues were also analyzed with wider geographical perspective. For example, data of WWF or International Union for Conservation of Nature (IUCN) were used in order to illustrate the problem of hunger and defaunization. It is worth to notice here that harmonized indices of consumer prices (HICPs) (Mazumder, 2018) that are designed for international comparisons of consumer price inflation were also analyzed. HICP is used for example by the European Central Bank for monitoring of inflation in the Economic and Monetary Union and for the assessment of inflation convergence as required under Article 121 of the Treaty of Amsterdam. HICPs statistics were obtained from the Eurostat database in 2010(2012)-2021.<sup>1</sup> HICPs information for the USA in 2021 was derived from the U.S. Bureau of Labor Statistics (2022). In the case of the EU, two data sets were taken into account: (1) describing European Union; (2) Euro area; and (3) United States of America. This approach allowed for taking into account a longer time series for uniformly recorded data.

## 2.3 Methodological framework

The data was presented with figures and described initiating a scientific discussion. Finally, we give insights for possibilities and limitations of a resilient approach implementation across the food sector. Due to the multithreaded nature of the study, the research methodology is presented in Figure 1.

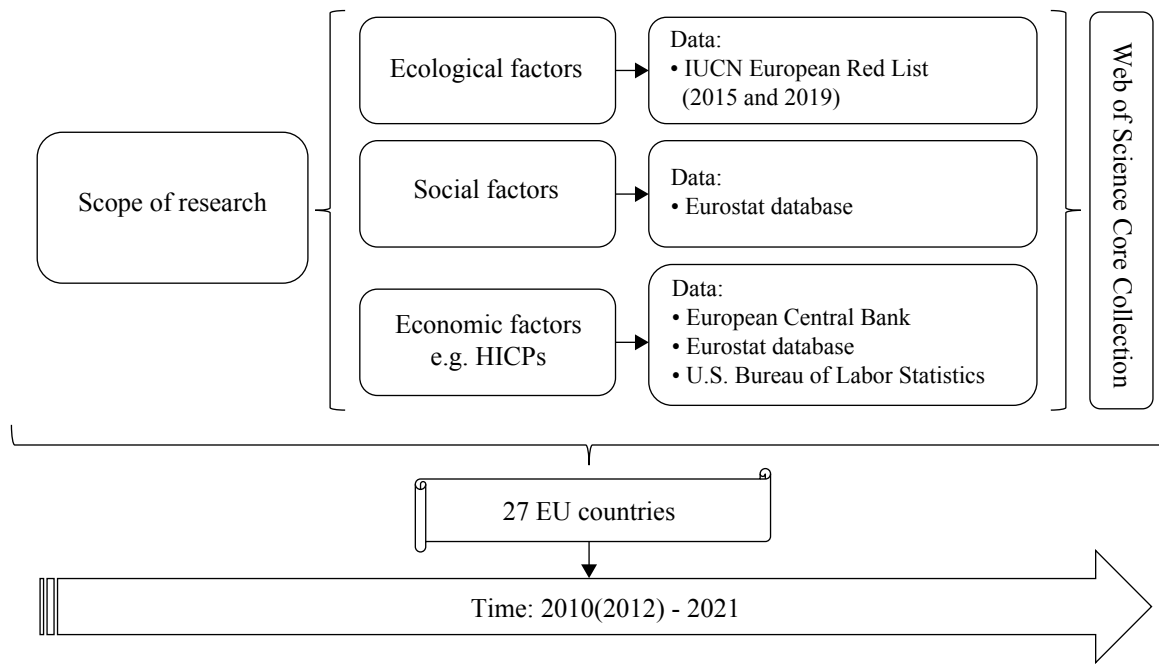
## 3. Literature review

The term resilience may be found together with sustainability in the state of the art. Marchese (*et al.*, 2018) even conclude on three following approaches dominating the literature: (1) resilience as a component of sustainability; (2) sustainability as a component of resilience; and (3) resilience and sustainability as separate objectives. As formulated within the aim, the literature study also refers to resilience according to three basic dimensions of sustainability (environmental, social and economic). Then a short literature review on symptoms of resilience in the food sector towards crises is presented.

### 3.1 Environmental, social and economic perspectives of resilience

Baum *et al.* (2015) provide a definition stating that, ‘a resilient system is able to retain critical functionality in the face of disruptions, even while it may make adaptations of noncritical attributes. In the face of global food supply catastrophes, a resilient global human system will adapt its food procurement practices to keep people alive and keep civilization intact’. In the context of resilience, Baum and Handoh (2014) referred to the risk of catastrophes beyond humanity’s capabilities, which resulted in humanity’s transition to a different, worse state. The context of the deterioration of the conditions for humanity is interesting, as it refers to disasters

<sup>1</sup> <https://ec.europa.eu/eurostat/web/main/data/database>



**Figure 1.** The research methodology.

comparable to ones resulting from volcanic eruptions, collisions with comets or asteroids, nuclear wars, as well as outbreaks of plant and animal diseases. There is no doubt that the effects of such events may not only jeopardize world food supplies, but may also lead to a shortage of food in large areas. Plants and animals mentioned above are undoubtedly connected to bioresources, so it is necessary to consider biodiversity and one of the key problems of the modern world like the widespread and ubiquitous defaunation process. Its effects are far-reaching and limitation of animal overexploitation and land use change are possible mitigation actions (Dirzo *et al.*, 2014). Hendrickson draws attention to the impoverishment of the environment and the monoculture occurring in many areas as a manifestation of the industrial approach to food production in the world. Additionally, conventional agriculture is an integral part of the economy. The paradigm that led to a highly concentrated and industrialized agri-food system has created environmental, social, and economic risks (Hendrickson, 2015).

Adding the social perspective makes it possible to refer to the term ‘social-ecological resilience’ as the capacity of a system to withstand shocks, still have the same identity and possibly to improve or even advance by learning, adapting, coping with shocks, as well as recovery afterwards (Maleksaeidi and Karami, 2013). It seems necessary to care for cultural continuity, generational diversity, support the family and community, and maintain the roles of older people in the family and society. In many cases, it is difficult to point to cultural continuity (e.g. the disappearance of certain professions, customs), generational diversity (elderly cannot count on childcare and are placed in specialized nursing homes, and the younger generation loses the opportunity to associate with their living ancestors) while families looking for a better existence are scattered around the world (Becker *et al.*, 2003).

The most numerous group in the food system are small agricultural entrepreneurs who can support the resilience of agri-food production, e.g. by providing socio-cultural services, playing a fundamental role in shaping landscapes and increasing the relationship between humans and nature (Manyise and Dentoni, 2021). A resilient food system must support the entire community (social resilience). There are examples of studies on social capital and resilience of food systems (Berno, 2017; McDaniel *et al.*, 2021; Nosratabadi *et al.*, 2020; Smith *et al.*, 2016). It is important to notice that social networks can contribute to resilience of agricultural systems in remote rural areas (Bruce *et al.*, 2021) typical for some forms of farming, e.g. beef

cattle or sheep production. Despite a decreasing role of agriculture in the economy, it is still an important component of the economic, social and cultural environment for specific geographical contexts.

Creating resilience can be understood as ‘a process of social learning, using human capacities and knowledge to reduce vulnerability and risk in the face of the unknown and unexpected’ (Hudson, 2009). Paganini *et al.* (2020) understand food system resilience as an opportunity to alleviate faults and build capacities. The first are coping capacities for cushioning shocks, then adaptive capacities build on the immediate environment within the family and community (social capital) and provide the flexibility to cope with shocks. Finally, transformative capacities are considered as a solution space that provides the opportunity to create longer-term change to sustainably improve the community and household food system. Hertel *et al.* (2021) indicate that diversification of income sources is critical assuming the prominent role of income in ensuring household well-being. Rural livelihood diversification and social capital are pointed out as enhancing rural resilience and contributing to sustaining sustainable rural communities (Li *et al.*, 2019).

At the same time, McDaniel *et al.* (2021) provide a wide approach to community resilience, including political, economic, social, natural, human capital as well as flexible and networked community resources and community pride & belonging. The social capital is approached as relationships among people that contribute to individuals’ capacity to overcome challenges. However, other dimensions listed can be at least partially applicable to wider perspective of social resilience. This refers to human capital, expressed within skills, education, and working experience increasing workforce productivity and wages, as well as community pride & belonging understood as a sense of being a part of a cohesive community with a unique collective identity. Resilience is simply more likely when people identify with places they live (McManus *et al.*, 2012).

Zanotti *et al.* (2020) analyzed issues of comprehensive changes in farming within the concept of resilience. This conceptual approach seems to be comprehensive, but still open to the inclusion of further factors, such as, for example, a broader connection of social changes, as well as taking into account changes in the area of finance. In this context, the problem of a very heavily regulated financial market, which is periodically plagued by crises (revealing the weaknesses of these regulations) is one of the interesting areas, showing the need to return to the rules that prevailed centuries ago. Historically, it is possible to point to a tulip bubble, a bubble in the real estate market, manifested by financial crises. These crises have become more severe with the liquidation of the marketable equivalent of money in gold deposited with banks and the increased rate of information flow due to computerization (Epstein, 2005; Foster, 2008). Direct references to financial crises lead the attention to the concept of economic resilience (Griffith-Jones and Tanner, 2016).

### 3.2 Crisis situations and resilience

Literature provides examples of situations when crises make farmers diversify their professional activities, mobility (Otsuki *et al.*, 2014), diversification of economic activities towards product innovation and agribusiness expansion (Chin and Pehin Dato Musa, 2021). It is an expression of rational behavior aiming at risk mitigation, which has quite long history in economic research, as for instance Stark and Bloom (1985) point out that the decision to change the employment sector may be driven by a tendency to avoid risk – if one of the household’s members changes the employment sector to one in which the salary is inversely correlated, statistically independent or slightly positively correlated with the salary in the previous sector (in which at least one of the other members of the household is still working). This relation explains both the change in the labor sector of one person and the fact that the other member of the household did not make such a change. There is simply a kind of insurance by diversifying the sources of livelihood. However, some research on crises other than current pandemic state prove that anti-resilient operations can also take place in a form of a return of the workforce to the family farm, as the external environment is perceived as unfriendly as the internal one – or even more so (Ragkos *et al.*, 2016).

It is interesting to notice that the mobility mentioned above as a way to react to crises through income diversification, can be also interpreted as a process which can hamper resilience. Camarero *et al.* (2016)

point out a process referring to the role that family strategies and inter-generational solidarity play in the resilience of rural society. Authors of this study describe a course which starts with movements of the mobile generation (30-50 years old) as the answer for a crisis. However, these generations play the crucial role in family strategies (care and assistance, productive and consumption activities), so their mobility can contribute to hampering rural resilience building. These topics have received little attention in the state of the art (Camarero *et al.*, 2016) but they exceed the food system framework and refer more to rural resilience in general. Long-term perspective on food system resilience at the farm level can be connected to intergenerational transfer in family farms, which succession is constrained by perceptions of farming as a relatively low income occupation with long working hours, remote locations, reduced social life and high financial challenges (Huber *et al.*, 2015; Meuwissen *et al.*, 2019).

One of the shocks that have had and are of global scope is the COVID pandemic. The second major shock to society is the ongoing armed conflict in Ukraine, and its social, economic and ecological consequences are currently impossible to estimate.

Some more on the effects of the COVID epidemic on resilience disorders have been described in the literature. The COVID-19 epidemic is one of the extraordinary phenomena affecting the functioning of people in virtually every sphere. The effects on food security are not the result of the virus itself, but a consequence of the loss of income and the purchasing power of money. These, in turn, result from the decisions of the governments of individual countries (Béné, 2020). Cottrell's *et al.* (2019) extensive research shows that of the 134 countries affected by the shocks, 2 experienced shocks across multiple sectors over the same five-year period. The shocks affecting many sectors simultaneously were geopolitical in nature, whereas armed conflicts led to extensive devastation of agricultural land, rapid declines in crops, livestock farming and fishing (Cottrell *et al.*, 2019). The consequences of such events are far-reaching. Not only for the ecosystem, but also for food security, in particular poverty, the reduction of education opportunities and hunger for entire societies.

Lack of resilience leads to crises. In the long run, the crisis may lead to a systemic weakening of agriculture, in particular poorer farmers, which may result in a reduction in their income. It may also lead to a total loss of income and elimination of such entrepreneurs from the market. As a result, the aging process of agriculture will progress (lack of its modernization and development) (Savary *et al.*, 2020). The COVID-19 crisis is affecting not only weaker farms but, in particular, the poorest people. This part of society may face difficulties in meeting basic needs, including nutritional needs. According to WFP data, as many as 768 million people were chronically hungry in 2020 (FAO, IFAD, UNICEF, WFP and WHO, 2021). An additional factor negatively affecting the income situation of the society, including farms, may be inflation, which in 2021 began to grow dangerously in many regions of the world.

The current study of Béné (2020) referring to the context of COVID-19, points out there is still very little formal analysis of the impact of COVID-19 on food systems and their actors and even less of the invasion on Ukraine. In the case of the latter, for example the Food and Agriculture Organization signaled on risks for global agricultural markets associated with the current conflict (FAO, 2022), referring for example to resilience of food systems especially in countries depending on food imports from Ukraine and the Russian Federation. A lot has been already commented about the problem of disturbances in the food value chain, which result also from difficulties or even the inability to obtain grain from Russia (the largest wheat exporter in beginning of the 21<sup>st</sup> century) (Svanidze and Gotz, 2019). Adding the inflation phenomena to these shocks (COVID-19, war in Ukraine, drought and embargo on grain exports from Russia), it should be emphasized that there are many factors disturbing resilience in the food economy at present.

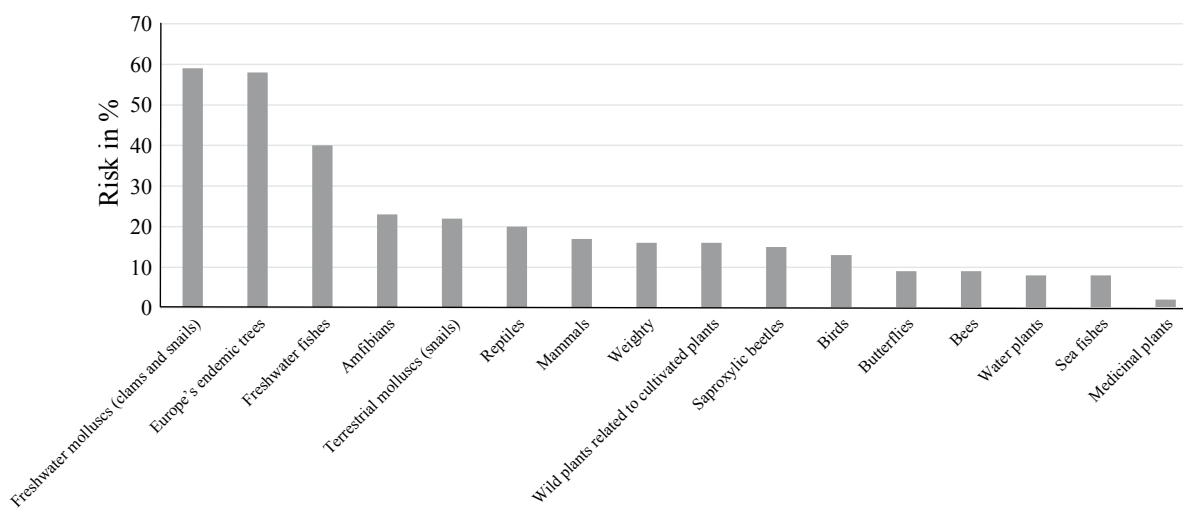
#### 4. Results

Production processes aimed at continuous increase in the productivity of plants and animals not only allow solving the problem of food waste in rich societies, and their shortage in poor regions of the world. They also lead to the disturbance of the natural processes of growth and development of living organisms (plants and

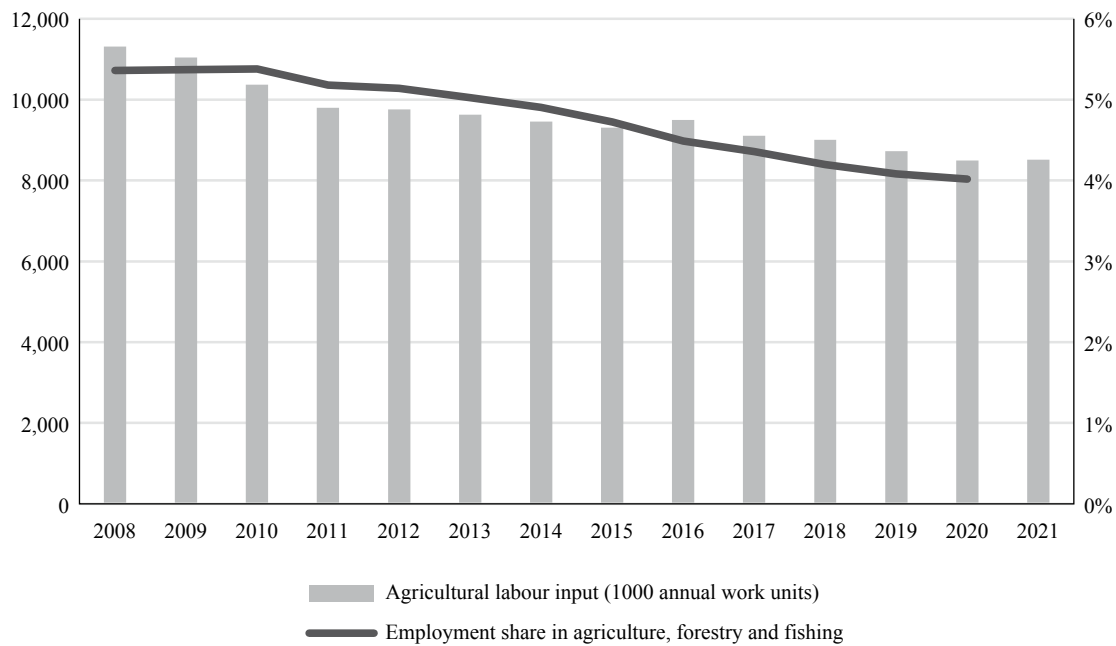
animals). In many cases, such activities lead to the suffering of animals which, e.g. due to their high efficiency, have unnaturally developed parts of the body (udders in dairy cows or muscles of pigs), or their growth is accelerated (broilers), but also to human suffering (emotionally connected with these animals) (Porcher, 2011). While attention is being paid to filling the information gap among farmers, which has a significant impact on sustainable agriculture and its development (Adamashvili *et al.*, 2019), it seems necessary to take a step further towards resilient agriculture and food production. Resilient food systems require linking to other concepts like circular economy but also specific practices for innovation (Brassesso *et al.*, 2022), just to mention farm digitalization (Fourati-Jamoussi *et al.*, 2018) addressed by the F2F strategy. Additionally, attention should be paid to depopulation of wild animals. Taking into account the WWF data, it should be emphasized that the population of wild animals has decreased by 68% over the last fifty years. It is the result of climate change, water pollution and acidification, natural threats, and harmful human activities (including deforestation, clearing meadows, draining swamps) (WWF, 2020). Balance in every sphere of life must be maintained (biodiversity), otherwise the scale of negative phenomena, including epidemics, will increase. To illustrate the scale of the problem, Figure 2 presents the most endangered species in Europe (expressed in % of risk). Bearing in mind that man is one of the species of mammals, it will not be possible to ensure the well-being without resilience (including the provision of food, hygiene, cultural, psychosocial and other needs).

Figure 2 proves that Europe has a large number of plant and animal species that are at high risk of extinction. The most threatened with extinction are freshwater molluscs (clams and snails), endemic European trees and freshwater fish. Many endangered species are the backbone of ecosystems and also enable people to feed and gain income from within these ecosystems. In this regard, three important areas come together: environment, society and economy, and therefore the areas of ensuring resilience. Following the results of the research by Hobbs (2020), it is worth emphasizing that it is important to distinguish between innate and adaptive immunity, which applies to each of the areas studied.

Food sector and generally the primary industry is important from the perspective of social resilience. The primary industry has long been perceived as being the backbone to successful economies of rural areas. However, a trend of leaving rural areas in favor of moving to urban ones, and a decrease in the number of small farms over a period of more than a century have been observed (Fourcroy and Drejerska, 2019). The share of agriculture in total employment is nowadays at the level of 4% (Figure 3). A decreasing trend in this



**Figure 2.** The most endangered species in Europe (expressed in % of risk) (based on IUCN European Red List (EC, nd)).



**Figure 3.** Employment share in agriculture, forestry and fishing (as % of employment in all NACE activities) and agricultural labor input (1000 annual work units) in EU-27 countries (Eurostat, 2022a,b).

sector's employment across EU is expected to slow down at -1% per year, reaching the level of 7.9 million workers in 2030 (European Commission, Directorate General for Agriculture and Rural Development, 2020). Increasing profile diversification of agricultural workers and farm managers is expected (European Commission, Directorate General for Agriculture and Rural Development, 2020) Different strategies can be found in the state of art – from diversification of marketing channels and product categories (Benedek *et al.*, 2021) even to selling livestock, seeking new off-farm income and sometimes selling land (non-European example) (Blazy *et al.*, 2021).

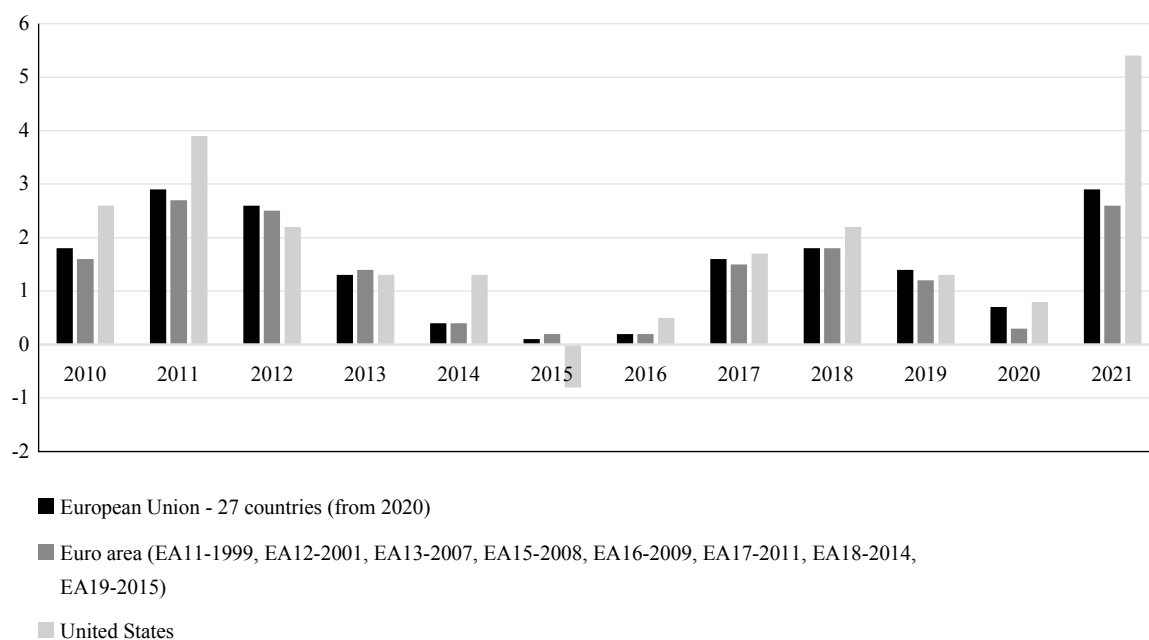
The resilience of the workforce has been tested through the duration of the COVID 19 global pandemic crisis. In case of European food system, it should be noticed that COVID mobility restrictions made seasonal temporary workers unavailable for some agricultural activities. It influences the sector's productivity, as for some regions or branches migrants' inflow is important labor supply channel. Taking into account the fact, that movers into agriculture are mostly migrant men older than 19 living in a rural area and with low qualification as well as recent labor market trends, it can be concluded that native workers can only partially fill potential vacancies in the sector (European Commission, Joint Research Centre, 2020). It should be pointed out that this problem does not only refer to food system resilience but also to resilience of entire economies as agriculture is understood as a sector where presence of migrants is essential to the pandemic response as well as long-term recovery and development (Guadagno, 2020). COVID situation put the light on the labor force quantity available for the food systems, but it is necessary to stress labor force quality required, as this perspective is an important part of the F2F strategy, as a factor enabling the transition through advisory services, data and knowledge sharing, and skills (European Commission, 2020). There is lack of current and reliable data and analysis on the impact of the ongoing armed conflict in Ukraine on the labor force in agriculture. It was a popular sector of employment for Ukrainian immigrants (mainly temporal) to the EU countries (e.g. in Poland, Chmielewska *et al.*, 2018). Nowadays, some males came back to Ukraine, while females left their country, which of course will not naturally lead to filling the gaps in employment in agriculture and related activities.

One of the areas that enables a person to provide resilience is income security. The situation in this respect has worsened as a result of the COVID epidemic. Due to the pandemic, public debt in the OECD area increased

by another \$5.7 trillion in 2020 – an amount of \$3.5 trillion higher than estimated before COVID (Lysandrou and Ranjbaran, 2021). This increase in government bond issuance took place in a context of zero interest rates, which has benefited both indebted governments and investors looking for safe assets amid the global economic recession (Stockhammer *et al.*, 2021).

Following the global finance crisis (GFC), quantitative easing (QE) measures implemented by the United States and some developed countries have created an excess of capital in international markets. A large amount of speculative capital has flowed into international grain futures and other derivative markets, resulting in large fluctuations in the international grain price market. This phenomenon is known as the financialization of grain (Yaojun, 2021). The volatility of grain prices, resulting from speculative activities, does not translate into an increase in the profit of agricultural producers, but into the profits of intermediaries participating in the trade. One may hypothesize that agricultural producers are losing out on speculations due to increased uncertainty and risk. The research by Sifat *et al.* (2021) shows that speculations in the gasoline, crude oil and gold markets are the most visible. Nevertheless, this situation also affects other groups of stakeholders. It is therefore difficult to talk about resilience in these conditions, and speculation on the agricultural commodity or energy markets should be considered a threat to the broadly understood food sector resilience. It is also a threat to the economic balance, and therefore one of the three pillars of resilience under consideration.

Figure 4 shows the time series relating to harmonized indices of consumer prices. In the period 2010-2021, clear increases in HICPs are visible, resulting from the global finance crisis initiated in 2007 with the speculative bubble on the US real estate market. The scale of this phenomenon surprised financial analysts, but most of all it gave rise to problems for many economies (especially developed economies). In addition, the GFC and 2012 Euro area sovereign debt crisis resulted in a reduction in investment in innovation (Peia and Romelli, 2022). In the period 2011-2015, a decreasing direction of changes in HICPs was observed both in the EU and US countries. As Mazumder (2018) states, most observers did not expect a sharp drop in inflation in the EU in 2012 (Mazumder, 2018). It was a time of gradual improvement in the financial situation of economies that experienced post-GFC recession and those that experienced a slowdown. Further increases in HICPs, both in the EU and in the US, occurred in the period 2015-2018, but their amplitude was smaller than during



**Figure 4.** Harmonized indices of consumer prices – inflation rate EU and US 2010-2021 (Eurostat, 2022c).



the GFC. After a short period of about two years of decreasing the level of HICPs, a significant increase was observed. U.S. The Bureau of Labor Statistics recorded an increase in the consumer price index for all urban consumers (CPI-U) in the USA in 2021 on a twelve-month basis (unadjusted percentage change Dec.2020-Dec.2021) by 7.0%. CPI in European Union (Nov. 2020-Nov.2021) was 111.7% (Trading Economics, 2022).

Undoubtedly, such a large increase in the inflation rate should be considered worrying, reducing the purchasing power of money in the food sector and, moreover, may cause a further deterioration in this sector, which started with the lock downs in 2020 and 2021 and war and sanctions in 2022. In our opinion, all the factors discussed across this study are known from the literature, and their combined appearance will threaten resilience in agriculture, especially in the context of drought in the early 2022. Considering the last shocks discussed (COVID-19, war in Ukraine, drought, embargo on grain exports from Russia, rising inflation), we should expect a difficult situation on the food market in the nearest future. Unfortunately, this situation will probably lead to deepening poverty and hunger in the poorest regions of the world.

## 5. Conclusions

The issue of resilience in the food sector must be considered multidimensionally. In the paper, we proposed environmental, social and economic perspectives, derived from the concept of sustainability. It seems that the sustainability approach is not sufficient, despite its very important role in modern agriculture and the departure in this concept from the abusive economy, manifested, for example, in excessive exploitation of agricultural land or animals (welfare). It is imperative to pursue a holistic approach involving three main interest groups: environment, society and economy (including finance). In this approach, the basic direction of activities should be the one focused on the resilience approach, both in environmental protection (including agricultural production) and society (with an attempt to return to the roots in the culture of the functioning of multi-generational families and local communities). For a harmonious combination of these activities, it is also necessary to look at the economic perspective of food systems and entire rural livelihoods (e.g. income and employment diversification).

The issue of biological balance (or its lack) is an important factor, both an opportunity and a threat to resilience in food sector. Human activity wreaks havoc, on the one hand, occupying new areas where wild species of animals and plants live, and, on the other hand, strives to rebuild the dying fauna and flora. It will not be possible to ensure the well-being of people (including the provision of food, hygiene, work, income or cultural, psychosocial and other needs) without resilience in human life in general.

Another factor negatively affecting food sector is the increase in prices, defined by harmonized indices of consumer prices, especially the one resulting from the GFC, but also those recorded in 2021, resulting from COVID. It has its source in the increase in energy prices, on which the profit of agricultural producers depends, but also in the standard of living of farms (the need to limit expenses for other purposes). The increase in prices caused by the war in Ukraine and the sanctions imposed on Russia is becoming more and more visible.

Speculation on the agricultural commodity or energy markets is one of the factors posing a threat to food sector. It makes it difficult to stabilize the terms of cooperation between different stakeholders. It seems, however, that this area will be difficult (even impossible) to regulate in such a way as to avoid the actions of people looking for profit maximization opportunities, often in isolation from the real economy. This perspective leads to appreciation of common strategic approach to food sector, as F2F strategy for European Union countries, which is extremely problematic for some other markets.

The wide scope of the paper does not facilitate to formulate specific managerial implications as they can refer to different entities operating within the food system aiming at being resilient. It can be farmers, food companies but also public and non-governmental bodies. Undoubtedly, proving that environmental, social and economic perspective are important features of resilience should encourage different stakeholders, not only managers, to realize about factors, which are not included in standard profit and loss accounts but has

impact on long-term development perspectives and can decide on retaining critical functionality in the face of disruptions, which can happen suddenly and unexpectedly. For example, it is reasonable to approach finance in a new way, especially taking into account the risks resulting from the negative effects of financialization.

Finally, while considering resilience in the food sector, attention should be paid to different groups of factors, both stimulating and limiting. The scale of the problem is so vast that it is impossible to put them all in one paper. Therefore, the focus was on current elements (regarding recent ones resulting from COVID pandemic), but with the indication of one of the primary sources of the problem, i.e. the biological imbalance resulting from human activity. Important limitation of the study results from its wide scope as research on environmental, social and economic dimensions are very broad and multi-threaded. It requires further study, but we believe that these three thematic areas cannot be analyzed only separately from the resilience point of view. Attempts to combine them are not easy and require improvement in further research. This is a key problem, as the agri-food sector must develop adaptation processes in response to subsequent shocks (e.g. the COVID epidemic; the war in Ukraine).

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*Special issue: Opportunities and challenges of EU farm-to-fork strategy*

## **Too much power or no power: when does intermediary's power result into better wine and happier farmers?**

### **RESEARCH ARTICLE**

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### **Abstract**

The study analyzes the trading relationship performance between farmers and intermediaries and the factors shaping it, with a focus on intermediary's power, based on a structured survey of vineyard farmers in Kosovo. Confirmatory factor analysis is employed to develop measures for the study latent variables, and ordinary least squares regression is used to test the hypothesis. To further validate the results, machine learning (i.e. random forest) is used to model the factors affecting the relationship performance between farmer and intermediary. The results show that when the intermediary has considerable (excessive) power, it leads to low trading relationship performance with farmers. Also, when the intermediary has little power, the relationship performance with farmers behaves in a similar way. The main contribution of this paper is to further illuminate the debate on the role of power in business-to-business relationships, in that it points out an alternative explanation; stating that there is an optimal level zone that power needs to exist, in order to achieve above average trading relationship performance. Outside this zone, either low or excessive/high intermediary's power results in poor relationship performance.

**Keywords:** power, relationship performance, vineyard value chain, Western Balkan, Kosovo

**JEL code:** D21, D22, D91, L25, Q12

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## 1. Introduction

Traditionally, transactions in the agri-food value chains in transitioning countries are conducted at the ‘arm’s length’ price mechanism (Hanf and Gagalyuk, 2018). Swinnen (2005) points out that vertical coordination’s importance in agri-food chains is increasing. Yet, in order to gain short-term advantages, existing contracts are broken quite often – a behavior that is easily encouraged due to weak enforcement mechanisms. According to Gorton *et al.* (2003), medium-sized processing enterprises suffer the most from breaches, because they lack the power mechanism to vertically coordinate the chain, in contrast to big processors (or traders) who possess large bargaining/market power.

In this view, to have a functioning value chain, there must be a coordinating chain agent (e.g. processor, exporter) who has the ability to control the decision variables of the other agents to deliver an outcome in the interest of the coordination agent (Belaya and Hanf, 2016). Hence, power plays a pivotal role in the coordination of supplier firms and their distributors (Wilkinson, 1973). Power is at the heart of any business-to-business relationship (Cox, 2001) and is a key behavioral construct that influences performance (Reve and Stern, 1979; Xhoxhi *et al.*, 2018).

On the one hand, power is seen as opposing effective relationships and successful cooperation (Bretherton and Carswell, 2002; Doney and Cannon, 1997), because the firm with (excessive) power advantage can abuse the weaker suppliers to obtain superior economic returns (Dore, 1983; Perrow, 1970). On the other hand, when power is used by the coordinating chain agent as a coordinative mechanism to increase quality and added value by promoting harmonious relationships and solving conflicts, that power may result in enhancing the performance of the whole network as well as its individual members. There are also a number of authors that argue that power is vital, because it can take the relationship out of the realm of chance and give it purpose, order, and direction (Dwyer *et al.*, 1987; Xhoxhi *et al.*, 2018).

This study analyzes intermediary’s power over farmers in an emerging economy context. The term ‘intermediary’ refers to chain actors that buy directly from farmers including, processors, wholesalers, retailers, etc. We have chosen the vineyard sector, as a suitable case, given the importance of quality (especially from wine-making prospective). The core research question leading the study is: How does intermediary’s power affect the performance of their trading relationship with farmers? By addressing this question, we contribute to the debate on agri-food value chains’ governance and on small farmers’ participation in these chains. In addition, we touch upon the issue of improving farmers’ business and livelihood through the development of sustainable relationships with their buyers, which are governed through the ‘power with’ perspective, which is about partnership and trust. Notwithstanding the fact that the analysis focuses on the case of Kosovo, the findings are relevant for other emerging or developing economies, sharing similar features.

While many argue that ‘market failure’ is endemic and public intervention is therefore justified in ensuring food safety, it can also be argued that public institutions may fail to play the crucial role of developing an enabling environment and guaranteeing (safety) standards in the market (under certain circumstances), and so in these situations, there is a lack of incentives and sanctioning mechanisms to enforce producers to comply with standards (Imami *et al.*, 2021). Thus, in a market economy there is not only ‘market failure’ but also ‘government failure’. In such a context, the role and power of the value chain leader is crucial to ensuring compliance with quality and safety standards, especially for markets or products which are sensitive to quality (such as wine) and in economies/context where government/public institution failures are more likely, such as in the case of developing/emerging economies. Consequently, another question that the paper attempts to address is: Can the free-market mechanism be considered as an alternative to public interference?

It should be noted that the concept of power in agri-food value chains is mainly studied as market power and bargaining power. In the former, power is defined as ‘the ability of a firm (or group of firms) to raise and maintain price above the level that would prevail under competition is referred to as market or monopoly power’ (Khemani and Shapiro, 1993: 57). While Kirkwood (2005) defines power as a party’s ability ‘...to

obtain a concession from another party by threatening to impose a cost, or withdraw a benefit, if the party does not grant the concession'. Instead of following these two perspectives, here power is viewed as a party's perception about the ability of the other trading party to influence his/her behavior or strategy decision variables in a direction that him/her would not have freely tended, which (the direction of influence) favors the one who exercised power (El-Ansary and Stern, 1972; Wilkinson, 1981; Xhoxhi *et al.*, 2014). Bacharach and Lawler (1981) look at power between parties in a negotiation process and claim that negotiation power is perceived power. Furthermore, they point out that meaningful power in a business relationship does not exist beyond the parties' perceptions of power. Therefore, power is measured from farmers' perceptions on the ability of intermediaries to influence price, payment terms and amount paid through Likert scale statements. All selected elements are in line with market power theory but are also the elements which are negotiated the most in trading relationships between farmers and intermediaries in emerging/developing countries.

Interestingly, the empirical findings from our study point out that when the intermediary has excessive power or – on the other hand – low power, the performance of the trading relationship is lower than when the intermediary's power exists at an optimal level. To the best of authors knowledge, this is the first time that empirical research casts light on the complexity and non-linearity of relations between power and trading relationship performance. Furthermore, this paper provides contribution to the literature by applying machine learning techniques which is rather new in the research domain of power in agri-food value chains.

The rest of the paper is structured as follows: Section 2 provides the literature review, Section 3 consists of an overview of the vineyard and wine sector in Kosovo, Section 4 describes the research methods used, Section 5 shows the empirical findings, which are discussed in Section 6 and Section 7 provides the concluding remarks.

## 2. Power in agri-food value chains

### 2.1 Value chain coordination in the global agribusiness and wine business

Today, the prevailing strategy in the agri-food sector focuses on vertically coordinated supply chains to adjust with the different changes in the agri-food sector (Carillo *et al.*, 2017; Ménard, 2004). Reasons for the development are issues of food safety, food security, changing consumer preferences, ethical concerns, and greater awareness of the environmental impact of food production. A self-evident reason for the formation of vertical networks instead of single line chains is the differing sizes of firms along the food chain – from extremely small-medium sized farms due to historical reasons to concentrated manufacturers and food retailers (Saitone and Sexton, 2017). Furthermore, product differentiation – to meet customer needs – plays a role in pushing supply chains to be more vertically or horizontally coordinated. In this context, Lazzarini *et al.* (2001) define netchains as 'a set of networks comprised of horizontal ties between firms within a particular industry or group, such that these networks (or layers) are sequentially arranged based on the vertical ties between firms in different layers'. Supply chain networks or netchains are mainly organised in a pyramidal-hierarchical structure, in which a focal firm from the downstream chain part is the centralised decision-making unit (Jarillo, 1988). Other network partners are dependent on the focal firm, due to long-lasting relationships. Thorelli (1986) describes networks as long-term relationships of power and trust through which organisations exchange influence and resources between at least two or more actors in the networks. If the focal firm depends on critical inputs from the suppliers, mutual dependencies exist, and the suppliers reclaim some of the power (Medcof, 2001). The focal firm coordinates the network to reach the strategic objectives and it possesses the necessary authority to do so (Lorenzoni and Baden-Fuller, 1995).

The wine sector represents rather a special case (Bitsch and Hanf, 2022). Strong efforts have been made to ensure quality upgrade and product differentiation to better meet demand. The wine has changed due to a greater attention to quality and diversification including aspects such as sustainability and organic (Carbone, 2021). The importance of high quality, when combined with perishability that characterises grape, require close coordination between growers and processors during the growing and harvest season to avoid disruption and instability in the supply chain, which have a negative impact on the quality and quantity of the final



product (Ashenfelter, 2007). Grape quality is a critical competitive factor for wine producers, requiring large investments in the vineyard and efficient management mechanisms of the grape material supply chain. There are numerous approaches for organizing and managing the supply of wine grapes, ranging from simple oral agreements to formally written contracts and joint ownership and management of neighboring stages in the supply chain (Bitsch, 2022; Franken, 2014). Numerous studies have well examined the mechanisms of vertical coordination in traditional and mature wine regions in France (i.e. Champagne) (Chambolle and Saulpic, 2006), Spain (i.e. Rioja) (Fernández-Olmos *et al.*, 2009), the United States (i.e. California) (Goodhue *et al.*, 2003; Franken, 2014), Australia (Fraser, 2005) and Germany (Bitsch and Hanf, 2022; Hanf *et al.*, 2012; Richter and Hanf, 2021). Findings in these studies indicate that the uncertainty, grape quality, investments on inputs, size of cooperating partners, etc. play essential roles in the decisions of supply chain management and contractual relationship. For emerging wine regions some results confirm earlier findings of other studies such as firm size, product quality and the level of specialised investments matter for coordination decisions (Bitsch *et al.*, 2019; Chaddad *et al.*, 2017; Hanf *et al.*, 2016; Li *et al.*, 2021).

Goodhue *et al.* (2003) find that more formal coordination is associated with higher product quality. As noted by Fernández-Olmos *et al.* (2009), wineries that produce high-quality wines are more likely to integrate vertically than those producing low-quality wines. Consistent with the broad quality-coordination relationship, it is found that different contract specifications are employed by wineries to motivate particular desired behaviors by growers in different regions, which is also supported by Fraser (2005). Contracts for grapes in premium grape regions are more likely to specify production practices that affect subtle wine attributes, while contracts for grapes in low-quality regions are more likely to be of longer duration and to specify price incentives for sugar and other easily measured characteristics rather than to emphasise the results of viticultural practices or wine quality (Goodhue *et al.*, 2003). Similarly, previous studies highlight that the degree of integration is significantly affected by specific growing investments, grape varieties, and the size of operation (Franken, 2014; Woods *et al.*, 2011).

Goodhue *et al.* (2003) find that the bonding between partners indicated by the length of a contractual relationship is more likely to be a substitute for contracting rather than learning and trust. Relationships can be driven by mutual understanding and trust (which makes the use of formal contract less important (Fraser, 2005)), and/or power. In terms of the unbalanced bargaining power between the merchant and growers, Chambolle and Saulpic (2006) demonstrate that when the tradable yield is high enough, imposed prices by the interprofessional system allows enhancing growers' position during grape price negotiations.

## 2.2 Vertical coordination and power

A crucial question in vertical coordination is how to align the actions and interests of the multitude of involved companies (Mentzer *et al.*, 2001). In this context a huge body of literature deals with trust as an appropriate tool (Belaya *et al.*, 2015; Gulati, 1995; Hanf and Pieniadz, 2007). However, looking at the agri-food business, in the majority of cases supply chains consist of a powerful retailer or processor coordinating various less powerful suppliers and/or buyers. In such an environment trust is often non-existent and very hard to establish, whereas power is 'naturally' there (Cox, 2001; Reve and Stern, 1979; Wilkinson, 1973). However, the question arises whether power can be used to align the interests and actions of the various actors. According to Kähkönen (2014), the relationships between buyers and sellers are mostly uneven. They state that buyers have usually more power, and relationships of balanced power are rather rare.

Configuration of power relations is crucial to agri-food systems' transformations (Rossi *et al.*, 2019). The distribution of power in the agri-foods value chain is increasingly associated with definitions of what constitutes a 'good' quality product or production, and that, itself, is related to the power in the chain (Renard, 2005). Since wine is considered as a quality product, and the higher quality of wine is associated with much higher price premiums (when compared to other agri-food products or commodities), it is of interest to investigate how power within the wine value chain is associated with value chain performance.

Vertical procurement relationships are consisting of heterogeneous firms (e.g. retailers, processors and farmers). Often, they serve as a focal company (Gagalyuk *et al.*, 2013; Hanf and Dautzenberg, 2006; Mentzer *et al.*, 2001). Thus, such relationships are providing a pyramidal-hierarchical structure (Gulati *et al.*, 2000; Hanf *et al.*, 2019; Jarillo, 1988). In this context, power has received increasing attention in the literature (Belaya and Hanf, 2012; Hingley 2005; Kumar, 2005; Sodano, 2006; Xhoxhi *et al.*, 2020). Because power can seriously hamper cooperation through its interactions with other constructs of the relationship atmosphere, making it very important for understanding supply chain issues to investigate power in buyer-supplier relationships (Chatziaslan *et al.*, 2005). In business-to-business relationships, the role of power has been treated in contrasting ways in the literature.

Naudé and Buttle (2000) express the idea that power has a negative influence and therefore is unhelpful for the building of relationship quality. Kumar *et al.* (1998) also view power as the antithesis of trust. This is manifested in a negative way in some cases, such as when retailers attempt to control the resources of their suppliers and limit their ability to take advantage of new opportunities, such as the development of new international markets and customer relationships (Johnsen and Ford, 2001). Xhoxhi *et al.* (2014) emphasise the necessity for more power symmetry between farmers' and intermediaries to foster a more collaborative relationship and to produce improved chain and trading parties' performance. In this context, power asymmetries are associated with less stability and more conflict and are considered to be detrimental to sustaining a business relationship (Ganesan, 1994; Hanf *et al.*, 2013; Rokkan and Haugland, 2002). All-in-all, in this situation, power appears to be synonymous with oppression, coercion, and force, even though such negative approaches are just one aspect of power (Duke, 1998).

Kumar *et al.* (1995) argue that if the powerful party treats the weaker, vulnerable party fairly, then trustful partnerships could be built. Furthermore, the possession of power does not necessarily have to result in exploitation or frequent use of coercion or force (Blau, 1964; Stern and Heskett 1969; Xhoxhi *et al.*, 2018); it may involve any degree of compulsion, ranging from the gentlest suggestion to absolute domination (Beier and Stern, 1969). In fact, Stern and Heskett (1969) argue that power can have a positive role in the achievement of integration, adaptation, and goal attainment within the channel system. Bierstedt (1950) suggests that power stands behind every association and sustains its structure; without power there is no organisation, no order. Therefore, and based on the review of the literature, it is hypothesised that:

**Hypothesis:** Intermediary's power and farmer-intermediary's trading relationship performance follows a quadratic relationship of an inversed U shape (i.e. at the extremes where power is low (left) and high (right) relationship performance is lower than in the middle area).

### 3. Overview of the wine sector in Kosovo

Kosovo is situated in the Western Balkans, with a population of 1.8 million. About half of the population lives in rural areas. Kosovo belonged to a centrally planned economy under Yugoslavia until late 1980s, while it underwent a notorious conflict and emerged as an independent country in the following decade. The conflict resulted in human losses as well as devastated the economy – the infrastructure of Kosovo was neglected for years, and fell into serious disrepair, and all forms of production capacities were damaged, including agriculture and specifically vineyards. Since the end of that conflict, Kosovo has continued to face many challenges, such as insufficient efforts to revive the weak institutional framework, which has affected also the agri-food markets and value chain organisation (FAO, 2016).

Wine production and vineyards growing is one of the most important agri-food sectors in Kosovo – wine is one of the main exported agri-food products. Indeed, wine and vineyards have historical importance – archaeological findings in Kosovo show that vineyards were cultivated over 2,000 years ago. Suitable agro-ecological conditions combined with tradition of wine making have been key factors for the growth of wine production. In 1980s, the Kosovo wine and viticulture sector covered an area of more than 9,000 hectares, and most of the wine and grapes produced from this area has been exported. However, after

achieving a production peak in the 1980s, the sector faced a major setback in the following decade, caused by the 1990s conflict, when many vineyards were destroyed, and the production of grape and wine were reduced drastically. After the conflict, there were revived efforts by private business, government, and donors to support the vineyard and wine sector, which resulted in growth and renewed investments in the sector (Zhllima *et al.*, 2020).

In 2019, the total area cultivated with grapes was 3,367 ha, of which 2,489 were used by wine grape varieties. There are altogether 26 registered companies producing 5,754,000 liters of wine (MAFRD, 2020). There is a lack of studies on wine sector / value chain trends. According to a study carried out by FAO (2016), the sector has been marked by overall growth and consolidation trend, as output is dominated by few large wineries (3 largest wineries make up for about 75% of the total wine production). Larger wineries have their own vineyards which are expanding but even in the case of wineries possessing their vineyards, supply from (small) farmers is crucial. About two thirds of grape supplies are being produced by farms smaller than 5 hectares, and most farms have less than 1 hectare. As a result, the number of grape suppliers per winery is very large, while power asymmetries occur frequently. Due to the current situation, part of the produce is being traded on 'spot market' terms, resulting in both large variance of quantity provided, and prices paid (FAO, 2016).

While some larger processors focus on producing/selling large volumes at affordable prices for local and especially export markets, there have emerged some processors focused on quality and niche markets. Downstream, there are different trends – while it is still common for many households to buy wine (and raki) directly from farmers (informally, at low prices), there have been established or expanded specialised wine shops, serving (both local and imported) quality wine. Improved quality of local wine, combined with evolving Kosovo consumer preferences as well as consumer ethnocentrism (FAO, 2016; Miftari *et al.*, 2021) imply a consolidation potential for the supply chain for local quality wine.

Kosovo's grape and wine industry is struggling to maintain its presence in the export market (targeting neighboring countries, notably Albania), while increasing its sales in the small but growing local market. Being a transitional economy, Kosovo household income and lifestyles are changing fast, implying a potentially higher demand for (quality) wine (Zhllima *et al.*, 2020). The perceived quality associated with a higher price may spur people to choose higher-priced wine (and other food products) especially in countries like Kosovo which have weak institutional frameworks related to food safety and quality standards control. Previous studies on consumer preferences for wine in Kosovo (*ibid*) and neighboring Albania (Zhllima *et al.*, 2012) show that some consumer groups prefer more expensive wine (*ceteris paribus*). Thus, achieving high quality not only is important to improve overall market access, but is crucial to reach higher paying consumers who are quality rather than price sensitive.

## 4. Data and methods

### 4.1 Data

The paper is based on a structured farm survey, which was conducted in 2016 in the Rahovec region of Kosovo, where most grape production is concentrated. The survey consisted of direct face-to-face interviews conducted by trained graduate students. In total, 222 vineyard farmers were interviewed, of which 105 specialised in table grapes and the others on wine grapes. The farm household heads are on average 51 years old and have extensive experience in vineyard farming (29 years on average). Table 1 provides some statistics on sample characteristics

Reflecting the mixed farm structure that characterises the Kosovo agriculture sector, grape production appears a major (but not the exclusive) farming activity, covering almost half of the farm cultivated area. Depending on the product orientation (table vs wine grapes) and farm profile, different marketing channels are observed for commercialisation of the produce. Table 2 shows the main channels of grape distribution. However, it should be noted that it is common that some farms have combined activities (both wine and table grape)

**Table 1.** Sample characteristics.

Variables	Mean	Std. dev <sup>1</sup>
Farmers' (household head) age	51.45	12.28
Farmers' (household head) education (years)	10.50	3.53
No. of family adult members (>18 years)	5.95	3.51
Experience cultivating grapes (years)	29.27	12.47
Area cultivated with grapes (ha)	1.15	1.07
Specialisation (vineyard area /total farm size area)	0.44	0.35

<sup>1</sup> Std. dev = standard deviation.

**Table 2.** Three types of intermediaries in market channels used by farmers.

Market channel	Frequency	Percentage
Wholesaler	82	36.9
Processor	67	30.2
Retailer	73	32.9
Total	222	100

and/or rely on multiple channels, but in context of the analysis, we focus on the main channel. On the other hand, wholesalers may serve as middlemen both for table and wine grapes, however, quality wine producers tend to buy directly from farmers (avoiding middlemen) to ensure raw grape quality.

#### 4.2 Measurement development

To develop measures for the latent constructs of the study such as intermediary's power, relationship performance, farmers' access to information and farmers' financial literacy confirmatory factor analysis (CFA) is employed, which generates measures and psychometric properties of each construct. To be space parsimonious, the items pertaining to each factor are presented in Supplementary Table S1. The items for each latent constructs were derived from a combination of literature review and qualitative in-depth interviews with farmers. Thus, construct reliability is assessed by estimating composite reliability (CR) and maximum reliability MaxR(H). According to Nunnally (1981), the minimum acceptable value for  $\alpha$  is 0.70. Table 3 shows that each construct has a CR greater than the suggested threshold value of 0.7.

Beyond reliability, each construct should be valid. A construct is considered valid when it fulfils two main conditions: convergent validity (i.e. items loading significantly on the factor they are measuring) and the condition of discriminant validity (ensuring that these factors are distinct and have a low covariance among each other) (Bagozzi *et al.*, 1991). Convergent validity can be assessed through AVE (average variance extracted). The suggested threshold value for AVE is 0.5 (Hair *et al.*, 2010). From Table 3, all variables have an AVE greater than 0.5.

Regarding discriminant validity, Hair *et al.* (2010) suggests two threshold values: (1) AVE should be larger than the maximum shared squared variance (MSV); and (2) the square root of AVE should be greater than inter-construct correlations. Based on the results of Table 3, all the threshold values suggested by Hair *et al.* (2010) are satisfied. Thus, it can be concluded that the constructs fulfil the conditions of convergent and discriminant validity. In addition, the model goodness of fit indices of the confirmatory factor analysis in Table 4 are all within the threshold values suggested by Hu and Bentler (1999). Having developed the variables of interests', multiple linear regression is employed to test the study hypothesis.

**Table 3.** Validity and reliability.<sup>1</sup>

	CR	AVE	MSV	MaxR (H)	Int. power.	Rel. perf.	Farm. acc. info.	Farm. fin. liter.
Intermediary's power	0.775	0.535	0.085	0.778	<b>0.732</b>			
Relationship performance	0.888	0.667	0.052	0.906	-0.059	<b>0.817</b>		
Farmers' access to information	0.841	0.579	0.052	0.926	0.201	0.227	<b>0.761</b>	
Farmers' financial literacy	0.955	0.913	0.085	0.958	-0.292	0.098	-0.092	<b>0.956</b>

<sup>1</sup> AVE = average variance extracted; CR = composite reliability; MaxR(H) = maximum reliability; MSV = maximum shared squared variance. In bold square root of the AVE on the diagonal below this diagonal factor correlations.

**Table 4.** Measurement model goodness of fit.<sup>1,2</sup>

Measure	Threshold	Model values
Chi-square/df	<3	(86/47) 1.83
<i>P</i> -value for the model	>0.05	0.004
CFI	>0.95 great; >0.90 moderate	0.976
SRMR	<0.09	0.043
RMSEA	<0.05 good, 0.05-0.10 moderate	0.061
PCLOSE	>0.05	0.171

<sup>1</sup> Chi-square/df is the chi-square value of the model divided by model degrees of freedom; *P*-value for the model – tests whether the departure of the data from the model is significant and a *P*-value  $\leq 0.05$  means the difference between the data and the model is significant.

<sup>2</sup> CFI = comparative fit index; PCLOSE = tests the null hypothesis that the population RMSEA is no greater than 0.05; RMSEA = root mean square error of approximation; SRMR = standardised root mean square residual.

#### 4.3 Estimation

The multiple linear regression procedure with ordinary least squares (OLS) estimation is employed to test the study hypothesis. In Table 5 is described how each of the variables in the model is operationalised. To get more reliable results, robust standard errors to heteroskedasticity are calculated and presented in Table 6. The model was also checked for the presence of outliers and influential cases, which do not appear to be an issue. Moreover, multicollinearity is not problematic since all variance inflation factor (VIF) values are below five. To further validate the results, machine learning (i.e. random forest) is used to model the factors affecting the relationship performance between farmers and intermediaries, which is a much more robust algorithm than OLS. Whereas the effects are visualised through the accumulated local effects (ALE) method (Apley and Jingyu, 2020).

## 5. Results

Table 6 presents the results of the multiple linear regression. As can be seen, the main factor to explain the trading relationship performance between intermediaries and farmers are farmers' access to information and intermediary's power. The results support the study hypothesis that low and high/excessive intermediary's power show lower levels of relationship performance. The vertex is at -3.93, meaning that up to -3.93 intermediary's power, the relationship performance between farmer-intermediary increases, and after that, the performance starts to decrease. The latent construct intermediary's power values range from -12.06 to 8.35.

**Table 5.** Variable's operationalisation.<sup>1</sup>

Variables	Operationalisation
Relationship performance	CFA – latent factor – composite – dependent variable
Farmers' access to information	CFA – latent factor – composite
Farmers' financial literacy	CFA – latent factor – composite
Intermediary's power	CFA – latent factor – composite
No. family members >18 years	Continuous
Years of experience cultivating grapes	Continuous
Area cultivated with grapes (ha)	Continuous
Specialisation (grapes/total farm size)	Continuous – ratio total area cultivated with grapes to total farm size
Farmers' education	Continuous – year of education
Farmers' age	Continuous
Selling to processors	Binary – selling to processors vs selling to other channels
Selling to retailers	Binary – selling to retailers vs selling to other channels

<sup>1</sup> CFA = confirmatory factor analysis.

**Table 6.** Multiple linear regression results.<sup>a</sup>

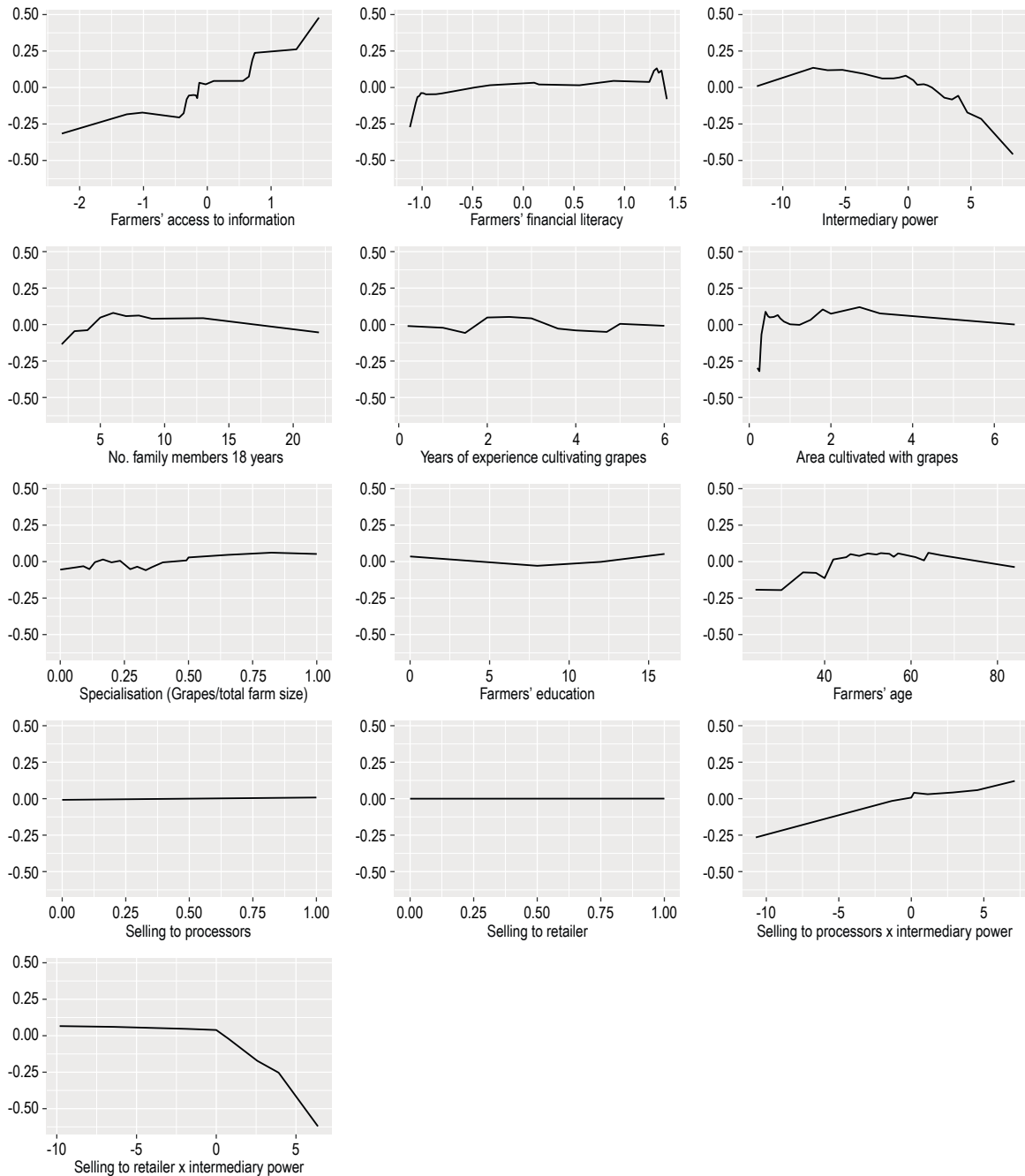
	Dependent variable: relationship performance	
Farmers' access to information	0.338***	(0.085)
Farmers' financial literacy	0.053	(0.064)
Intermediary's power	-0.055**	(0.026)
Intermediary's power <sup>2</sup>	-0.007**	(0.003)
No. family members >18 years	0.014	(0.014)
Years of experience cultivating grapes	0.002	(0.006)
Area cultivated with grapes	0.024	(0.06)
Specialisation (grapes/total farm size)	0.138	(0.197)
Farmers' education	0.017	(0.017)
Farmers' age	0.009	(0.006)
Selling to processors	0.111	(0.135)
Selling to processors × intermediary's power	0.072**	(0.03)
Selling to retailer	-0.022	(0.143)
Selling to retailer × intermediary's power	-0.037	(0.033)
Constant	-0.827**	(0.4)

<sup>a</sup> \* $P < 0.1$ , \*\* $P < 0.05$ , \*\*\* $P < 0.01$ ; observation = 222; Adjusted  $R^2 = 0.127$ ; F statistic 3.3\*\*\* on (df=14; 207); in parenthesis = robust standard errors.

On the other hand, the more farmers have access to information (e.g. about markets and standards) the higher the performance of their relationship with intermediary. In addition, interestingly, the interaction effect between intermediary's power and processor channel is significant and has a positive effect on the trading relationship performance.

As outlined in estimation subsection 4.3, to get further results validity, a machine learning approach is employed to model the relationship between the predictors and the relationship performance of farmer-intermediary. More specifically, the random forest is used for the modeling part and ALE method to visualise the effects (Apley and Jingyu, 2020). Figure 1 shows the results of this approach.

As can be seen from the Figure 1, the visualised effect produced through ALE from the random forest model converge with the results of the OLS estimation. Also, the inversed U-shape relationship between intermediary's power and relationship performance is visible. In addition, the positive association of farmers access to information and performance is again confirmed by this approach. Lastly, while the curve effect of selling to processor channel is straight (i.e. no effect), the interaction with intermediary's power shows a positive association with relationship performance.



**Figure 1.** Visualizing the effects of the factors affecting relationship performance with accumulated local effects.

## 6. Discussion

The literature has treated the role of power in business-to-business relationships in contrasting ways. Many authors view power as a negative phenomenon, which leads to conflict, distrust, uncollaborative relationship and low trading relationship performance as shown in the introduction and literature review sections of this paper. However, other authors (Dwyer *et al.*, 1987; Xhoxhi *et al.*, 2018) point out that power is a necessary mechanism to effectively coordinate an exchange relationship; without power there is ‘chaos’ – the power is vital, because it can take the relationship out of the realm of chance and give it purpose, order, and direction. This is particularly relevant in the context of a developing or emerging economy (like the case of Kosovo), where the enabling environment and public institutions fail to (properly) play the crucial role of guaranteeing (safety) standards in the market.

In such a context, the role and power of the value chain leader is crucial, to ensure compliance with quality and safety standards, especially for markets or products which are sensitive to quality (such as wine and export markets). Furthermore, the wine sector represents an interesting set of analysis, because wine is considered a quality product, and the quality of wine can be rewarded with far higher premium when compared to other agri-food products. Therefore, it is rational that the main effort of the value chain leaders or intermediary would be to exercise a level of power which maximises quality, since that can translate in higher prices and margins (potentially for all actors in the chain).

In this study it is shown that the relationship between power and relationship performance is not linear as assumed in most studies. Here, the results point out that when the intermediary has excessive power, it leads to low trading relationship performance with farmers (in line with the branch of the literature that has a negative view on power) (Bretherton and Carswell, 2002; Kumar *et al.*, 1998; Naudé and Buttle, 2000). Also, when the intermediary has little/no power, the relationship performance with farmers behaves in a similar way to when the intermediary possesses excessive power, whereas when power is within optimal (middle) levels, the relationship performance appears high (in line with the branch that has a positive view on power) (Dwyer *et al.*, 1987; Xhoxhi *et al.*, 2018).

The goal of the intermediary and the goal of the farmers form a shared goal as they are mutually and integrally linked in the agri-food value chain. With less stability and more conflict associated with the power asymmetry of the intermediary in the spot market, where there are large fluctuations in price and quantity of product of dispersed farmers, and where the customer is less sensitive to price than product quality, the intermediary stabilises the market and reduces price-induced farmer conflict, co-creating a community focused on increasing product quality and consolidating relational trust. This increased price benefits the intermediary as well as the farmers. In this case, the asymmetric power of the intermediary, driven by a shared goal, is more advantageous than if he were without power vis-à-vis the highly dispersed farmers. In turn, greater symmetry of power between farmers and the intermediary would favor the dominance of more farmers and less stability in this peculiar highly dispersed market of farmers.

Not only does the power of the intermediary co-create order in the market as a bridge between farmers and customers, but his asymmetrical power, by perpetuating relational trust, creates the prospect of his ‘power’ not controlling but co-creating partnership and trust in the community over a longer period than just the time of spot market transactions. The power of the intermediary in the community is not an attribute of his superiority but serves to perpetuate relational trust and co-create a value chain oriented towards the quality of the product and the price dependent on it, contributing to the improvement of the relationship performance.

Another interesting finding of the study is the interaction effect of farmers’ selling to the processor channel with the processor power level, which appears to have a positive effect on relationship performance. In other words, when the processors have high power, farmers selling to them experience higher levels of trading relationship performance. Consequently, since the quality of the final product of the processor is highly influenced by the raw product supplied by farmers, processors with large power influence farmers to produce



high quality grapes by influencing their production technology. In turn, by ensuring high quality grapes, a higher standard of wine is produced. Thus, the processors are in a better position to market their products, and thereby they also have a greater capacity to better pay farmers (e.g. in terms of price and timing of payment). This result is consistent with the broad quality-coordination relationship literature, which points out that more formal coordination is associated with higher product quality (Fernández-Olmos *et al.*, 2009; Fraser, 2005; Goodhue *et al.*, 2003).

Furthermore, compared to the producers of grapes, processors have more market information, i.e. they know which grape varieties and grape qualities are demanded. They translate this market knowledge into 'grape' production knowledge which is shared with the grape producers. Therefore, farmers are accepting them as 'expert' which can't easily be cheated. This result can be regarded as a source of power which has a positive connotation, (i.e. it does not hamper the relation between grape producers and grape processors).

On the other hand, retailers or wholesalers may often source grapes for lower quality and mass marketed wines, they may not be so critical regarding the grape quality; sufficient quantity and low cost is more of concern. Thus, they do not pay so much attention to quality control and prefer coordination mechanisms that dispose over a lower degree of vertical coordination, which results in a lower product quality (Goodhue *et al.*, 2003). Hence, typical traders have lower specific assets investments, and are less likely to establish long term relations with both buyers and supplying farmers, and thus may be more likely to behave opportunistically in relation with the supplying farmers. Similar result is found in Woods *et al.* (2011) and Franken (2014) pointing out that the degree of integration is significantly affected by specific investments.

Lastly, the findings show that farmers' access to information culminates in improved trading relationship performance with intermediaries. This result has implication for both policymakers and enterprises which are pointed out in the conclusion section.

## 7. Conclusions

There are differing views about the importance and effect of intermediary's power in relation to farmers – each of the previous studies tends to take a stand, considering (excessive) possession power as either 'good' or 'bad'. However, the importance of power should be discussed in the context of the specific country (including the country's enabling environment) and sector. In cases of developing or emerging (transition) economies, where enabling environment and public institutions fail to play the crucial role of guaranteeing (safety) standards in the market, the role and power of the value chain leader is crucial, to ensure compliance with quality and safety standards. Furthermore, the sector context is very important – in the case of commodities, which are limited in terms of increasing added value and prices, the intermediary's power may not be as crucial as it is for commodities (e.g. wine), where improved quality can result in significant increase of added value and prices.

Consequently, in the context of a weak institutional framework (government failure), free-market mechanism cannot function perfectly for distributing and allocating goods and for guarantying standards. A solution in this case would be the power of the value chain leader to coordinate the other agents to fulfill the common value chain goal.

The main contribution of this paper to the debate on the role of power in business-to-business relationships is that it points out an alternative explanation; stating that there is an optimal level zone that power needs to exist, in order to achieve above-average trading relationship performance. Outside this zone, either in the case of excessive/high power or in the case of little/no power, relationship performance deteriorates.

Indeed, it is rational – and further, it is a good investment for the processor to share part of the created added value with the farmers, to incentivise their growth and quality standards compliance. This is particularly

relevant for larger wine processors, because of the high cost of fixed investments and specific assets, which encourages them to think in the long term in relation to the suppliers as well as end markets.

The findings also show that farmers' access to information improves trading relationship performance with intermediaries. This implies that enabling better access to information among farmers through extension services or ICT platforms (e.g. with information about market prices, information and training materials on good agricultural practices) can improve farmers and value chain performance, which could lead to an amelioration of farmers' business and livelihood conditions. In addition, business practitioners (e.g. processors, exporters) who seek to achieve above-average performance should be sensitive about the sources they use for generating power (i.e. they should rather use 'position' and 'expert' power). Furthermore, they should provide information to farmers about quality standards, about specific harvesting packaging procedures to reduce post-harvest losses, and about potential markets and required varieties that can be explored in the future. They should explain and demonstrate to farmers why and how improved (grape and relatedly wine) quality enhances market access and enables better prices, which in turn can make both farmers and processors more prosperous. Thus, possessing and exercising an optimal level of power by quality wineries combined with information can result both in better wine and happier farmers.

The study has several limitations. First, the survey took place about six years ago and as such, there should be caution over its interpretation in the context of the current situation. Although there have not been more recent studies on the subject and chosen sector (in Kosovo), literature suggests that farm typology and main issues remain similar as in the past (Kostov *et al.*, 2021). Furthermore, the study is focused on one single sector and country – replication of this study to other contexts would yield more insight. Furthermore, the study relies on cross-sectional observations – panel data can provide deeper insights into the association between power and relationship performance. Lastly, the dependent variable relationship performance measured through a subjective measurement approach which might have some bias – future research work might consider more objective indicators such as product quality and post-harvest losses.

## Supplementary material

Supplementary material can be found online at <https://doi.org/10.22434/IFAMR2021.0143>

Table S1. Confirmatory factor analysis standardised factor loading.

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## Conflict of interest

The authors declare no conflict of interest.

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*Special Issue: Opportunities and challenges of EU farm-to-fork strategy*

## **Research and innovation challenges for better policies in food systems and bioeconomy transitions – evidence from Poland**

### **RESEARCH ARTICLE**

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### **Abstract**

Climate changes and depleting natural resources call for the urgent sustainability transition of the economy. This also refers to food systems, which are a vital part of the economy directly linked to the nature. The first step in creating better forward-looking policies for the transition of food systems is identification of knowledge gaps to target R&D spending. In the paper we focus on the presentation and analysis of research directions that constitute future challenges for the transformation of research and development in Poland. The methodology of research applied in the study is based on participatory action research philosophy. The approach to determine the research challenges and needs included round tables and focus groups under the BIOEAST initiative. The results show that the most important weakness is low level of R&D expenditure in bioeconomy sectors, while the strength is a large number of new active entities for implementation of innovations, supporting bioeconomy and science-practice cooperation. The key recommendation is increasing the R&D spending and prepare national bioeconomy strategy to make use of the large potential of the Polish bioeconomy sector.

**Keywords:** value chain, food systems, SWOT analysis, research and innovation, BIOEAST, CEEC, Poland

**JEL code:** M30, L22

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## 1. Introduction

Climate changes and depleting natural resources call for the urgent sustainability transition of the economy to meet Sustainable Development Goals (Sachs, 2012). This also refers to food systems, which are a vital part of the economy directly linked to the nature. Introducing new sustainable and circular processes in the food system requires intense R&D activities to create new solutions that ensure tackling the triple challenge facing food systems: food security and nutrition, livelihoods and environmental sustainability (OECD, 2021). The transition is an opportunity to improve the functioning of the food systems. The first step in creating better forward-looking policies for the transition of food systems is identification of knowledge gaps to target R&D spending where it is most needed (De Vries, 2021; McCarthy *et al.*, 2013).

The complexity of food systems, value-based dilemmas related to them and the necessity to answer long-term questions related to functioning of different elements of food systems call for deliberative process for public decision making as they are best suited for such problems (Chwalisz, 2020). This can help in creating policies that are accepted by a wide range of stakeholders. The challenge of transition of food systems and bioeconomy requires innovative approach that offers effective and inclusive empowerment of different stakeholder groups in process of shaping better policies. This is due to the nature of the bioeconomy, which is based on knowledge (and human resource) based production and the use of biological resources to provide products, processes and services in all sectors within the frame of a sustainable economic system. Food systems are a major contributor to the development of the bioeconomy, as they are the main provider of biomass as a material base and energy source for the economy. Nowadays, these two elements are closely interlinked, responding to the challenges of a changing climate and the need to implement a sustainable growth model.

In the context of the implementation of EU policies, including in particular those related to the implementation of the Farm-to-Fork strategy, research on research capacities as well as mapping of research and innovation needs for the positive transformation of food systems is crucial (Sonnino *et al.*, 2020).

In the paper we focus on the presentation and analysis of research directions that constitute future challenges for the transformation of research and development in Poland, in the context of the development of the whole macro-region of Central and Eastern Europe (Chmieliński *et al.*, 2021). The paper is structured as follows. The introduction addresses the main issues related to the subject of the study, the methodological part shows the collective approach and the logic behind the analysis presented. The analytical part includes on the one hand a general background indicating the potential of the sectors related to bioeconomy and food systems in Poland, and the characteristics of the research and innovation related sectors in the light of international statistics, followed by the results of own study, based on participatory approach for SWOT (strengths, weaknesses, opportunities and threats) analysis as well as a set of priorities for the development of the research and innovation (R&I) sector in Poland, identified by the multi-actor group of experts. The results of the study are followed by the conclusions.

## 2. Data sources and methodology

We used a mix-method design of our study. The methodology of research applied in the study is based on participatory action research philosophy often applied in social sciences (Bergold and Thomas, 2012; Masson *et al.*, 2021; Sautier *et al.*, 2017). It is a reflexive process, where the next step is conducted after a critical analysis of both results and process leading to these results. This approach also helps to bridge the gap between theory and practice (Moote *et al.*, 1997).

The approach to determine the research challenges and needs included round tables and focus groups organised by the Thematic Working Group on Food Systems under the BIOEAST initiative (Chmieliński *et al.*, 2021; Horváth, 2019; Vásáry, 2019), with the participation of the representatives of Polish Ministry of Agriculture and Rural Development and Ministry of Science, as well as research institutes, NGOs and other entities (n=187). The analysis of research and innovation needs in Poland was a summary of consultations among

a group of researchers and experts representing Polish Research Institutes and departments in particular public administration units. Similar studies conducted in other central and eastern European countries (CEECs) under the H2020 BIOEASTsUP project<sup>1</sup> allow not only to identify challenges from a multi-actor perspective, but also allow comparisons of the results with other countries of the region. The application of the participatory method to the countries of our region not only allows for a better identification of the problems and challenges facing food systems in the future, but also makes it possible to relate these problems to other research conducted at EU level. Such work results in the inclusion of the most pressing problems in EU research programmes, and it is with this intention that the survey described in this study has been conducted.

The systemic approach to identify challenges and problem themes for future research and innovation in CEECs, including Poland, involved a triangulation of research methods based primarily on the participatory method. Developing future topics that will advance the transformation of food systems, as well as bioeconomy is a task based primarily on the experience of various expert groups, including not only the administration shaping public policy, but primarily scientists and representatives of practice and entrepreneurs (Juhász and Vásáry, 2017).

The study was conducted in stages. In the first stage involved the analysis of the strategic documents, as well as documents developed by Polish administration and scientific units, mapping the themes and research needs for R&D in agriculture and bioeconomy sectors for joint strategic planning in CEEC macro-region, and also as a Poland's and BIOEAST inputs, as a suggested topics for the Horizon Europe Work Programme 2021 – *Cluster 6 'Food, Bioeconomy, Natural Resources, Agriculture and Environment* (Ministry of Agriculture and Rural Development (MARD), 2016). The approach to defining the topics involved a group of experts, who made a first, preliminary catalogue of research and innovation issues, and then agreed with representatives of the Polish research institutes working in the field of agriculture, rural development and food systems. In February 2021 a validation meeting among Poland's research institutes and representatives of ministries, experts and practitioners (n=187) was organised to discuss and prioritize specific SWOT elements and to identify Research and Innovation Needs for food and bioeconomy sectors in Poland. Finally, a subsequent expert workshop (with active participation of 81 experts and direct input from 58 participants) identified key characteristics to prioritise and rank challenges and opportunities and to sort out the different food systems related R&D characteristics (Chmieliński, 2021). The distribution of respondents according to the type of institution/entity they represented was as follows:

- industry / business or business association – 13.8%;
- academia/research institution – 63.8%;
- government – 19.0%;
- other – 3.4%.

The study included a synthesis of other activities aimed at mapping research and innovation needs for the formulation of national guidelines for EU framework programmes, and research to identify challenges for science and practice in agriculture and food systems. The main research material was obtained by conducting interactive online workshops using the interview method and structured online questionnaires (used in discussion, for structured collection of opinions and information in real time), thus bypassing the organisational problems associated with COVID-19.

<sup>1</sup> Project 'Advancing Sustainable Circular Bioeconomy in Central and Eastern European Countries' is a project funded through the European Research and Innovation programme, Horizon 2020, for the duration of three years (October 2019 to September 2022), see: [www.bioeast.eu](http://www.bioeast.eu).

### 3. Results and discussion

#### 3.1 Agriculture and food sector in Poland

Food sector is an important part of the Polish economy, while the strength of the food economy is based on cooperation in the food chain, although agriculture plays a key role here in terms of organisation and structure of biomass production. With economic development, the share of agriculture in the structure of the national economy in Poland is decreasing in favour of non-agricultural sectors, especially industry and services. The development possibilities of agriculture result to a smaller and smaller extent from endogenous conditions of this sector, and depend more and more on the general economic situation and the macroeconomic policy. This is mainly due to the changing role of the food sector in national economies. The productive and non-productive functions of agriculture for the economy, society and natural environment require close interactions of this sector with other sectors of the economy. Moreover, the supply and prices of agricultural products are subject to stronger fluctuations than most other products on world markets. This process has been intensified as a result of globalisation processes (MARD, 2019).

The share of agriculture in the creation of GDP and employment in economically developed countries has decreased to 1.4% (in Poland the share of agriculture in the creation of GDP amounts to 3%, and in employment in the agri-food sector to about 10%).

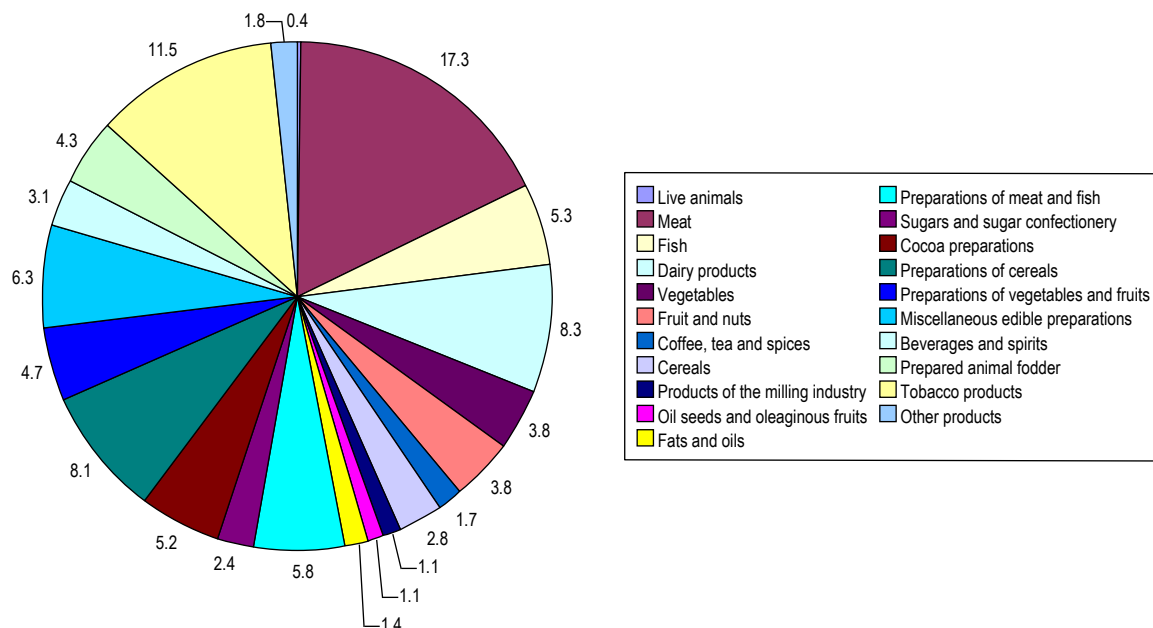
The productivity of Polish agriculture is increasing, decreasing the gap in relation to the results obtained in the EU, however, structural problems in this respect include mainly the fragmentation of Polish agricultural holdings, the average size of which in 2020 amounts to slightly more than 11 ha. Despite significant progress, the productivity of Polish agriculture is lower than in leading EU countries, e.g. the yield of Polish cereals per 1ha is equal to the level that France and Germany achieved in the 1970s (MARD, 2019). Opportunities for improvement in this regard are associated with the possibility of scientific and technological progress and the degree of absorption of innovations in the food sector.

Agriculture is naturally an important part of the Polish food system. After the EU accession the Polish agriculture started to develop rapidly (Table 1). This is reflected also in the increase of the Polish share in the EU agri-food export. In 2008 it amounted to 3.4%, while in 2018 it reached 5.7% (Wigier *et al.*, 2021). However, the share of meat – 17.3% and dairy products – 8.3% (Figure 1) can be a barrier for further growth with the changing consumer preferences and the European Green Deal leading to include agriculture in the effort of reducing GHG emissions.

The food industry in Poland is one of the most successful in the period of social and economic transformation and Poland's membership in the EU. Food manufacturing companies have made numerous investments to bring their plants up to world standards and to reduce the technology gap. These activities have turned the food industry from traditional and labour-intensive to modern. The high technological level of food processing makes the Polish food industry considered to be one of the most modern in the EU. The food industry (including the tobacco industry) in Poland generates about 3% of the GDP and employs about

**Table 1.** Output of the Polish agricultural industry – basic and producer prices (in million Euro) and change 2019/2009 (in %) (Kowalczyk, 2021).

Year	Value
2009	17,461
2013	23,669
2019	26,358
2019/2009	151



**Figure 1.** Commodity structure of the Polish agri-food exports (based on Kowalczyk, 2021).

420,000 people (full-time equivalents), which constitutes about 18% of the labour resources in industrial processing in the country. It should be emphasized that the value of sold production of the food industry in 2004-2018 more than doubled in current prices (to about 62 billion Euro), and in constant prices it increased by almost 80%. Its growth rate (in current prices, 6.2% per year on average) was higher than GDP, but slightly lower than industrial production (6.8%). The food industry is one of the few sectors of the economy with a positive balance of trade exchange, which has been successively increasing after Poland's accession to the European Union. Already over 40% of articles produced in the domestic food industry are directed for export (Szczepaniak *et al.*, 2020).

The production capacity far exceeds the needs of the Polish market. The Polish food industry is among the most modern in the EU. Therefore, it exports much to other EU countries as well as to third countries. In 2019 export amounted to app. 44% of the value of sold production of the Polish food industry with the level of production capacity utilization at 80% (Szczepaniak *et al.*, 2020). The concentration in the sector is relatively small. In 2018, among app 16.9 thousand companies 91.8% were micro and small companies. However, their share in sales amounted only to 16.8% (Szczepaniak *et al.*, 2020). Poland is an important producer of food in the EU. In 2018 its share in the value of sold production of the food industry in the EU-28 amounted to 9.1% and its share in the employment in food industry reached 9.4% (Wigier *et al.*, 2021).

Polish food system needs development of e-services in agri-food trade. Much needed is also development of programmes to raise awareness and educate agricultural producers on the principles and elements of a circular economy.

### 3.2 Research, development and innovation expenditure in food and bioeconomy sectors

Poland suffers from a low level of R&D expenditure in food and bioeconomy sectors. The situation further deteriorated in the COVID-19 pandemic and even in the highly-developed food industry the level of investment was in 2020 significantly lower than in 2019 (Szczepaniak *et al.*, 2020). Ensuring sustainable food production requires human and financial investment – innovation, skills and technological change.

The position of Poland in the region and in the EU is shown by the European Innovation Scoreboard (European Commission, 2020), according to which innovation performance is improving in all EU countries. On average, EU innovation performance has increased by 12.5 percentage points since 2014 (BIOEAStsUP, 2021). In terms of regional variation in innovation indicators, the phenomenon of convergence persists in the EU, with lower-performing countries growing faster than better-performing countries, thus narrowing the innovation gap. According to the Regional Innovation Scoreboard (European Commission, 2021), this trend also applies to innovation in individual EU regions. Based on the results obtained, EU countries are divided into four groups, depending on the value of the synthetic indicator: Innovation leaders, Strong innovators, Moderate innovators, Emerging innovators. Sweden remains the EU innovation leader, followed by Finland, Denmark and Belgium, all with innovation scores well above the EU average (Lopes *et al.*, 2021).

Poland was among the emerging innovators and strengths include digitalisation, intellectual assets and the use of information technology. Among the top three indicators are design applications, population with higher education and environmental technologies. In contrast, Poland has an above-average share of non-innovators without a propensity to innovate and scores below average on indicators related to climate change.

Data from the RIS (2021) show that five Member States have improved their score by 25 percentage points or more (Cyprus, Estonia, Greece, Italy and Lithuania). Four Member States recorded an improvement in performance of 15-25 percentage points (Belgium, Croatia, Finland and Sweden). In eight Member States the performance improved by 10-15 percentage points (Austria, Czech Republic, Germany, Latvia, Malta, the Netherlands, Poland and Spain). The remaining 10 Member States recorded an improvement of 10 percentage points or less.

On a regional basis, innovation performance has increased in 225 regions out of 240 EU regions since 2014. The most innovative region in Europe is Stockholm in Sweden, followed by Etelä-Suomi in Finland and Oberbayern in Germany. Hovedstaden in Denmark is fourth and Zurich in Switzerland is fifth. In Poland the most innovative regions are Warsaw Capital Region (Moderate Innovator) and Małopolska (Moderate Innovator). There has been a process of convergence of regional performance over time, with differences in performance between regions narrowing.

Globally, the EU still performs better than its competitors, such as China, Brazil, South Africa, Russia and India, while South Korea, Canada, Australia, the USA and Japan maintain their lead over the EU. Comparing the EU average with selected global competitors, South Korea is the most innovative country, scoring 36% higher than the EU in 2014 and 21% higher than the EU in 2021.

The European Innovation Scoreboard 2021 (European Commission, 2021) already includes elements that are important for both the development of food systems and the overall transition towards a bioeconomy. These include new indicators on digitalisation and environmental sustainability, bringing the scoreboard more in line with EU priorities outlined in the European Green Deal and Farm to Fork Strategy.

Research and development activity of Polish enterprises is considered low and cooperation between enterprises and science is underdeveloped. This is true for all sectors of the Polish economy in general, but especially for the food and beverage industry, where R&D expenditure in relation to value added is 0%.

Poland has the status of ‘moderate innovator’ in the European Innovation Scoreboard (European Commission, 2020) with innovation performance below the EU average and ranking 24<sup>th</sup> among the 27 EU countries in 2019. Poland has an innovation performance advantage over Romania, Bulgaria and Croatia and an innovation performance gap with the other seven CEE EU countries.

In 2018, Polish R&D intensity was 1.21% of GDP, which is less than half of the EU Europe 2020 target of 3% and almost half of the EU27 average (2.2%). There is a need to increase both public and private investment in R&D in order not to lag behind in the EU’s green transformation process.

In Poland, gross expenditure on research and development (GERD) as a share of GDP (commonly referred to as national R&D intensity) is increasing from 0.64% in 2000 to 1.21% in 2018. This share is significantly lower than the 3% target set by the Europe 2020 strategy for the EU28 as a whole and lower than Poland's planned target of 1.7%. R&D intensity in Poland is almost half lower than the EU27 average (2.2%) and is significantly lower compared to innovation leaders with developed innovation systems, such as Sweden (3.3%), Denmark (3.0%) or Finland (2.8%). In the group of Central and Eastern European countries, Poland is also below the average of other countries in terms of R&D intensity: Slovenia (1.9%), Czech Republic (1.5%), Hungary (1.5%) and Estonia (1.4%) (EUROSTAT, 2021).

Within the reported industries classified as fully or partially bioeconomy (Figure 3), Polish business R&D activity is low in all reported fully and partially biomass and biobased industries in terms of the ratio of R&D expenditures to value added (business sector R&D intensity) – ranging from 0% in the production of food and beverages to 0.50% in the production of paper and paper products excluding pharmaceuticals (14.9%) in 2017. Significantly lower business R&D expenditures per value added (less than 0.1%) were recorded in industries such as manufacture of wood and wood products (0.03%), textiles, clothing and leather (0.04%), manufacture and supply of electricity, gas and water (0.07%), manufacture of furniture (0.08%). The highest increase in R&D intensity is observed in the manufacture of paper and paper products (from 0.08% in 2010 to 0.50% in 2017). In some industries, such as the production of food and beverages, agriculture, forestry and fishing, the production of chemicals and pharmaceuticals, R&D intensity decreased.

The Polish R&D and innovation system has seen rapid development over the past two decades. In real terms, between 2000 and 2018, the total expenditure on R&D (GERD) increased significantly – from PPS 2,486.3 million to PPS 9,107.5 million (in constant 2005 prices). It should be pointed out that over the long term (2000–2018), R&D expenditure grew at an annual rate of 7.48%, compared to 2.8% in the EU27 (BIOEASTsUP, 2021).

In terms of the share of product and/or process innovation enterprises involved in the cooperation with scientific partners, the cooperation of business with science in Poland was the most active in the field of production, transmission and distribution of electricity (35.9%) and production of gas and distribution of gaseous fuels (20%). A slightly different situation occurs in the case of cooperation with governmental or public scientific entities. The highest cooperation is shown by enterprises dealing with gas production and distribution of gaseous fuels (20%), pharmacy (11%) and production, transmission and distribution of electricity (10.3%). The lowest cooperation of enterprises with universities is observed in the production of furniture (2.6%) and in the production of food, beverages and tobacco products (2.4%). The cooperation in the production of food products, beverages and tobacco products is also relatively low (1.8%).

The relative importance of factors preventing or hindering innovative activities of enterprises varies within Polish industries, which are wholly or partially included in the bioeconomy. According to the 2016 Community Innovation Survey (CIS) – the last one for which data is available – fully bioeconomy industries are most often hampered by lack of external funding, low market demand and lack of collaboration partners. These factors are also most important for the production of chemicals and electricity, gas, steam. The biggest constraint in the production of textiles, clothing, leather is the lack of good ideas. In the production of pharmaceuticals, in addition to the lack of external funding, the other most important constraint is uncertainty due to legislation/regulation (BIOEASTsUP, 2021; Szczepaniak *et al.*, 2020).

Transformation of the Polish food systems requires changes in every element of the food chain. This also applies to consumers and their dietary habits and preferences. The above analysis provided the background for a participatory approach involving researchers, practitioners, experts and representatives of public administration to work together to identify good and weak points as well as opportunities and threats for the development of a research and innovation system in Poland in the field of food systems, as part of creating a bio-economy.

### 3.3 Poland's bioeconomy and food systems related research and innovation

The analysis of Poland's bioeconomy-related research and innovation included the SWOT analysis as well as identification of actions necessary to overcome weaknesses (internal factors) and threats (external factors) and recommendations boosting for bioeconomy related RDI in Poland. The process of preparing the SWOT table was preceded by an analysis of the development characteristics of agricultural and food systems in Poland, going beyond a simple approach to food production, but as an element of a broader approach to supporting the development of bioeconomy sectors.

In the area of strengths, a growing number of actors in the economy were identified and pointed out, both on the part of businesses seeking new areas of activity, but above all a growing number of representatives of the civil society sector (NGOs) and consumer representatives, actively supporting food transformation from the point of view of changing food composition, production techniques and its assortment so as to respond to the growing need for dietary change among consumers (Table 1). The potential in terms of active actors in the food chain as well as pro-consumer organisations (including short and alternative supply chains) is complemented by a growing scientific capacity, its participation in EU research programmes, which results in a sustained contribution to the pan-European debate on the food systems of the future (De Vries, 2021). This has a very practical dimension, as the investment gap in this area – discussed in more detail earlier – creates new opportunities to fund new directions for research and innovation. This is reflected in the programmes implemented in Poland for the development of bioeconomy and food systems. One of them is BIOSTRATEG, the programme aimed in increasing of innovation and competitiveness of Polish economy, particularly in agricultural-food and forestry and related industries (Chylek, 2014). The program covered five strategic problem areas in line with the priority research directions currently carried out in the European Union and worldwide. These areas are:

- food security and food safety;
- rational management of natural resources with particular emphasis on water management;
- prevention and adaptation to climate change, with particular emphasis on agriculture;
- protection of biodiversity and sustainable development of agricultural production space;
- forestry and wood industry.

The scientific policy also supports the expansion of technology transfer units and serves to improve the situation at the level of primary production, including in particular the access of farm managers to specialised knowledge offered by agricultural advisory services.

Weaknesses include the still low investment in research and development, especially in modern areas of the food economy, which currently need increased investment in research and innovation. Differences in this respect reflect the gap that CEE countries in general have in comparison with western EU countries. The low level of internationalisation of research and the emphasis on the commercialisation of research results still characterise the Polish R&I sector, which is why there is both a decreasing number of scientists in general and a relatively large group emigrating to countries that offer better salary conditions and a more modern approach to the area of development and research on sustainable food systems.

The opportunities for the development of the research and development sector include above all a fundamental shift in EU policies towards the implementation of the European Green Deal paradigm. It should be emphasised here that for countries with a relatively traditional structure of agriculture (with a large share of small and medium-sized farms), the change of philosophy based on economies of scale to one in which natural resources (and land) are substituted with modern technologies, is a chance to change with the use of existing resources (mainly biomass) or with activities related to agriculture, e.g. aiming at the production of clean energy or ecological products.

In this respect, cooperation is important, not only between the scientific community at home and internationally (such as within the Horizon Europe programme), but also within the food chain. Producers are getting

**Table 2.** SWOT analysis of Poland's bioeconomy and food systems related research and innovation (R&I).<sup>1</sup>

<b>Strengths</b>	<b>Opportunities</b>
<ul style="list-style-type: none"> <li>• A large number of new active entities for implementation of innovations, supporting bioeconomy and science-practice cooperation.</li> <li>• Strategic documents, roadmaps, policies on bioeconomy.</li> <li>• Strategic programmes related to bioeconomy financed from public funds.</li> <li>• Highly qualified scientific personnel.</li> <li>• Knowledge of advisory services and scientists.</li> <li>• Highly qualified and experienced personnel in business.</li> <li>• Potential to develop R&amp;D laboratory facilities.</li> <li>• Strong private and commercial technology transfer units.</li> <li>• High innovative potential of Polish ICT companies.</li> </ul>	<ul style="list-style-type: none"> <li>• Increasing level of implementation of new solutions for biomass production and use in Poland.</li> <li>• Increasing global demand for innovations in new products of bioeconomy sectors.</li> <li>• Creating new measures of development in the light of the Green Deal paradigm.</li> <li>• Increasing business expenditure in science, technology and innovation.</li> <li>• New AKIS developed under the new CAP.</li> <li>• New EU policies, including the CAP and policy changes related to Green Deal and Farm-to-Fork Strategy.</li> <li>• Growing number of cooperation initiatives between science and policy makers – hub, technology centres, clusters.</li> <li>• International initiatives in which Poland participates (e. g. BIOEAST).</li> <li>• New education programmes (new university courses and training modules for adults).</li> <li>• Promoting and enhancing cooperation between entities involved in knowledge creation process, e.g. cooperation platforms, Horizon 2020, research networks.</li> <li>• Demand from practice for specialists and new skills in bioeconomy.</li> <li>• Participation in international cooperation and new exchange programmes in science and education at all levels.</li> <li>• New additional sources of EU funding for research development under Green Deal.</li> <li>• Global climate programmes and initiatives (such as FAO, Paris Agreement, etc.)</li> <li>• Cooperation with new actors in bioeconomy.</li> <li>• Increase the internationalisation of research.</li> </ul>
<b>Weaknesses</b>	<b>Threats</b>
<ul style="list-style-type: none"> <li>• Low level of R&amp;D expenditure in bioeconomy sectors.</li> <li>• Low overall spending on R&amp;D.</li> <li>• Decreasing human resources in R&amp;D.</li> <li>• Insufficient cooperation of science with business environment institutions.</li> <li>• Lack of direct commercialisation support projects.</li> <li>• Low level of commercialisation of research results.</li> <li>• Relatively low internationalisation of research.</li> </ul>	<ul style="list-style-type: none"> <li>• Lower (price) competition for production in bioeconomy-related sectors compared to conventional production.</li> <li>• Global economic slowdown.</li> <li>• Wrong measuring of country's development (using traditional categories, such as GDP).</li> <li>• Changing national policy priorities with regard to bioeconomy sectors.</li> <li>• Low level of public spending related to research.</li> <li>• Low recognition of universities and research institutions in the international arena.</li> <li>• Strong negative influence of agricultural lobby organisations on political decisions.</li> <li>• Lack of experienced and skilled central public administration representatives (policy makers).</li> <li>• Lack of setting the bioeconomy development as a main goal of strategic programming.</li> <li>• Persistent restrictions in national spending on scientific activities.</li> <li>• Unfavourable demographic trends.</li> <li>• Limited number of high-quality researchers meeting high standards of scientific work.</li> <li>• Failure to increase the level of internationalisation of research and participation in research consortia.</li> </ul>

<sup>1</sup> CAP = EU common agricultural policy; AKIS = agriculture knowledge and innovation systems.



closer to consumers, and other actors in the chain are increasingly including sustainability and food in their marketing strategy in line with a healthy diet, but also biobased products and policies against food waste. In this case, the approach in Europe is not regionally differentiated, unlike in the academic research and development sector, companies act uniformly in terms of their response to environmental and climate challenges. This is linked to consumer awareness and demand oriented towards providing specific added value to solve global challenges.

The realization of the vision and assumptions of the transformation of food systems, as well as the whole economy, towards their sustainability faces a number of risks, identified in the research process (Table 2). One of the fundamental threats is to remain on the hitherto path of development, which we developed after World War 2, and which traditionally perceives the food economy only as functions of cheap food production, with limited concern for the environment, as a public good requiring valuation and inclusion in production costs. This may happen if consumer awareness and the quality of food demand do not result in a transformation of the supply side, i.e. of each element of the food chain. Apart from consumer awareness and willingness to pay for public goods and access to better quality food, the most important is the public policy framework, both at the EU and state level, promoting the paradigm of sustainable food systems, modern use of biomass with emphasis on reducing food waste, adulteration eggs and waste management. At the same time, it is important to pursue a skillful scientific policy promoting the internationalization of research, cooperation with business towards dissemination of implementations, as well as basic research on the limits of development, resources and intensification of work on the possibilities of solving global problems at the local level.

### *3.4 Recommendations boosting for bioeconomy related R&I in Poland based on SWOT and needs*

The SWOT analysis allowed, in the next stage, to define the main areas in which intensive efforts should be made to actively support the development of research and innovation for food systems and economic development (Table 3).

Financing research and innovation is the main factor supporting positive transformation of food systems not only in Poland, but in all countries of the region. CEECs constitute a group of countries in which expenditure on science has always been significantly lower than in other EU countries. Furthermore, the promotion of research that goes beyond a sectoral approach to the perception of the economy may contribute to a more comprehensive approach to food production and use, as well as to the various possibilities of using non-food biomass in non-agricultural sectors of the economy. The definition of the bioeconomy points to going beyond a sectoral approach, which may contribute to facilitating the development of interdisciplinary research that looks at economic, social and environmental systems holistically.

According to the participants in the study greater attention is recommended for the preparation of a national strategic research and innovation agenda in the area of primary production, food chains, consumer education and research infrastructure could help to boost bioeconomy sectors. This includes both understanding of the bioeconomy at business, scientific, governmental and consumer levels, better use of the education system at all levels, as well as concrete actions to support new business models, innovation, digitalization of processes in sectors related to agriculture, forestry and fisheries.

Above all, a positive transformation requires an absolute increase in investment in research, strengthening human resources while promoting the best and the young. Equally important is AKIS' focus on supporting the development of agriculture as a provider of biomass, the guarantee of rural resilience and the equitable distribution of benefits from the modern value chain.

**Table 3.** The assessment of the factors of the development of food systems and bioeconomy-related research and innovation (R&I) in Poland.<sup>1</sup>

<b>Bioeconomy-related research and innovation needs (research sector and organisation)</b>	<b>Average (score 1-5)</b>
Increased investment in R&D in bioeconomy sectors	4.5
Promoting interdisciplinary research and development cooperation	4.4
Increase understanding of the bioeconomy at business, scientific, governmental and consumer levels, better use of the education system at all levels	4.3
Optimise processing technologies, reducing food waste	4.3
Methodologies and technologies to reduce biomass and waste losses in production	4.3
Development of knowledge and technology for the creation of new, high quality local products	4.2
Methods of digitising production processes in agriculture and public services in rural areas	4.2
Coherent and planned research funding, based on long-term strategic planning	4.0
Develop programmes to raise awareness and educate agricultural producers on the principles and elements of a circular economy	4.0
Programmes to attract young people to science and advisory services	4.0
Promotion of commercialisation of research results	4.0
Ensure sustainable food production through human and financial investment – innovation, skills and technological change	4.0
Putting into practice state-of-the-art preservation technologies (with special attention to environmentally friendly packaging, storage conditions, etc.) to extend the shelf life of raw materials and the durability of final products.	4.0
Methods for developing and mapping sustainable short food chains, initiatives and new green business models in food processing, wholesale, retail and food service	4.0
Better use of the opportunities offered by the European Research Area by universities, institutes and companies	3.8
Develop incentive schemes for advice and science to increase commitment to general knowledge transfer and voluntary data sharing	3.8
Promote the development of bio-clusters, development of cross-sector collaboration initiatives and multi-level science and practice	3.7
Effective transfer and adoption of digital technologies in agriculture and rural public service infrastructure	3.7
Development of principles for effective implementation of crop diversification technologies	3.7
Development of e-services in agri-food trade	3.5
Research to reduce digital exclusion among farmers and the rural population	3.5
Integrated bioinformatic system for the management of genetic resources of livestock breeds and crop varieties	3.5
Development of data bases for decision support systems for climate change adaptation in rural areas	3.4
Increasing funding and improving the status of public research institutes	3.4
Identify and identify opportunities for dissemination of ICT solutions for actors in bioeconomy sectors	3.3
Focus on business models and governance using digital tools, artificial intelligence and robotics along the bio-product value chain	3.2

<sup>1</sup> Own compilation based on responses (n=58).

## 4. Conclusions

Food sector and bioeconomy are an important part of the Polish economy. Therefore, their future prospects to a large extent determine the long-term economic situation of Poland. Strengthening public and private R&D is necessary for a successful transition of the food systems and bioeconomy in Poland and other CEECs. Further promotion of co-operation between business and science as well as international co-operation is also vital for bioeconomy's development.

We argue that greater attention is recommended for the preparation of a national strategy in the area of agriculture and other bioeconomy sectors with the aim to strengthen the development of RDI sector. This includes both understanding of the bioeconomy at business, scientific, governmental and consumer levels, better use of the education system at all levels, as well as concrete actions to support new business models, innovation, digitalization of processes in sectors related to agriculture, forestry and fisheries. A systemic approach to the formation of bioeconomy sectors, with a particular focus on food systems development, will require investment in the creation of correct institutions based on human capital and knowledge transfer. The development of innovation and knowledge systems (and AKIS in particular) is an opportunity for primary producers, who gain not only as providers of biomass to different sectors of the economy, thus creating a sustainable basis for the local economy, but also allows for an equitable distribution of benefits from the modern value chain.

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*Special issue: Opportunities and challenges of EU farm-to-fork strategy*

## **Operationalizing circular economy. Reflections on a by-product upcycling value chain construction in the brewing sector**

### **RESEARCH ARTICLE**

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### **Abstract**

The concept of a circular economy has arisen in response to the problems related to the limits of the dominant linear economic system in contemporary societies and of the finite resources of our planet. The transition from waste status to a raw material by reusing it makes it possible to modify its value for future users and thus to redistribute this value. This article focuses on the case of spent grain to illustrate the role of the circular economy in food transition. Bases on a series of interviews, the paper discusses business modeling to operationalize sustainable development in the food sector and presents a discussion and conclusion on the advantages and limitations of the deployment of the circular economy in the brewing industry, taking into account and understanding the interests and constraints of various stakeholders.

**Keywords:** circular economy, by-product, sustainable development, upcycling, brewer's spent grain  
**JEL codes:** L23, L21, Q01, Q56

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## 1. Introduction: food and the circular economy

The implementation of a circular economy is based on a stable economic system guaranteeing the reuse of materials such as biowaste with a view to achieving convergence between economic and environmental performance (Fercoq, 2014). While some research shows a certain convergence (Antheaume and Boldrini, 2017), it comes up against sociocultural, legal or organizational obstacles in the project implementation phase.

However, the agrifood industry is still poorly represented within the institutional framework of the circular economy. While its standards can be transposed in the same way as for any other economic sector, issues related to food production require special treatment, particularly with regard to economic burden, public health, territorial development, environmental impacts and consumer perception/acceptance. Indeed, there are strong constraints and specificities inherent in the agrifood sector, essentially linked to the seasonality of production and consumption, the perishability of agricultural products and the variability of their yields due to climatic hazards (Notarnicola *et al.*, 2017). These constraints have a strong impact on the organization and on the location of productions and transformations. Thus, in value chains, the adoption of technologies that facilitate sourcing and processing is a major issue. The application of these technologies determines the organizational modalities through industrial standards that ensure coordination among actors. The actor who is able to enforce a standard, or control the global level of quality, is often in a strong position and manages the entire food chain (Jacobides and Winter, 2005). The circular economy approach in the agrifood sector is therefore limited, on the one hand, to organic waste recovery from a market diversification perspective and, on the other hand, to addressing food waste from an economic and social sustainability perspective (Rousselière *et al.*, 2022).

Substantial upgrading must take place to limit the biosphere withdrawals flows entering the system and produce less waste that leaves the system (Braungart *et al.*, 2007; El Hagggar, 2010; Niero and Hauschild, 2017). This article focuses on the case of spent grain, in Nantes and Québec basins.

After a literature review on major challenges and issues of the circular economy in the food sector, the case of the brewing sector and the methodology bases on semistructured interviews will be presented. The results section focuses on brakes and levers for operationalizing the circular economy with spent grain. and the discussion the discussion sheds light on understanding the interests and constraints of various stakeholders thanks to the synthetic contribution of a business model built on the basis of the material collected during the interviews.

## 2. State of the art

The circular economy is frequently approached from the point of view of waste management of upstream economic actors on the one hand and from the perspective of supply and demand and the behavior of downstream economic actors on the other. An entry into the circular economy can involve a reflection on the use and consumption of upcycled resources while simultaneously taking into account the organizational, economic and managerial issues of the actors who generate resources previously considered waste. Indeed, the consumption of 'ex'-coproducts can be considered a virtuous and responsible mode of supply, aiming to ultimately meet the expectations of a user of the finished product or not, whether he or she is the final consumer or an economic player further down the value chain. In all cases, the finished product must be of global quality to an equivalent finished product made from nonrecycled raw material. This product must therefore respond to issues of conventional quality and better environmental impact and even social performance. This product from a circular value chain is therefore more eco-efficient than a conventional product. This is the case, for example, for products with an extended product life produced through more efficient sorting, better equipment maintenance, repairs or donations. It can also be achieved through the substitution of products by others, requiring less material or energy for its production or use, an eco-designed product, or the replacement of a product with a service. Another type of practice concerns the reduction of consumption: reduction of acquisitions, reduction of superfluous purchases, reduction of uses, reduction of

the frequency or quantity of products used, and reduction of rejected products by avoiding waste. Exchange or sharing measures associated with cooperation or pooling, self-production, reduction of intermediaries or actors in a value chain, with the aim of reducing the stages of transport, can also be targeted. These reduction behaviors are associated with principles of moderation, technology transfer, and even decreased consumption.

By optimizing the consumption of resources and minimizing discharges, the application of the principles of the circular economy to production-distribution systems results in the reduced flow of matter, water and energy. Its corollary effect is the redesign of the life cycle of a product 'from cradle to cradle' (Desvaux, 2017). To reinforce the idea of closed loop production and consumption systems, tools for measuring, analyzing and optimizing material flows can be used to upcycle waste into new resources (Piña and Martínez, 2014). To complete the flows, waste management takes on particular importance because it allows, via recovery policies based on the '5 Rs' (Reduce, Renew, Replace, Reuse, Recycle), to limit the need for natural resources (Lanoie and Normandin, 2015). However, the circular economy is not just about closing a loop and organizing a reverse supply chain to recover waste. Indeed, circularity modifies the value attributes of products, upsets the mechanisms of creation and distribution of value and can cause major strategic, organizational and cultural changes. In its broad understanding, the circular economy must take into account the protection of the environment and living organisms by preventing the emission of toxic substances. This principle is called sealing. Intensification then makes it possible to dematerialize products and services to increase the productivity of the resource by limiting the need for necessary resources. Finally, the functional economy makes it possible, by substituting the sale of a product for the sale of its use (Mont, 2002), and by promoting only the necessary adequacy between supply and need, to limit the consumption of resources while satisfying the needs of users. Finally, the last step consists of decarbonizing or producing energy with less fossil carbon, developing renewable energies and controlling energy consumption.

The circular economy therefore sets itself the objective of increasing the profitability of an economic activity (McDonald *et al.*, 2016). Advantageous for all and potentially leading to customer loyalty, this production model can allow companies to stand out in a market in constant tension due to the volatility of the price of resources. Based on the fundamental principle of the sustainability of societies, its implementation is based on the search for a system with looped circulations, which maintains a stable use of matter and energy. The deployment of the circular economy must also include social and political dimensions, taking into account the expectations of different stakeholders and their practices. However, questions about the real impacts of circularity, the keys to distributing the value of resources, the organizational capacities of companies and the cognitive frameworks of actors are still relevant. Very virtuous in theory, the circular economy model is slow to be deployed compared to other economic models. This latency could be due to the potential 'rebound effects' that can be generated when the initiatives are operationalized (French Local Authorities Association, 2020). On the other hand, more fundamental limits can be linked to the substitution of resources or to the entropy of recycling. The model must now be enriched with more sectoral case studies.

Our study therefore focuses on the operationalization of the circular economy. It seeks to understand the implications of the implementation of the circular economy in the food industry by identifying the brakes and levers that would persist for the different actors involved.

Breaking with the current linear vision of food value chains and seeking to complete the nutrient cycle, two types of resources must be used according to the French Transitions Agency: human excreta (urine and nutrient matter) and organic waste or 'biowaste'. A study (Desvaux, 2019) identified four levels of action to limit losses:

1. make public establishments examples of excreta recycling;
2. install excreta collection equipment;
3. structure a sector for agricultural recovery of human excreta in the territory;
4. recycle biowaste.



This study examines the fourth lever of action. The management of biowaste produced at each stage of the food chain is essentially linear. Companies that produce a large quantity of biowaste have an obligation to sort it and have it recovered in suitable channels (Albert *et al.*, 2018). The thresholds have been gradually lowered; today, the requirement applies to professionals producing more than ten tons of biowaste per year (Bletzacker *et al.*, 2009). Restaurant owners are struggling to comply with this regulation, and this threshold remains high. Organic waste constitutes a quarter of household waste, or approximately 150 kilograms per year and per inhabitant. The vast majority are incinerated or landfilled, and the nutrients they contain are lost (Redlingshofer *et al.*, 2019). Circular management of biowaste is still insufficiently generalized.

In France, food waste represents 10 million tons of waste per year, with a commercial value of 16 billion euros (Rollot and Rebois, 2014). However, the use of natural resources and the associated greenhouse gas emissions could be limited/avoided (Fooddiver, 2019). Upcycling is a strong trend in the circular economy and is more generally part of the process of sustainable development. Its ambition is to preserve the environment and ecosystems by reducing waste and saving energy and raw materials based on the operationalization by all stakeholders in society: companies, associations, citizens, consumers, etc. Upcycling also seeks financial savings by saving energy and materials. Today, the development of this process is still very limited on an industrial scale.

In recent years, the use of the term '*recycling*' has intensified, but the terms '*overcycling*' and '*upcycling*' in French appear in the mainstream media, indicating the intention to release more value from the subsequent reuse of a material stream previously considered a coproduct. The very meaning of '*upcycling*', which literally means '*to recycle upward*', gives an indication of *better*, connoting a product or a service of higher value than the original coproduct. Whereas recycling results in a product of lower or equal quality to that of the original product, upcycling reflects the intention to add value to the product obtained. In addition, another difference comes from the recycling process. This usually includes a step of chemical restructuring of the materials, while upcycling uses the raw products, thus saving processing energy. Recycling therefore extends the life of the product, while upcycling gives it a new life. However, recycling and upcycling have in common their preservation of the environment.

In the food industry, associations such as the Upcycled Food Association<sup>1</sup> (UFA), in co-construction with governments, universities, industries and NGOs, promote the concept of '*upcycled food*'. One way to formalize this concept or make it operational would be, for example, the development of a label, which could be affixed to product packaging. Similar to other labels (such as clean labels or environmental labels), this label would help the consumer choose a product by highlighting the attributes of '*upcycling*' to increase the recycling economy. This market seems to benefit from considerable growth potential in the food sector, as 39% of consumers currently want to buy foods and drinks containing upcycled ingredients, and 57% plan to buy more next year (De Ketele and Roegiers 1991). Upcycling therefore responds to strong consumer demand in terms of sustainable development.

Today, companies collect and process spent grains, mainly into energy but also into products for human consumption. This deposit can therefore be '*upcycled*' and transformed into finished products, such as snacks, cookies, granola or chips. Resources previously considered biowaste, such as coffee grounds, *ugly* fruits and vegetables, and spent grain, can now be considered a raw material that creates value for subsequent consumers.

Tackling sustainability in commercial relations between actors has strong organizational repercussions (El Ouardighi, 2008). It requires value-based management and implies a redistribution of responsibilities. Value is embodied in business relationships, the effects of which can be measured by qualitative and quantitative variables (Fabbe-Costes, 2002). With the rise of sustainable thinking in management science, the conventional understanding of business models such as the business model canvas (BMC) (Osterwalder and Pigneur, 2010) has appeared not to be completely fitted to sustainable business modeling. Indeed, it tends to focus

<sup>1</sup> <https://www.upcycledfood.org/>.

primarily on customer value (Bocken *et al.*, 2013), while sustainable thinking requires the consideration of a wider range of stakeholders. A new vision has therefore emerged, incorporating sustainability into the conventional understanding of business and leading to a conceptual transformation of business models. In the context of this literature review, the following section seeks to test the theoretical proposition for integrating sustainability into the understanding of the company by relying on the construction of business models that take into account a wide range of stakeholders.

### 3. Methodological approach

Considered producers of biowaste, breweries are responsible for the grains they produce until their final disposal or recovery, under penalty of sanctions. This legislation applies to those breweries considered large producers of biowaste. Since 2016, breweries that produce more than 10 tons of brewer's spent grain per year have been obliged to 'sort at the source', with a view to organic recovery or separate collection. The obligation that applies to all producers of biowaste, regardless of their level, breweries included, as well as all communities and individuals, was announced for 2025. However, with the circular economy package adopted in the EU in 2018, and quite recently transposed to the French level, this obligation should be in force beginning in 2023.

For the past ten years, in France, as almost everywhere in the Western world, a considerable increase in the number of micro- or small breweries has been observed, concomitantly with the evolution of consumer demand toward more diversification, naturalness and authenticity of products. The number of breweries in France thus increased from 1,023 units at the end of 2016 to more than 2,000 units at the end of 2019. The Nantes Basin has followed this trend and now has more than thirty breweries. This strong growth in the sector has raised new problems, particularly regarding spent grain valuation. The recovery of brewer's spent grain responds to two national objectives: the recovery of organic matter and the fight against food waste<sup>2</sup>. This recovery effort helps meet the challenges of the circular economy and food transition. New technically and legally feasible but also economically and environmentally viable recovery paths should meet the challenges of food waste and the policies promoting a circular economy. The case of brewing spent grain is described in this article to illustrate a pathway to value creation for an agrifood by-product from a circular economy perspective.

Querying someone who has information is often a great way to access the information yourself. During a series of interviews, information about our research subject was obtained. This method of oral data collection relates to facts or representations (Baumard, 2007). The 26 individual interviews in the series, 'intended to collect, in the perspective of their analysis, discursive data reflecting in particular the conscious or unconscious mental universe of individuals' (Baumard, 2007), allowed us to complete a preliminary documentary study to better understand the study context.

The selection of interviewees was determined based on the objective of our study. Within the value chain studied, experts have been appointed and served as advisers. Within the limits of everyone's availability, we have therefore chosen to interview players in the brewing sector representing organizations of all sizes, all geographic representations, and with the most diverse activities possible to provide a representative portrayal of the profession. Some stakeholders involved in the value chain studied, such as the association of microbrewers in Quebec or the brewer's association of Pays-de-la-Loire, were also interviewed. Our list is therefore representative of the different functions of the spent grain production chain. These interviews, which lasted approximately one hour, took place between May and October 2019 (Supplementary Table S1).

At the stage where we had chosen to conduct interviews, the degree of development of our hypotheses was low. As a result, we used 'semistructured' interviews as recommended in De Ketele and Roegier (1991). This choice made it possible not to compel the interviewee and not to lead him or her to a preconceived idea of

<sup>2</sup> French environmental code.

the brakes and levers for the revalorization of brewing grains. This method gives the interviewees a certain freedom to express their conception of the feasibility of using spent grain in human nutrition. Compared to open interviews, semistructured interviews are generally shorter and more efficient in obtaining the information sought. The main open questions submitted to the interviewees were expressed, on the one hand, around their 'business' vision of the brewing sector and, on the other hand, around existing or potential practices to revalue the spent grain in human nutrition. Finally, they were asked to speak about the brakes and levers accompanying these practices and the involvement of other actors. Each of the players in the value chain interviewed was asked to give their point of view on the potential of the spent grain and to formalize any wishes for change on this subject. Although we used an interview guide, the questioning and the interview schedule were adjusted on a case-by-case basis because each individual interviewed is unique (Stake, 1995). This guide was completed, adapted, and modified iteratively as the interviews progressed.

The corpus made up of the entire speech of the interviewees was coded and then analyzed using the IRaMuTeQ tool. IRaMuTeQ (for 'R Interface for Multidimensional Analyzes of Texts and Questionnaires') is free and open software for analyzing textual data or textual statistics that works in interface with the R language. It allows statistical analyses on text corpora and on individual/character tables based on the Reinert classification method (hierarchical classification descending on a table crossing solid forms and text segments) (Reinert, 2015). IRaMuTeQ is based on the free R language and the Python language. It is developed within the Laboratory of Studies and Applied Research in Social Sciences (LÉRASS, University of Toulouse) and supported by the LabEx 'Structuring of social worlds' and is distributed under GNU GPL v2 license. IRaMuTeQ represents an alternative to the proprietary Alceste software. Both makes it possible to extract classes of meaning, made up of the most important words and sentences, and the classes obtained represent the dominant ideas and themes of the corpus. The results are sorted according to their relevance and give rise to graphical representations and analysis reports.

#### 4. Results

Among the 26 interviews, 22 texts were analyzed for reasons of data homogeneity. A total of 2,600 text segments were processed by the tool, 90.77% of which were analyzed using a simple classification to optimize the sensitivity settings of the software. For comparison, a dual classification was also implemented, and the results were similar. The results obtained using IRaMuTeQ, that is, the number of word classes, their composition and their distribution according to the profile of the respondents, informed us about the point of view of brewers and stakeholders on the revaluation of the spent grain and its implications. In the end, four classes of words were analyzed, which is quite weak and may require a subsequent manual analysis of the content of the speech. The first of these classes, which contains more than a third (33.2%) of the segments analyzed, contains the expression *spent grain*. This class describes the agricultural world, which therefore today seems to be the predominant link to the valuation of the spent grain. It includes words such as farmer, cow, breeder, goat, cattle, animal, and donate. This class is mainly associated with breweries located in rural areas. We also note that for this valorization of the spent grain, the donation is the process in which the brewers move grain to the farmer or vice versa. Both cases have been encountered. In some cases, the farms, brewing and agricultural, are even nearby.

Then, a second class is defined, very close to the first in the sense that they are nested and where there are interrelations between them. This second class represents 17.4% of the classified segments and contains words such as owner, decide, regulation, think, world, company, Mapaq, speak, and pay. This class could represent the world of decision-makers and the possible alternatives to donating spent grain for animal nutrition. It describes how the different management scenarios for spent grain, excluding animal feed, represent alternatives to assess and study, which are subject to strategic decisions because they are highly constrained. Constraints include the cost of collection when it is a question of having the grain removed by the companies for reprocessing of biowaste under contract with local communities (Sanimax in Quebec or Veolia in France, for example); the very short deadlines because of the odor nuisance in the neighborhood caused by spent grain when it degrades; and the lack of space to store spent grain in urban areas, where

rents are particularly expensive. This class seems to be mainly associated with Quebec breweries among those who were interviewed. One could imagine that it is because of a higher real estate pressure exerted on urban breweries in Quebec or because more urban microbreweries were visited in Quebec, despite the fact that the corpus processing software should allow us to eliminate this kind of bias. In addition, the graphical representations given by IRaMuTeQ seem to show that, in the case of two separate persons, this decision is made independently by the manager and the brewer. It appears that in these structures, perhaps due to the culture of the brewing environment or due to the small size of the craft breweries, strategic decisions concern both the tactical players who manage and operational players who brew.

For the vast majority of interviewees, the current fate of the spent grain is not a waste. This remark was sometimes made spontaneously, by the brewers who bring the grain themselves to the cattle and noting the important value of this raw material to many species (some brewers described whole herds of cattle or goats recognizing the van delivery and rushing toward it) or even more indirectly, by indicating that using the spent grain for human nutrition would reduce the need for more crops grown for fodder. In addition to the declaration of the value of the spent grain, none of the interviewees spoke of ultimate waste, incineration or landfilling of this by-product. This is due to the geographic representation of our study. In both Quebec and France, recent laws prohibit the disposal of biowaste, which must inevitably be recovered, in the worst case in energy flow.

Then, two word classes that are more disconnected from the previous classes; these word classes seem less directly concerned with the theme of the grain. They probably represent the business aspect of the brewers interviewed. The first of these word classes is fairly representative of the classified segments since it includes 29.1% of them. It is characterized by very technological terms such as tank, sugar, CO<sub>2</sub>, fermentation, brewing, cooling, enzyme, cold, temperature, extraction, pump, cycle, etc. This class seems more correlated with the brewers interviewed from Quebec, indicating that they are more professionalized than French brewers today and suggesting that they are one step ahead in the evolution of the brewing sector. Indeed, their transition to more artisanal structures, both smaller and of higher quality, occurred a few years earlier than across Europe and, more precisely, France. The brewers are perhaps quicker to gain competence in Quebec and express themselves more readily on the unit operations involved in their manufacturing processes and the link with the type of product and its overall quality. Furthermore, this class is correlated with the largest brewery sizes. Unsurprisingly, the hypothesis that the smallest structures are the most artisanal and the most recent can be proposed. Some brewers were in their thirties or forties and had abandoned a first job in favor of work as brewer in a search of meaningful work and a sense of authenticity. For these brewers, who are younger in the profession and have not necessarily had specific training, a rise in skills, reflected in jargon and a technical vocabulary, will occur over the years of experience. This word class can also illustrate a major constraint of the brewer's profession and therefore technological elements to take into account to revalue the spent grain after its production, simultaneous with that of beer. At the same time, these constraints must be studied in the case of a revaluation of the spent grain, in connection with its potential food quality as well as its standardization, according to the type of beer brewed, the brewing process, etc. For industrial use, a raw material with consistent characteristics and properties as well as availability will be sought and preferred by potential customers, as is conventionally the case for the food industry. In addition, all this technical language illustrates a cognitive brake mentioned by several brewers. Even with the proven potential value of the grain, these actors do not see themselves seizing this advantage because they do not consider it a core business activity. In addition, we can imagine that for some, the recent interest in the use of spent grain implies an unstable economic environment for the product that is not necessarily remunerative, and given the limited human resources, little time is given to tasks outside the brewing process itself.

The last word class represents 20.2% of the segments analyzed. It is characterized by geographic or relational terminologies such as Loire, country, association, and network and seems to designate both the geographic network of breweries and their network of stakeholders. These stakeholders include upstream actors, such as growers of hops. Indeed, this profession is being restructured in the different territories studied under the effect of the intensification of demand. In addition, there is real pressure on the hops market because it

was still recently controlled by seed companies that exercised considerable power over hops users due to the patents imposed on the varieties. Today, the ‘neo-hoppers’ are happy to restructure through professional associations. They therefore benefit from technical, cultural, commercial and communication, representation and image support. Finally, the players in the professional brewing associations who have been interviewed intervene. Both Association of Microbrewers of Quebec and French Association of Independent Brewers seem to have developed and diversified missions, but also acted on their negotiation capacity.

Finally, with regard to the correlations of the variables between them, the most important phenomenon to note is that of the restaurant or brewery activity, which is linked to the territory of Quebec. This coactivity, albeit initiated over a hundred years ago by a French group, is today much more heavily imbedded in Quebec. Brewpubs, neighborhood microbreweries, restaurateurs-brewers, and brewery farms are much more represented in Quebec. A large majority of microbreweries offer a range of restaurants, more or less elaborate and diversified, but with the beer most frequently prepared on site using fresh, local, quality products. While in France, tradition and habits conceive of beer as more of an aperitif at the bar with friends or colleagues, in Quebec, it is customary to snack on something at the same time as you taste a beer. However, this model now seems to be spreading in Europe, where quality takes precedence over quantity, with the development of consumer demand for healthier food.

For these operating models, even for very small volumes brewed, the number of employees immediately increases. For small breweries in the Quebec suburbs, which are well established in their neighborhood and do not exceed 600 hectoliters per year, a staff of thirty employees can be reached. Almost all of these breweries have already introduced spent grain on their menu, whether in granola in desserts, in breading of meat or fish, in burger buns, in roasted accompaniments, etc. However, the volumes of spent grain needed are tiny compared to the quantity produced. Thus, brewers should look into pooled collection and treatment solutions for spent grain, with the production of intermediate products such as flour with several particle sizes, more or less toasted granola, or ‘milk of spent grain’. Alternatively, they should consider the use of spent grain for a food purpose in addition to an already existing use, such as animal nutrition or composting.

Table 1 summarizes all the brakes and levers identified using the interviews for the value chain. This information illustrates the very diverse and multidisciplinary types of skills, information and resources to be mobilized for future projects to revalue by-products of the food industry in human nutrition.

In this article, the question addressed by the semi-structured interviews and their analysis by IRaMuTeQ is that of the obstacles and levers to the implementation of the circular economy in the brewing sector. But in addition and in order to link different works of a collaborative research context (2-year project), a business model is proposed based on field elements (interviews, discourse analysis). This business model has been put in place by some of the brewers interviewed. As at this stage it does not benefit from an in-depth hindsight, the article is not entirely focused to it, but it is nevertheless an interesting guide for discussion. Supplementary Table S2 shows the value proposition of a circular valorization of brewer’s spent grain. The need is great for the emergence of a new actor in the agrifood value chain to link between producers and users of spent grains while taking into account the expectations of the various stakeholders and their practices. For all the products identified, the common and major obstacle lies in the reorganization of market actors and their capacity to carry out the activities required by spent grain valuation. The mission of a new economic actor who is responsible for spent grain is to take care of the spent grain collection and logistics, in a synchronized manner with the brewing process, as small breweries that are voluntarily involved do not necessarily brew every day and on a regular basis. This actor is therefore in charge of the transport, storage, stabilization, and subsequent marketing of spent grain. To this end, without necessarily building a downstream production tool, a simple shared workshop could be sized to process the deposit of 10 tons of spent grains available in the Nantes basin (within a radius of approximately 20 or 30 kilometers) each week. Then, the identified need is to find potential users of stabilized spent grain using their own production tool for spent grain valuation. The spent grain product (flour, for example, and the different possible steps of milling involved) could be used as a raw material in many industrial, semi-industrial or even artisanal products in the region. Particular

**Table 1.** Brakes and levers for spent grain valuation in human nutrition.

Constraints	Associated quotations	Further research needed
Regulatory	We would need another license to do the restoration We must value our biowaste via specific sectors because it is forbidden to bury it in storage centers	Bibliographic synthesis
Technological	BSG is very unstable. It ferments very quickly. The smells are really unpleasant for the residents We dry them in our oven to extend their life	Technico-economic feasibility analysis for BSG differentiated scenarios in human nutrition valorization
Geographic	Downtown, I have no place to store the BSG Our possibilities of BSG valorization are limited in urban areas Downtown, we have to pay for the removal of the BSG by a company that works with the city Breeders do not want to come here	Scenario: creation of local valuation chains
Cognitive	I cannot do it; it's not my job I already have a job We have an interest in keeping this path of valuation (purchase price and large tonnages)	Focus groups
Economic	Our activity started very recently; we are not able to invest We can invest the amount that we currently pay We would have to be subsidized by the city It is a means of valorization with low added value	Technico-economic feasibility analysis for BSG differentiated scenarios in human nutrition valorization
Environmental	We must limit the consumption of water and energy	Extended LCA
Societal acceptance	It stinks for the neighbors I transport directly to the breeder. It's heavy The cattle love it (BSG)	Focus groups
Temporal	As we have just started, we are completely dedicated to our brewing activity	Focus groups

care must be taken in the fine construction of the possible economic model(s) to offer a competitive price because acceptable value sharing at all stages of the value chain has to be demonstrated as a condition for value chain sustainability (Paillard *et al.*, 2009). Determining whether to communicate to the final consumer the inclusion of spent grain in the finished product also remains to be determined. Likewise, subsequent work should study which equipment is required for spent grain stabilization as well as potential funders for the implementation of such a collaborative scenario.

## 5. Discussion

The circular economy, faced with environmental and social challenges, can be both stimulated and curbed by regulations. As it embodies a business model in which creativity makes it possible to go beyond the horizons currently explored (Rey-Valette *et al.*, 2006), the circular economy is based on proactive initiatives by actors who anticipate the arrival of new regulations. Here, in the example of spent grain, the regulations on the obligation to recover biowaste both in France and in Quebec, Canada, encourage brewers to seek new ways of recovering their coproducts. On the other hand, the spent grain can no longer be wasted, that is, incinerated or buried (final disposal).

In addition, despite their ambitions to reduce environmental impacts, the practices linked to the circular economy nevertheless generate remaining questions as to their real and generalizable benefit, particularly concerning cooperation or pooling initiatives, for which risks of impact transfer or rebound effects are cited. There are therefore obstacles to these changes in practice. These brakes can be economic on the one

hand but also cognitive. Faced with a change in paradigm, the development of inertia linked to a feeling of helplessness in the face of multiple challenges is often observed.

However, levers push companies to turn more to these models, including the personal convictions of the manager, the search for new markets while standing out to customers and the prospect of future regulations (Lanoie and Normandin, 2015). These levers of action can be the responsibility of the actors in the value chain themselves but also of their stakeholders, such as public authorities or even consumers. The adoption by the various stakeholders of an approach to implementation is necessary to go beyond the stage of information sharing, which results in changing visions but not practices. It is therefore necessary to cooperatively build new collaborative solutions (Fabbe-Costes, 2015). To this end, it is possible to re-examine the contributions of the different actors to the value of the product. This value is material in terms of the availability of resources and prioritizing the intrinsic value of the products rather than their number, and it is also human, as it takes into account the working conditions and time required for the production of the products as well as the impacts generated by their consumption (Fabbe-Costes, 2015).

A limitation lies in the fact that only actors downstream of the production, transformation and distribution chain of spent grain have been heard for the most part, such as producers (brewers) or their stakeholders. However, currently, the market for the revaluation of spent grain is not yet structured, and the downstream actors were not identified before the launch of the project, and they did not answer our call as quickly as the brewers. However, the downstream were then invited to creativity sessions aimed at identifying new scenarios for the use of spent grain in human nutrition. This design thinking study will be published separately as part of our current project.

Another limitation lies in the fact that the case of large volumes of spent grain and large groups of brewers is not described. We were unable to meet with a multinational or a large brewing group, such as Heineken or RJ. However, we know that today, these breweries have solutions for their grain. More often than not, this coproduct is stored in large containers outside, then sometimes collected directly by animal nutrition cooperatives, sometimes by companies specializing in the logistics of spent grain in animal nutrition. The grains are then ensiled or transformed into granules and then sold on a dedicated, very dynamic market, the costs of which are determined as for any other cereal, according to the prices of agricultural materials.

The study shows that one route to the success of spent grain upcycling initiatives lies in the multiplication of value creation channels and therefore of business models that involve joint activities. For example, for a structure handling small volumes, one could imagine a facility directly adjacent to a brewery for the production of raw materials. The establishment of a new actor in the chain of actors (the 'grain feeder') can rely on the logistics activity of collection, in addition to the stabilization and processing of spent grain. The development of a sector therefore requires structures that can handle large volumes to achieve economies of scale, which could then lead to a production process in which human food may not be the only possible end. This player will therefore be a producer of spent grain products targeting different markets, such as human food, animal feed, cosmetics, furniture, and construction. In the case of a small-volume activity, the use of spent grain can be considered a complementary activity to that of beer brewing. For these small volumes, the models that create value are based on a business model that relies on the co-development of activities, such as a combined brewery and bakery. Alternatively, an association with linkage, awareness and prevention activities could be developed with a wide variety of audiences, ranging from economic players to the general public.

In a highly constrained framework, a structural change in the modes of production, distribution and consumption of a coproduct such as brewer's grain will necessarily involve all the players in the valorizing chain but also in society. Thus, the major challenge of the circular economy lies in the alignment of all the actions implemented throughout the product's entire life cycle. In this regard, it has already been shown to what point the management of uncertainty and complexity is a determining element because it is necessary to find

individual and collective compromises, or at least prospective solutions that satisfy a minimum level of all the players involved, in a continuous improvement process that is part of the long term model.

In this context of innovation management and change management, Hatchuel (2000) has underlined the importance of ‘reciprocal prescription’ activities between actors in the conduct of design activities. According to Hatchuel, in such ‘specifier markets’, where product qualification is difficult, the intermediaries the markets constitute play a crucial role. Prescriptions that can in particular be ‘technical’ and ‘judgmental’ based on precise knowledge would constitute a condition for the functioning of the collective action that constitutes market exchange. These ideas have exerted an influence on academic marketing research, some of whose currents are now aiming to organize such prescription systems (Stenger, 2011).

A collaborative change management process could lead to a solution that satisfies all stakeholders at an acceptable level. To this end, this article shows how these actors and decision-makers must have multidisciplinary skills and resources, which make it possible to impose a sharing of value rather than a monopoly, implying that the partners involved can preserve their margin. Then, the question of capturing additional value will arise when the system is shown to be viable. In the case of spent grain, new markets, such as that of ‘superfood’ could be explored because it would maximize the margin of finished products, qualified with high energy or nutritional value. This step will require ensuring a secure and standardized supply. It will be necessary to scrupulously study the technological solutions of stabilization and transformation of spent grain to ensure their nutritional and energetic quality.

This is why the early stage of involvement of a new actor is major. This actor could be called the ‘degrainer’ and would have the major mission within the value chain to collect, stabilize, transform and redistribute the spent grain. Part of his or her work, in collaboration with the other actors, would consist of negotiating the new frontiers of concepts. Through these concepts, the services they negotiate, the business opportunities they are trying to capture or protect, and the new markets they constitute are at stake. The promotions, interpretations and definitions of new regulatory frameworks and associated standards will have to be rethought. In new economic sociology, Callon *et al.* (2000) conceive of the product as a ‘variable’ resulting from the ‘struggles and negotiations’ that the actors engage in during its qualification process. Even more so in the case of the revaluation of a coproduct from the food industry, a consensus on its characteristics can be difficult to reach. The finished products should meet lists of controversial global quality criteria due to assessments and judgments that vary from one actor to another, likewise for the values to be achieved for each quality criterion or even the objectivity and robustness of the procedures used to objectify them. Thus, all of the quality criteria for a product made from grains as a whole or in part could evolve as the product is transformed. Likewise, establishing the relative importance of each of the quality criteria for such a product would be an integral part of its collaborative qualification process.

Despite the nutritional value of spent grain, brewers, whose main mission is to make beer, very rarely have the resources (time, money, manpower) to deal with the grain problem. On the other hand, they willingly cede their deposits free of charge because, on the one hand, the subsequent user addresses the logistical problem of the spent grain or even saves them the cost of collecting and then discharging it. It is therefore a win–win partnership, albeit more often than not informal. Because of its great microbiological alterability, due in particular to its high water content and the elements of nutritional interest that it contains, the spent grain must be stabilized in a very short time (cooling, drying, separation, grinding, etc.) to limit or stop the fermentation of the material.

In terms of flow control, this processing step induces a logistical difficulty for reuse or subsequent processing because the volumes of spent grain arrive in batches at the end of each brew, unlike waste produced by chains processed online. To consider it as a useful material, therefore, large quantities of spent grain must be stabilized with each batch. For example, the combination of conventional unit operations of stabilization and then grinding would make it possible to produce flour of good nutritional quality, which would meet a need expressed by certain brewers, especially small and urban brewers. In addition, the incorporation of such flour



in (new) finished products would be part of a food offering that meets consumer needs and expectations in terms of sustainable positioning (upcycling of biowaste), virtuousness (supply local), health (nutritional aspect) and naturalness (minimally processed raw material)<sup>3</sup>. More specifically, with regard to the environmental impact, the factors involved include the reduction of waste at the source and the fight against food waste; the social factors include the local manufacture of products; the economic factors include the creation of added value for local players in a local circuit and the reduction in collection costs for (micro) brewers.

Because most microbreweries, craft breweries and small breweries do not produce enough spent grain to be reused on their own, cooperative solutions<sup>4</sup> have already been studied. The development of cooperation between microbreweries has shown conclusive and innovative results based on a collaborative work base with urban agricultural cooperatives of similar volume and size that use the spent grain as compost. The actors involved became familiar with this use of spent grain, and companies were found to buy this compost. The very positive final report assessed business practices and models, logistics, costs, storage, packaging and partnership options. Such a study to revalue spent grain must address many aspects to ensure the success of the industrial technology and management initiative.

The logistical aspect of collecting and distributing spent grain is a major factor among those to be dealt with. Currently, start-ups intending to produce spent grain flour are looking for one or more subcontractors to organize collection, transport, and logistics in the most sustainable conditions possible. For some, this involves the use of electric vehicles or the use of soft mobility. The model of a Spanish company providing precisely this type of service, for large volumes, in a given geographical area, but for reuse in animal nutrition, can nevertheless be duplicated or adapted. This company offers support to the brewing industries of different types by managing the coproducts resulting from their industrial processes and improving their properties with the aim of increasing both the life cycle and the added value. They ensure the collection of spent grain with dedicated vehicles on a daily basis or just after the end of the brew to avoid paralyzing the plant. Distribution is programmed individually with each customer, in particular for feeding dairy cows. This distribution can also be daily. A pioneer<sup>5</sup> in the collection of coproducts from the brewing industry, this company has contributed for 80 years to the responsible and sustainable management of spent brewer's grain.

In the case of animal nutrition, to ensure the inventory and storage of the spent grains, the installation of large-capacity silos (800 to 1,000 tons of spent grain, investment of 80,000 to 100,000 dollars) allows a refill approximately every two weeks. Previously, the grain was stored in 20-ton bins, which the users of the spent grain (farmers) overturned and then shoveled manually into a truck. Today, a silo valve opens, and the grain is automatically poured into the truck. For animal nutrition, this installation makes it possible to limit the excessively high costs of more frequent transport. For example, in the US<sup>6</sup>, some breweries estimate that they have to pay between 60,000 and 70,000 dollars per year for the transport and disposal (dumping) of spent grain. The silo solution facilitates collaborative work between collectors and users of spent grain. However, a simple transposition for human nutrition would be insufficient because of the rapid degradation of the raw material. The organization of the collection of spent grains is the first obstacle to the viability of improvement initiatives in human nutrition. To ensure a tight flow at the end of each brew, the different players involved will have to share production information, such as volumes and brewing frequencies. One could think of the utility, for purely managerial uses, of synchronized applications,<sup>7</sup> such as those that put traders in touch with perishable unsold products and users ready to buy baskets of unknown composition at discounted prices. The value of this type of solution could first be demonstrated at the local level and then supported in other areas to develop similar initiatives with a view to making a greater impact.

<sup>3</sup> <https://maltivor.com/>.

<sup>4</sup> For example: <http://www.nogashi.fr/>; <https://boomerang-coop.com/>.

<sup>5</sup> <http://fr.lpernia.com/services>.

<sup>6</sup> At Weyerbacher Brewing <https://weyerbacher.com/>.

<sup>7</sup> For example: <https://toogoodtogo.fr/fr/>; <https://www.wearephenix.com/>.

## 6. Conclusions

This article focused on the operationalization of the circular economy by seeking to highlight the implications of its implementation in the food industry. Examining the case of spent grain, this work took into account the points of view of different actors involved in the value chain and identified the brakes that should be lifted and the levers that should be mobilized for valuation in human nutrition. The extent to which such work around the revalorization of biowaste from the food industry can mobilize multiple and interrelated disciplinary fields was also demonstrated.

Developing an operational management of biowaste involves defining the technical, organizational and financial means adapted to a given context, the deployment of technical means of communication and cooperation of the different stakeholders, and the quality control of products from by-products. In particular, a specific collection allows the resource to be recovered under conditions that then allow it to be used, for example, in human nutrition, locally or not, in urban or peri-urban areas. From an economic point of view, the benefits associated with a *more intensive* recovery of waste bioproducts such as brewing dregs reduce costs as well as farm expenses. Pooled collection reduces individual costs through economies of scale. From an environmental point of view, more ambitious studies are needed to show how the reuse of nutrients makes it possible to reduce greenhouse gas emissions linked to the production of food. It also makes it possible to greatly limit the pollution of aquatic environments thanks to the reduction of nutrients in products rejected by producers, logisticians, and further users of products.

However, today, the installation and optimization of suitable equipment and processes constitutes a brake because specific skills are required to limit the use of energy flows (important in the context of the stabilization of a raw material that is produced at 80% moisture, leading to its rapid degradation that is not compatible with human consumption). Furthermore, current brewing tanks primarily require manual recovery of the spent grain. This operation requires either human labor or an investment. Several professionals are able to support communities to meet these challenges. This type of installation is an opportunity to educate users who often readily adopt the new system when they understand the stakes. Cooperation and the emergence of sectors and networks of actors will make it possible to remove these obstacles and better use biowaste.

Finally, the question of the real contribution of the circular economy to the reduction of impacts on ecosystems and species has to be addressed. Although product and service systems often aim at triple performance, environmental gains are often modest. In the case of spent grain, convergence can be found, but it encounters technical, sociocultural, legal or organizational obstacles. Not only is a great deal of work necessary to study the best parameters for the success of projects to revalue brewer's grain in human nutrition, but specific research related to sustainable development should be multidisciplinary.

## Supplementary material

Supplementary material can be found online at <https://doi.org/10.22434/IFAMR2021.0154>.

**Table S1.** Summary of the interviews carried out for this study

**Table S2.** Value proposition of a circular valorization of brewer's spent grain.

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