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HUNGARIAN UNIVERSITY OF AGRICULTURE AND
LIFE SCIENCES
KAPOSVÁR CAMPUS

H-7400 Kaposvár, Guba Sándor u. 40.
H-7401 Kaposvár, P.O.Box 16.
Tel.: +36-82-505-800, +36-82-505-900
e-mail: rbs@uni-mate.hu

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CROSS-FUNCTIONAL TEAM COOPETITION TO IMPROVE SDG 8.4 – A FUZZY-SET QUALITATIVE COMPARATIVE ANALYSIS

Anh Don TON

Hungarian University of Agriculture and Life Science, H-7400 Kaposvár, Guba Sándor u. 40.

ABSTRACT

To ensure global sustainability, the UN has set 17 sustainable development goals (SDG). With the 8th goal, which is described as decent work and economic growth, the UN pursues economic growth with economically more efficient production and consumption. Many critics see these aspects as conflicting, so that meeting one goal in certain cases does not lead to reach the other goal. This paper examines the influence of employees' personalities on their preferences for economic efficiency and environmental friendliness in economically strong countries. This study provides a survey of 117 participants using a fuzzy-set qualitative comparative analysis. The results show that individuals can be categorized into the following personality profiles based on their preferences: Open minded and neurotic employee classified to environmental friendly thinking, and extravert employee classified to economic efficient thinking. In the theory of coopetition cross-functional and -thinking teams, it could be potentially assumed individuals can be brought together to improve reaching both aspects of SDG 8.4. The major contribution of this study is to provide a conceptual foundation and identify a possible way to improve team cooperation on the SDG 8.4 that shows promise for future research.

Keywords: Big Five, personality traits, competition, cooperation

JEL codes: D23, Q56, E71

INTRODUCTION

The economy has grown steadily over the years. The question is often asked how long continuous economic growth is ecologically sustainable. A hypothesis by Kuznets (1955) states that economic growth and environmental pollution are directly interdependent in a U-shape. This hypothesis, also called Environmental Kuznets curve (EKC), suggests that economic growth leads to increasing environmental pollution until they reach a turning point, in which the pollution drops while economic growths continue. This relationship between economic growth and environmental impact is discussed in several publications, remaining very controversial (Almeida *et al.*, 2017; Deininger & Squire, 1998; Dong *et al.*, 2018; Kerekes *et al.*, 2018). There is also empirical evidence that some developing countries are adopting environmental standards faster than developed countries and even exceeding them (Stern, 2004). The main arguments supporting the EKC hypothesis is that increasing income shifts people's preferences towards non-economic aspects, such as a cleaner environment. Additionally, the development of a country takes place first via a polluting industrial society to a relatively environmentally friendly service society later on.

The United Nations also has supporting targets for sustainability and economic growth. The Sustainable Development Goal 8 (SDG 8) of the *United Nations* (2015) is about decent work and economic growth. Within the SDG 8, the UN has defined several targets, in which, among other things, sustainable economic growth is to be ensured. The official aim of the SDG 8.4 is to "... progressively, through 2030, global resource efficiency in consumption and production and endeavor to decouple economic growth from environmental degradation, in accordance with the 10-Year Framework of Programs on Sustainable Consumption and Production, with developed countries taking the lead" (*United Nations*, 2015). Target 8.4 is therefore supporting economy growth with sustainable consumption and production. Also resource efficiency in consumption and production can decouple economic growth from environmental degradation (*United Nations*, 2015).

The EKC hypothesis only explains macroeconomic hypotheses in which economically strong countries focus on the service sector. The targets of SDG 8.4 also aim to show that sustainable production is clearly positively correlated with economic growth. But what happens in microeconomics if people work in heavy polluting industries in countries with high economic power? According to the EKC, in contrast to the service society, a conflict often arises between environmental impact and organizational benefit. Also, for the SDG 8.4, organizational benefit cannot easily be aligned with environmental degradation.

This paper examines the relationship between environmental impact and organizational benefit in relation to employees' personality in developed countries to support the target 8.4 of the SGD8 of the UN. The following research questions will be answered:

Q1: Which personality profiles make people more likely to be environmentally friendly and which more likely to be those who are aiming at economic efficiency?

Q2: How can teams be created to improve environmental friendliness and economic efficiency and at the same time based on the cooperation theory?

The aim here is to identify above all those individuals who pursue predominantly environmentally friendly and sustainable production (SDG 8.4) and those individuals who pursue the organizational benefit approach, even if production is not sustainable. This aim becomes more important as companies' way of thinking has changed in recent years. The goal of a company is often no longer purely economic growth, but also corporate social responsibility. The concept of integrating social and environmental concerns into the business activities of for-profit companies on a voluntary basis is a challenging one and highly discussed (*Byrne et al.*, 1996; *Cramer*, 2002). The result could be used to build interdisciplinary teams that perform better on conflicting goals in environmental impact and business performance by mixing both types together.

MINOR LITERATURE REVIEW

Big Five Personality Traits

The Big Five personality traits will be used to assess different personalities. Personality traits distinguish individuals from one another and are responsible for

patterns of behaviour, feelings and thoughts across different situations (*McCrae & Costa, 2006*). The Big Five model is one of the most well researched and widely accepted using the personality traits conscientiousness, agreeableness, neuroticism, extraversion and openness to new experiences. There are strong arguments that personality traits can relate to environmentally friendly thinking and organizational benefit thinking.

Openness to experience encompasses several dimensions such as active aesthetic sensitivity, attention to feelings, intellectual curiosity, and questioning authority (*McCrae & Costa, 1997*). Research has shown that these dimensions are significantly correlated with each other (*McCrae & John, 1992*). In some studies, Openness shows associations with environmental intentions so as behaviour (*Hilbig et al., 2013; Hirsh, 2010; Markowitz et al., 2012*) and pro-environmental motivations (*Hirsh & Dolderman, 2007*). While openness leads to more political consumption, extraversion tends on the contrary to be negative (*Quintelier, 2014*). Individuals with high expression on extraversion do not show any correlation to environmental concern (*Hirsh, 2010*). They have been characterized by having great number of friends (*Kosinski et al., 2014*), having higher task performance and creativity (*Rothmann & Coetzer, 2003*), having high job performance in some cases (e.g. sales), strong leadership skills (*Blickle et al., 2015*) and commitment to the organization and normative commitment (*Erdheim et al., 2006*). Similar to extraversion, conscientiousness provides clear correlations to professional success. This personality trait describes the degree of self-control, accuracy and purposefulness inherent in a person. It correlates very strongly with perfectionism facets such as being organized, sense of duty and achievement striving (*Stoerber et al., 2009*). Conscientious individuals are rated better by their supervisors, have objectively better output in the workplace, exhibit better team behaviour and show high performance (*Colbert & Witt, 2009*). Conscientiousness correlates with emission reduction behaviours (*Brick & Lewis, 2016*), but is also most strongly linked to environmental engagement (*Milfont & Sibley, 2012*) and environmentally-friendly behaviour (*Hilbig et al., 2013*). Nevertheless, it is still controversial, as some studies showed no relationship between conscientiousness and environmental behaviour (*Markowitz et al., 2012*) or environmental concerns (*Hirsh, 2010*). *Hirsh & Dolderman (2007)* found a significant effect of Agreeableness on pro-environmental motivations. Individuals, who score high on agreeable are characterized by altruism and helpfulness. High ratings on this personality trait are characterized by adjectives such as compassionate, kind, warm, trusting, helpful, cooperative and indulgent. Neuroticism includes personality traits such as anxiety, anger, depression and insecurity (*Milfont & Sibley, 2012*). It is related to environmental values (*Wiseman & Bogner, 2003*) and also to environmental concerns (*Hirsh, 2010*).

Quintelier (2014) concluded that the personality played a significant role in political consumption, such as not buying certain products or preferring goods with fair-trade or organic label. Using the 100-item HEXACO personality inventory, *Brick & Lewis (2016)* have proven that personality traits also influence the environmental behaviour. A meta-analysis of *Judge (2008)* showed several relations of organizational behaviour and personality. Above all, job motivation, organizational commitment and influence play a significant role in entrepreneurial success. Job motivation was

measured by different motivational aspects (i.e. goal-setting motivation, self-efficacy, expectancy motivation) which correlated negatively with neuroticism and positively with conscientiousness (Judge & Ilies, 2002).

Theory of Cooperation

The dynamics of cross-functional individuals is also called cooperation, which was first adapted by Brandenburger and Nalebuff (1997) from the game theory. They suggested that companies should not compete with their competitors, but to cooperate with them in order to gain market advantages. On team level, cooperation can improve the performance (Ghobadi & D'Ambra, 2012b; Raza-Ullah, 2020; Seran et al., 2016; Strese et al., 2016; Thongpapanl et al., 2018; Zhang & Guo, 2019), the relationship (Ghobadi & D'Ambra, 2013; Knein et al., 2020; Strese et al., 2016) and innovation (Chen et al., 2020; Chiambaretto et al., 2019; Nguyen et al., 2018). Cross-functional rivalry (i.e. preferences of being environmentally friendly or economically efficient) can occur, when people from different departments compete with each other, which can reduce the performance (Luo et al., 2006). Grouping them together in cross-functional teams can have positive effects on creating a solution, which increases the performance of problem solving more than homogeneous teams.

MATERIAL

To study which personality profiles make people more likely to be environmentally friendly and which more likely to be those who are out for entrepreneurial success, an online survey was conducted (see Annex). The survey consists of 21 questions, in which 3 questions in the survey match each personality trait and 3 questions to each environmentally friendly and organizational benefit. We used the survey questions of Soto et al. (2017) as their reliability and validity has already been proven. They developed a short form of the Big Five personality test called BFI-2-XS, in which only 15 questions were used.

The survey was created on SoSciSurvey to collect the data. All the participants took part in the study between 15th March 2021 and the 27th March 2021. Before starting the study, all participants had to accept the declaration of consent. The items were rotated within the study in order to avoid primacy and recency effects (Deese & Kaufman, 1957) or order bias (Blankenship, 1942) of the Big Five items.

METHODOLOGY

We have used the fuzzy-set qualitative comparative analysis to represent the personality traits. The fuzzy-set value of one expresses that the personality trait is given, while a value of zero indicates the personality trait is not given. Representing the big 5 personalities in fuzzy values enables us to investigate which personality profiles make people more likely to be environmentally friendly and which more likely to be those who are out for entrepreneurial success. The response options are structured on a 6 point Likert scale, so additional calibration according Rangin (2008)

is required. In the first step, the mean value of the different item categories (Extraversion, Agreeableness, Conscientiousness, Openness, Neuroticism) was calculated. If the value was higher than 3, it was transferred to a fuzzy value of 1, while the other values were transferred to 0. The outcome was raised also by a 6-point Likert scale and transferred identically. With these data we constructed the truth table (*Table 1*). The truth table consists of seven columns for the fuzzy value of each level and two additional columns for the outcomes. In total the truth table has 117 rows, one for each respondent.

Table 1: Truth table

O	C	E	A	N	Environmental friendly	Organizational benefit
1	1	0	0	0	1	0
1	1	1	1	0	0	1
1	0	0	0	0	1	0
1	0	0	0	0	0	1
...						

For the analysis of the survey we took the fuzzy-set configurational approach, called fuzzy-set qualitative comparative analysis using fsQCA software 3.0 (*Ragin & Davey, 2016*). Based on the results of the study we calculated a consistency and coverage score to measure how reliable the combination results were in the outcome. A high consistency value indicates a necessary condition for the outcome while the coverage value indicates how often the condition is present for the outcome. To check the sufficient condition, we apply the truth-table algorithm to identify combinations of our fuzzy values that produce the outcome (in this case it is work satisfaction). All possible combinations of fuzzy values are included in the truth table, each row presents a combination. In total we have 32 possible combinations (2^k with k = number of the personalities) (*Korjani & Mendel, 2012*). In line with a recommendation from QCA literature, we did not take cases with very low frequency into account (*Ordanini et al., 2014*). The minimum acceptable frequency of cases was set to 4, lower frequency was not considered.

The truth-table algorithm gives two consistency values. The first one, the raw consistency, provides an output how consistent the combination giving us the same outcome is, while the second one, the proportional reduction in inconsistency is more exacting than the raw consistency due to its elimination of the influence of cases in both the outcome and its complement (*Park et al., 2017*). We rely only on raw consistency and set 0.8 as a cut off, which means only combinations at least 0.8 are reliable for personality profiles being environmentally friendly or organizational benefit friendly (*Riboux & Ragin, 2009*). We take the truth table analysis into account to check the sufficient condition.

RESULTS

Based on the results of the survey we had a sample of 117 participants. The sample size fulfills the requirements for the qualitative comparative analysis as the ratio of the variables to the sample size is smaller than 0.2 (Marx, 2010). As respondents from the survey are source of the exogenous and the endogenous variable which can cause a distortion of the measurement results (Podsakoff et al., 2003), we apply Harman’s single factor test to load all items into one common factor. For our data set, the strongest single factor explains 31%, which is smaller than 50%. This indicates our data set was not affected by common method bias. Firstly, the descriptive data is checked (Table 2).

Table 2: Descriptive data

Gender in percent		Age in percent mean:		Highest education in percent	
Male	69.2	< 21	0.8	Secondary school	2.5
Female	30.8	21 – 30	10.2	Grammar school	8.5
Other	0.0	31 – 40	23.9	Bachelor	21.3
		41 – 50	41.8	Master	46.1
		51 - 60	17	PhD	13.6
		> 60	5.9	Other	7.7

Table 2 shows the demographic data. The result of this survey shows that mainly participants with an age range from 41–50 and with a higher educational level (Bachelor, Master) participated in this survey. We also conducted a survey of acquaintances, which, however, constitutes the minority of the respondents. The results of the fsQCA shows different personality profiles associated with the outcomes. The first profile, we call them the “open-minded employee” is open, conscientious and agreeable. The second profile, called the “neurotic employee” is conscientious, agreeable and neurotic. The third profile, called the “extraverted employee”, is conscientious, extraverted and agreeable. The results are shown in Table 3.

Table 3: Personality profiles

Profile	Environmentally friendly		Economic efficiency
	Open-minded employee	Neurotic employee	Extraverted employee
Openness	•		
Conscientiousness	•	•	•
Extraversion			•
Agreeableness	•	•	•
Neuroticism		•	
Frequency	10.3%	15.9%	10.3%
Raw consistency	0.82	0.82	0.91

The raw consistency of the open-minded employee and the neurotic employee is very high (> 0.8), while the frequency is quite low (0.103; 0.159). This indicates that participants who can be assigned to the open-minded or neurotic employee seem consistently environmentally friendly, while the profile “extraverted employee” seems to be consistently more organizational benefit friendly. The overall frequency is quite low, meaning on average only 11.7% of the sample can be explained by the personality profiles. It is noticeable that Conscientiousness and Agreeableness are present in all three profiles, while Openness, Neuroticism and Extraversion are significant for each profile.

The results of the truth table algorithm give us three solutions (*Table 4*).

Table 4: Consistency and coverage of the personality profiles

Profile	Raw coverage	Unique coverage	Consistency	Solution coverage	Solution consistency
Open-minded employee	0.14	0.14	0.81	0.36	0.82
Neurotic employee	0.22	0.22	0.82		
Extraverted employee	0.17	0.17	0.91	0.17	0.91

The first one is the sufficient conditions “Openness”, “Conscientiousness” and “Agreeableness”. As mentioned above, we defined this profile as the open-minded employee. This profile covers 0.14 with a consistency of 0.81. The second solution is the “neurotic employee”, identified due to the sufficient conditions “Neuroticism”, “Conscientiousness” and “Agreeableness” with a raw coverage of 0.22 and a consistency 0.82. Both together cover 0.36 of the solution and have a together consistency of 0.82 explaining the outcome of the participants being environmentally friendly. The third solution is the “extraverted employee” with the sufficient conditions “Conscientiousness”, “Agreeableness” and “Extraversion”. This profile covers 0.17 of the outcomes and 0.91 consistent being organizational benefit friendly.

DISCUSSION

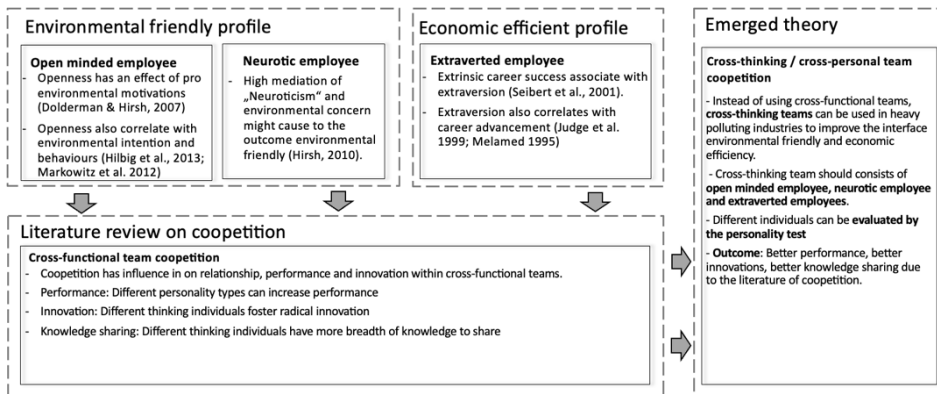
The present study aimed to examine the relationships between the Big Five dimensions of personality on the preferences of being environmentally friendly or economic efficient for more organizational benefit. Our results show that “Openness” and “Neuroticism” in combination with “Conscientiousness” and “Agreeableness” are highly consistent (0.82) with organizational friendly, while “Extraversion” is highly consistent (0.91) with economic efficiency. According to different studies on personality profiles, there are tendencies that environmentally friendly and economic efficiency can be related to personality. Comparing the personality trait “Openness” with the literature, we get similar results. The results support the studies of *Dolderman & Hirsh* (2007) that Openness has an effect on pro-environmental motivations. The results also reinforce the studies showing that openness correlates with environmental

intentions and behaviour (Hilbig et al., 2013; Hirsh, 2010; Markowitz et al., 2012). Environmental factors such as emission reduction and environmental engagement are implied in our items, so our study yields results similar to those of Brick et al. (2016) and Milfont et al. (2012). For the high consistency of “Neuroticism” on the outcome environmentally friendly, we assume high mediation of “Neuroticism” and environmental concern might be the cause (Hirsh, 2010).

Our study shows “Extraversion” is consistent with the preference of being economically efficient. Studies showed that extrinsic career success was associated with extraversion. Individuals, who are higher on extraversion also received higher salaries and more promotion (Seibert & Kraimer, 2001). These relations of extraversion are also consistent with earlier studies on career advancement (Judge et al., 1999; Melamed, 1995). We assume that the preference of being economically efficient, which plays a significant role in career success, correlates with the personality trait Extraversion. The results of our study could be used by companies facing the decision of preference between environmental friendliness and economic efficiency in projects. According to the findings, a theory for practical implications was built. For cross-disciplinary projects, often interdisciplinary individuals with different mindsets are assembled to work together.

Based on our findings, the theory of cooptation and the classification of different personality profiles are combined in an emerged theory (Figure 1).

Figure 1: Emerged theory based on the personality profiles



The theory uses the proven approach that cross-functional teams with different mindsets improve the outcome performance (Ghobadi & D’Ambra, 2012b; Raza-Ullah, 2020; Seran et al., 2016; Strese et al., 2016; Thongpapanl et al., 2018; Zhang & Guo, 2019), innovation (Chen et al., 2020; Chiambaretto et al., 2019; Nguyen et al., 2018) and knowledge sharing (Albort-Morant et al., 2018; Ghobadi & D’Ambra, 2012a, 2013) due to their collaboration and competition. From this assumption it follows that for projects in which sometimes conflicting goals, such as profitability and environment are pursued, cross-thinking individuals can be assembled to optimize outcomes such as performance, innovation & knowledge sharing within the teams. In cases where

conflicting goals between environment and economy play a significant role and an optimal intermediate path must be found, the theory of coepetition offers the composition of individuals who come from different areas and consequently have different mindsets. Our results show that individuals with high personality trait expression in openness and neuroticism tend to be more environmentally aware, while extraverted individuals focus on the financial aspects. Based on the theory of coepetition, it could be potentially assumed that these cross-thinking individuals should therefore be brought together as a team. This could increase the performance, innovation and knowledge sharing based on the coepetition theory.

CONCLUSIONS

Our practical implication on the contradicting topics is that it is recommended to create cross-thinking teams in order to improve the Sustainable Development Goals 8.4. The main aim for these contradicting issues is that the competitors, which have the preferences of environmental advantages and economic benefit goals, become partners vice versa (*Gnyawali & Park, 2011; Raşa-Ullah et al., 2014*). Our findings have given us a deeper insight into the extent to which individuals' personalities play a role in their preferences. This helps to explain the background and intentions behind the preferences that emerge during collaboration between interdisciplinary teams working on conflicting issues such as economic efficiency and environmental friendliness.

This study was characterized by the following limitations. This study can only explain the specific context of economic efficiency and environmental friendliness on the SDG 8.4 as the items were created on that basis. It was performed with 117 people. The sample size fulfills the requirements for the fsQCA, nevertheless the results can vary greatly with small deviations in their consistency. The outcome was conducted by only three items each. To get a better view of the preferences, more questions ranging for the outcome should be performed in further research. There is also no subdivision of the people. We included people with part-time and full-time jobs, as well as temporary managers with temporary jobs. Also, no specification of a specific sector (industry, NGO etc.) was done, as this was a generic approach of an explorative topic. Additionally, we raised the study in Germany, our results can be different in other regions, as different culture might play a role in personality traits with the respective outcome.

Our study points to other possible research directions. First, the distinction of survey could be applied to different areas in order to have a closer examination of different groups of people. Second, the reason why people are focusing on economic efficiency or environmental friendliness should also be asked and evaluated. The focus of the study is primarily on the theory of coepetition among cross-thinking teams. It is not clear whether these teams perform significantly better in practice. Thus, it is necessary to validate the interim results with empirical studies of cross-thinking teams. Other influences, such as bearing responsibility for projects and the environmental impact, could be analyzed further (*Kerekes, 2011*). Future research should also focus on social environment factors, such as social difference, cultural areas, beliefs and career priorities.

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Corresponding author:

Anh Don TON

Hungarian University of Agriculture and Life Sciences

Doctoral School of Management and Organizational Sciences

H-7400 Kaposvár, Guba Sándor u. 40.

e-mail: Ton.Anh.Don@phd.uni-szie.hu

ORCID: <https://orcid.org/0000-0003-0139-0007>

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ANNEX

Questionnaire

	Question	6 point Likert scale (1 = I don't agree; 6 = I fully agree)					
		1	2	3	4	5	6
E	I am someone who tends to be quiet						
E	I am someone who is dominant, acts as a leader						
E	I am someone who is full of energy						
A	I am someone who is compassionate, have a soft heart						
A	I am sometimes rude to others						
A	I am someone who assume the best about people						
C	I am someone who tends to be disorganized						
C	I am someone who has difficulty getting started on tasks						
C	I am someone who is reliable, can always be counted on						
N	I am someone who worries a lot.						
N	I am someone who tends to feel depressed, blue.						
N	I am someone who is emotionally stable, not easily upset						
O	I am someone who is fascinated by art, music, or literature						
O	I am someone who has little interest in abstract ideas.						
O	I am someone who is original, comes up with new ideas						
S	Optimizing resource efficiency is a key goal for me, even if it means reducing profits.						
S	I would not want to work for a company that is not improving its sustainable consumption and production.						
S	When it comes to developing or deciding on new processes, the environmental factor is crucial for me						
B	Economic growth and entrepreneurial success is the most important factor of a company, therefore this goal also stands above all others.						
B	If it is legally compliant and we make more profit as a result, I would also access processes that have a negative climate footprint						
B	When it comes to developing or deciding on new processes, cost-effectiveness is crucial for me						

Notes: E Extraversion, A Agreeableness, C Conscientiousness, N Neuroticism, O Openness, S Environmental friendliness, B Economic efficiency

Source: Based on *Soto et al.* (2017)

LOCAL RESOURCE CLUSTERS OF SOUTHERN TRANSDANUBIAN SETTLEMENTS

**Bernadett HORVÁTHNÉ KOVÁCS, Diána KOPONICSNÉ GYÖRKE,
Bernadett NAGY, Kinga SZABÓ**

Hungarian University of Agriculture and Life Sciences, Kaposvár Campus H-7400 Kaposvár, Guba
Sándor u. 40.

ABSTRACT

Development goals, priorities and strategies need to be based on available (local) resources, which are identified as either comparative advantages or uniform development goals at certain planning level. Core development policies of the region take centrum-periphery theory as the primary approach in planning allocating development funds. In this paper authors developed four settlement clusters based on their local resources (HCSO, AC, T-STAR database, 44 variables, cross section 2018). Few Strong and capable cities (n=31) are accompanied by mainly Agricultural villages (n=155) and there are settlements (n=170) with Concentrated capacities. But majority of the region's area (n=299) has Limited resources. The classification of the settlements can be used in gravity models that test the pull effect of central cities on the complex development of the surrounding settlements.

Keywords: planning, settlements, classification, spatial heterogeneity, local resources, clusters

INTRODUCTION

There are substantial differences across EU member states in terms of knowledge and institutional settings as well as the objectives of regional policies (Varjú, 2021). Hence, the approach, the applied methods and materials to support regional planning vary from country to country.

The Hungarian Government decided on the establishment of the South Transdanubian Economic Development Zone with its Government Decree of 1569/2020 (IX. 4.) in order to form economically and culturally unified areas, to develop internationally competitive economic units that will play a key role in strengthening the economy.

The current article analyses the local resources and classifies the region's settlements to provide most update information on and understand a) the variation of the local resources availability of settlements and b) support development strategies and policies targeting. The classification allows to describe the relative development status of each settlement groups in details. With the help of the results obtained, it is possible to suggest an allocation of diverse development funds which may better fit to the EU Horizon 2050 planning period. Further research may also build on the above classification of the settlements; e.g. we suggest to use it in gravity

modelling of the region in order for defining more suitable territorial scale and boundaries for planning and implementation of developments.

LITERATURE REVIEW

According to the followers of local resources based development (earlier: *Capello*, 2007; *Camagni*, 2009 and neo-endogenous: *Cejudo & Bavarro*, 2020; *Pollermann et al.*, 2020; *Biczekowski*, 2020), development goals, priorities and strategies, concepts are supposed to be based on the resources that can be allocated, and are identified as either comparative advantages or uniform development goals. Resources are considered as factors that constitute the set of opportunities and provide value to developers (*G. Fekete*, 2013; *Mezei*, 2018; *Varjú et al.*, 2020). The project absorption capacity of settlements also depends on the availability of local capital (e.g. resources) (*Horváthné et al.*, 2021a). For most local developments, a territorial scale that goes beyond the boundaries of a particular municipality would be ideal for implementation (*Mezei & Varjú*, 2018).

The current planning period is specific and unique from certain point of view. Beside the bottom-up approach (where regional planning considers the county plans), planners have to deal with the central expectation of South-Transdanubian Economic Development Zone (*Hungarian Government*, 2020) in the new planning period. The development planning strategy suggests that core or central territories shall be targeted and it is expected that such developments are planned that best fit to the territories. The regional plan had to consider the county concepts, too. An earlier study (*Horváthné et al.*, 2021b) on the county development plans (*Tolna County Local Government*, 2021; *Baranya County Local Government*, 2021; *Somogy County Local Government*, 2021) identified seven specific zones that are characterised by single or multiple development aims, but majority of the region's settlement are not targeted by development in the county concepts. Further feature of the planning is that it relies on the central focus and peripheral effect (i.e. pulling) of gravity. However, the (small) cities' capabilities for playing central role in the development of micro regions had not been found clear (*Horváthné et al.*, 2017) in the Southern Transdanubian region, neither may be maintained if considering the perforated spatial structure of the region (*Máté et al.*, 2017).

The authors' intention is to illustrate the dispersion of resource availability of settlements and to show that the settlements on the administrative micro regions are very diverse in terms of development and local resources. Several types of patterns can be applied (*Jia et al.*, 2020) according to different relations of centrum – periphery (rural – city, etc.) and understanding the spatial structure of the region may help identify the most applicable ones for individual micro regions for better planning and allocation of developments.

The paper is structured as follows: after this introduction, in the second part the used materials, data, and the analytical, methodological framework are presented. In the results and discussion part the short description of the planning area is followed by the detailed presentation of the analyses. In the last part the authors conclude by arguing that the development strategy of the region needs to consider the diverse endowments and understand the possible roles of micro region centres.

THE STUDY AREA

The region includes 3 counties: Somogy, Tolna and Baranya. It is very heterogeneous from the point of view of development; it is made up of several development areas at administrative level. 656 settlements (41 towns and 615 villages) can be found in the region on a 14 198 km² large territory with 894 223 inhabitants, more than half of which (333 settlements) are social, economic and infrastructural beneficiaries, while 265 (40.4%) belong to the group of settlements with significant unemployment (105/2015. (IV. 23.) Government Decree). The Southern Transdanubian Region is bordered by lake Balaton in the North, river Danube in the East, the Croatian border line following River Drava on the South (*Figure 1*), which limits the peripheries' expansion.

Figure 1: Location and natural borders of the South Transdanubian Region (NUTS2)



Source: Szabó (n.d.)

Government Decree of 290/2014 (26.11.2014) on the classification of beneficiary districts defines the beneficiary areas as those districts where the complex indicator is lower than the average of the complex indicator of all districts. It also defines those districts among the beneficiary districts which have the lowest complex indicator and are home to 10% of the cumulated population of the country as districts to be developed with a complex programme.

MATERIALS AND METHODS

A cross section database of 656 settlements was created by using 44 socio-demographic, business-economic and agricultural indicators of the T-STAR settlement HCSO statistics of 2018 and Agricultural Census of 2010.

As a first step the data was divided with the number of permanent population or the size of the settlement in order to avoid size effect.

Then, three methods of index generation were employed to rescale data.

Relative index numbers of intensity

Relative index number xy_{ij_rate} (1) is calculated in a way that given variable for i^{th} settlement (x_i) is divided by another variable (mostly population or size) of the j^{th} settlement (y_j); it takes on value in range of [0-1].

$$xy_{i_rate} = \frac{x_i}{y_i} \quad (1)$$

The same procedure was applied for the calculation of the ratio number of land use, where y_i was the total of agricultural land of i^{th} settlement.

Normalisation

We applied *min-max normalization* (2) to rescale values of variables ranging between 0 and 1. The normalised value for each observation x_{i_st} is calculated by the following formula, taking the range of each variable as denominator of the ratio.

$$x_{i_st} = \frac{x_i}{max_{x_i} - min_{x_i}} \quad (2)$$

Scale transformation

We used the process of dividing the data by 100 or 1000 in order to rescale into [0;1].

Dummy variables

The value of a variable may take only 0 or 1. There was no need for scaling.

The set of indicators and variables used in the analysis is summarised in *Table 1*.

Table 1: Indicators and variables of settlements with main statistics

Indicator Name	Variable Name	Mean	St. Dev.	Min	Max
PERMANENT POPULATION (NORM) (HEAD) 2018	population (norm)	0.01	0.05	0.00	1.00
PERMANENT POPULATION AGED ABOVE 60 (HEAD) 2018	old (rate)	0.26	0.06	0.08	0.56
AREA OF SETTLEMENT (NORM) (KM ²) 2018	acreage off settlement (norm)	0.13	0.12	0.01	1.01
AVERAGE NUMBER OF REGULAR CHILDREN AID PER MONTH (RT) (HEAD) 2018	children aid (rate)	0.07	0.06	0.00	0.31
INVESTMENT OF MUNICIPALITIES (HUF PER HEAD) (NORM) 2018	municipal investment (norm)	0.01	0.04	0.00	1.00
FULL TIME PRIMARY SCHOOL CLASS (Y/N) 2018	primary school (Boolean)	0.38	0.49	0.00	1.00
MIGRATION (PERMANENT AND TEMPORARY) RATE (RATIO) 2018	migration rate	0.08	0.03	0.01	0.32
UNEMPLOYMENT ABOVE ONE YEAR (RT) 2018	unemployment rate	0.01	0.01	0.00	0.09
NUMBER OF CULTURAL EVENTS (PCS PER YEAR) (RT) 2018	cultural events (rate)	0.04	0.08	0.00	1.67
MUNICIPAL SELECTIVE WASTE (TONS PER HEAD) (RT) 2018	recycled waste (rate)	0.07	0.09	0.00	0.55
GOVERNMENT AGENCY (Y/N) 2018	government agency (Boolean)	0.05	0.21	0.00	1.00

Indicator Name	Variable Name	Mean	St. Dev.	Min	Max
NUMBER OF COMPANIES WITH (PCS PER HEAD) 2018					
500+ EMPLOYEES (INCL. NONPROFIT) 2018 + 250-499 EMPLOYEES (INCL. NONPROFIT)	large companies (Boolean)	0.03	0.18	0.00	1.00
50-249 EMPLOYEES (INCL. NONPROFIT) + 20-49 EMPLOYEES (INCL. NONPROFIT)	medium sized enterprises (rate)	0.07	0.16	0.00	2.02
10-19 EMPLOYEES (INCL. NONPROFIT)	small sized enterprises (rate)	0.10	0.19	0.00	1.91
REGISTRATED COMPANIES IN PROCESSING INDUSTRY (Y/N) 2018	processing industry (Boolean)	0.54	0.50	0.00	1.00
NUMBER OF REGISTRATED COMPANIES IN PROCESSING INDUSTRY (PCS PER HEAD) (NORM) 2018	processing industry (norm)	0.01	0.05	0.00	1.00
AGRICULTURAL CENSUS 2010					
TOTAL UTILISED AGRICULTURAL LAND (NORM)	Agric acreaga (norm)	0.01	0.07	0.00	1.72
UTILISED LAND RATE OF FOREST PER AGRICULTURAL LAND (RATIO)	forest rate	0.13	0.19	0.00	0.95
UTILISED LAND RATE OF ORCHARD PER AGRICULTURAL LAND (RATIO)	orchard rate	0.02	0.05	0.00	0.89
UTILISED LAND RATE OF FISH LAKE PER AGRICULTURAL LAND (RATIO)	lake (fish) rate	0.01	0.04	0.00	0.50
NUMBER OF AGRICULTURAL PRODUCRES (HEAD PER POPULATION HEAD)	number of agricultural producers (rate)	0.86	0.20	0.05	1.00
UTILISED LAND RATE OF CROPLAND PER AGRICULTURAL LAND (RATIO)	cropland rate	0.69	0.26	0.00	1.00
AGRICULTURAL LAND PER SETTLEMENT AREA (PER 10000)	agri_land (rate)	0.01	0.05	0.00	1.21
NUMBER OF PIG (PCS) (NORM)	pig (norm)	0.02	0.09	0.00	1.00
NUMBER OF CATTLE (PCS) (NORM)	cattle (norm)	0.03	0.09	0.00	1.00
NUMBER OF POULTRY (PCS) (NORM)	poultry (norm)	0.02	0.06	0.00	1.00
NUMBER OF GOAT (PCS) (NORM)	goat (norm)	0.07	0.13	0.00	1.00
NUMBER OF HORSE (PCS) (NORM)	horse (norm)	0.06	0.09	0.00	1.00
NUMBER OF FARMS WITH ANIMALS (PCS) (NORM)	number of farms with animals (norm)	0.15	0.15	0.00	1.00
PRODUCTIVE FORESTS (HA PER SETTLEMENT HA)	Product_forest	0.1	0.12	0.00	1.00
SOIL_PROT_FOREST (HA PER SETTLEMENT HA)	Soil_prot_Forest	0.05	0.10	0.00	1.00
NAT_PROT_FOREST (HA PER SETTLEMENT HA)	Nat_prot_forest	0.03	0.12	0.00	1.00

Remarks: NORM refers to min-max normalisation; RT refers to relative index numbers; RATIO refers to ratio variable; Y/N refers to the Boolean (dummy) variable; / 100 or /10000 means a transformation of dividing the data by 100 or 1000 in order to rescale into [0;1].

The dataset of altogether 44 transformed variables of 656 settlements was imported to STATA 15 software.

Methods used

The counties and settlement shape files were downloaded from OpenStreetMap. We merged the panel data with the shape file. The visualisation of the results was based on maps created with QGIS 3.16.0 software.

In the cluster analysis K-means model (type: partition, method: k-means, dissimilarity measure: continuous, distance: Euclidean) was applied with STATA 15 software. The optimal number of clusters was selected on the basis of the Calinski–Harabasz–pseudo–F statistics of stopping rule and the size of generated clusters (See Annex).

RESULTS

In the following, the results of the cluster analysis are shown. *Table 2* summarises the main statistics of the cluster model variables by clusters.

Table 2: Scores of variables in the resource clusters of South Transdanubian settlements

ID OF CLUSTER AND NUMBER OF SETTLEMENTS	CL 1 n = 31		CL 2 n = 155		CL 3 n = 299		CL 4 n = 170	
	mean	s.dev	mean	s.dev	mean	s.dev	mean	s.dev
VARIABLES								
population (min-max norm)	0.110	0.184	0.003	0.002	0.002	0.002	0.010	0.006
old (rate)	0.293	0.031	0.261	0.062	0.248	0.071	0.264	0.048
acreage off settlement (min-max norm)	0.443	0.261	0.092	0.049	0.088	0.058	0.199	0.108
children aid (rate)	0.024	0.016	0.066	0.056	0.089	0.068	0.053	0.044
municipal investment (min-max norm)	0.083	0.185	0.001	0.003	0.001	0.001	0.004	0.008
primary school (Boolean)	1.000	0.000	0.000	0.000	0.164	0.371	1.000	0.000
migration rate	0.061	0.011	0.082	0.031	0.084	0.043	0.070	0.015
unemployment rate	0.008	0.005	0.014	0.014	0.016	0.016	0.011	0.008
cultural events (rate)	0.023	0.017	0.054	0.139	0.050	0.061	0.026	0.029
recycled waste (rate)	0.173	0.145	0.071	0.083	0.041	0.045	0.096	0.103
government agency (Boolean)	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
large companies (Boolean)	0.484	0.508	0.013	0.113	0.000	0.000	0.029	0.169
medium sized enterprises (rate)	0.149	0.066	0.089	0.164	0.043	0.191	0.091	0.108
small sized enterprises (rate)	0.173	0.080	0.148	0.236	0.070	0.205	0.104	0.111
processing industry (Boolean)	1.000	0.000	1.000	0.000	0.000	0.000	1.000	0.000
processing industry (min-max norm)	0.109	0.185	0.003	0.003	0.000	0.000	0.007	0.010
agricultural acreage (standardized)	0.011	0.024	0.005	0.011	0.011	0.100	0.006	0.011
forest rate	0.167	0.243	0.136	0.178	0.132	0.193	0.124	0.174
orchard rate	0.028	0.054	0.017	0.038	0.010	0.021	0.023	0.084
lake (fish) rate	0.001	0.002	0.006	0.035	0.009	0.044	0.005	0.022
number of agricultural producers (rate)	0.831	0.243	0.856	0.183	0.857	0.201	0.864	0.187
cropland rate	0.626	0.281	0.681	0.243	0.699	0.266	0.690	0.260
agri_land (rate)	0.006	0.021	0.019	0.099	0.012	0.035	0.004	0.006
pig (min-max norm)	0.153	0.283	0.007	0.029	0.007	0.029	0.032	0.101
cattle (min-max norm)	0.189	0.232	0.010	0.028	0.010	0.051	0.043	0.091
poultry (min-max norm)	0.060	0.103	0.016	0.093	0.006	0.019	0.028	0.065
goat (min-max norm)	0.235	0.228	0.045	0.088	0.053	0.112	0.111	0.126
horse (min-max norm)	0.223	0.217	0.037	0.041	0.030	0.050	0.095	0.093
number of farms with animals (min-max norm)	0.44	0.262	0.093	0.067	0.083	0.067	0.254	0.159
Product_forest	0.213	0.218	0.075	0.084	0.077	0.093	0.131	0.157
Soil_prot_Forest	0.137	0.187	0.050	0.091	0.036	0.083	0.069	0.120
Nat_prot_forest	0.140	0.267	0.028	0.086	0.016	0.059	0.057	0.152

Source: Based on HCSO settlement data (2018) and Agricultural Census data (2010)

Looking at the scores related to each variable across the four clusters defined in more details (*Table 2*), the main characteristics of the clusters are discussed in the following. The bold letters indicate highest, while the italics the lowest values for given variable, which information is used when describing the clusters of settlements.

Settlements belonging to *Cluster 1* are typically greater sized (acreage=0.443) and most populated (population=0.11) cities (n=31). Cluster 1 is characterised by the highest municipal investments (0.083), ratio of selective waste (0.173), relative number of large and medium sized companies (0.484; 0.149) and size of agricultural land (0.011). Due to the size of these settlements, the size (0.167) and relative size of forests to agricultural land are the highest, while the relative size of croplands (0.626) and agricultural lands (0.006) is the second smallest. This is the only cluster where all settlements have some government agencies (Boolean government agencies = 1.00). Furthermore, the regional capacity for processing industry is concentrated (Boolean processing industry = 1.00) in this cluster. The lowest migration rate (0.061), unemployment (0.008) and number of cultural events per capita (0.023) are seen here. This Cluster is named: *Strong and capable cities*.

The settlements of *Cluster 2* (n=155) lack primary schools (0.000), government agencies (0.00) and face high migration (0.082) and unemployment (0.014). Although the relative size of agricultural land is highest (0.019) and cropland (0.681) is significant, the number of farmers is moderate (0.856), suggesting a concentrated agricultural farm structure. Further strength of the settlements of this cluster is the presence of processing industry (1.00). The size and population of the settlements are the second smallest (0.003) among the four clusters. This Cluster is named: *Agricultural villages* (Small villages with agricultural and processing industrial capacities).

Cluster 3 settlements are the smallest ones, and the second highest migration (0.084) and unemployment (0.016) is seen here (n=299). It lacks processing industry (0.00). Children aid is the highest (0.089). Large parts of fishponds (0.009) and croplands (0.699) are here compared to the other clusters. Like cluster 2, the number of livestock is low. This Cluster is named: *Limited resources* (Small villages with very limited resources). The number of cultural events is the highest in Cluster 2 and 3.

The second highest part of livestock (pig: 0.032; cattle: 0.043; poultry: 0.028), high rate of orchards (0.023) and size of forests (0.124) are found in *Cluster 4* settlements (n=170). It is strong in the number of mid (0.091) and large sized (0.029) companies compared to cluster 2 and 3. This Cluster is named *Concentrated capacities* (Areas with significant livestock and processing industry, relatively high number of large and medium sized enterprises).

The boxplots of the variables compare visually the four clusters in *Figure 2 a to d*.

The groups of variables in the boxplot charts give a visibly comparable information on the difference between clusters of settlements (described above).

The membership of settlements in clusters 1 to 4 was illustrated in a settlement border map of the Southern Transdanubian region (*Figure 3*)

The settlements of Cluster 1 are major cities by lake Balaton and county capitals. Majority of these cities are micro region centres, too. Namely Balatonboglár, Balatonföldvár, Balatonlelle, Barcs, Bátaszék, Bóly, Bonyhád, Csurgó, Dombóvár, Dunaföldvár, Fonyód, Kaposvár, Komló, Marcali, Mohács, Nagyatád, Nagybajom, Paks, Pécs, Pécsvárad, Sásd, Selye, Siklós, Simontornya, Siófok, Szekszárd, Szentlőrinc, Szigetvár, Tab, Tamási and Tolna belong here.

Figure 2 a: Boxplot of variables of four resource clusters of South Transdanubian settlements



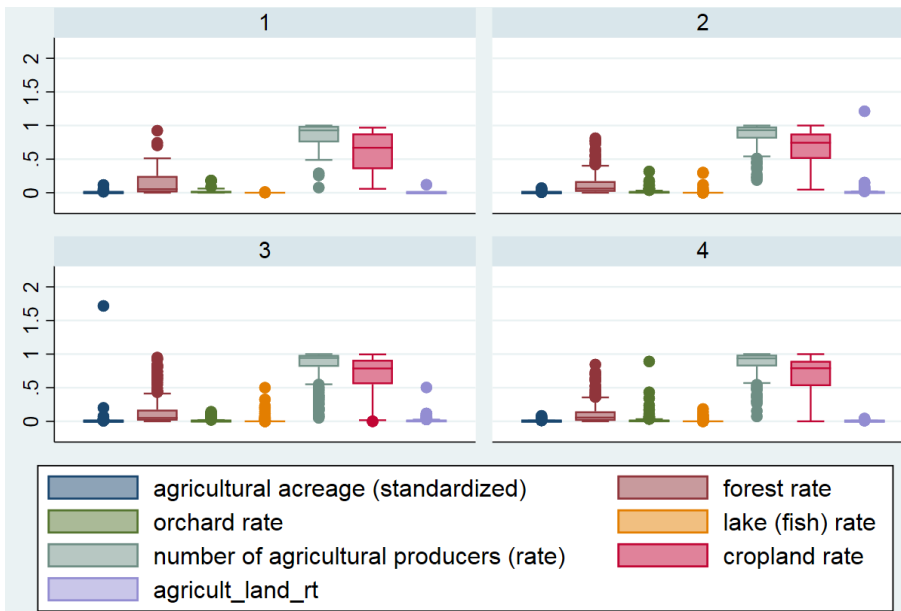
Source: Based on the HCSO settlement data of 2018 and the Agricultural Census data of 2010

Figure 2 b: Boxplot of variables of four resource clusters of South Transdanubian settlements



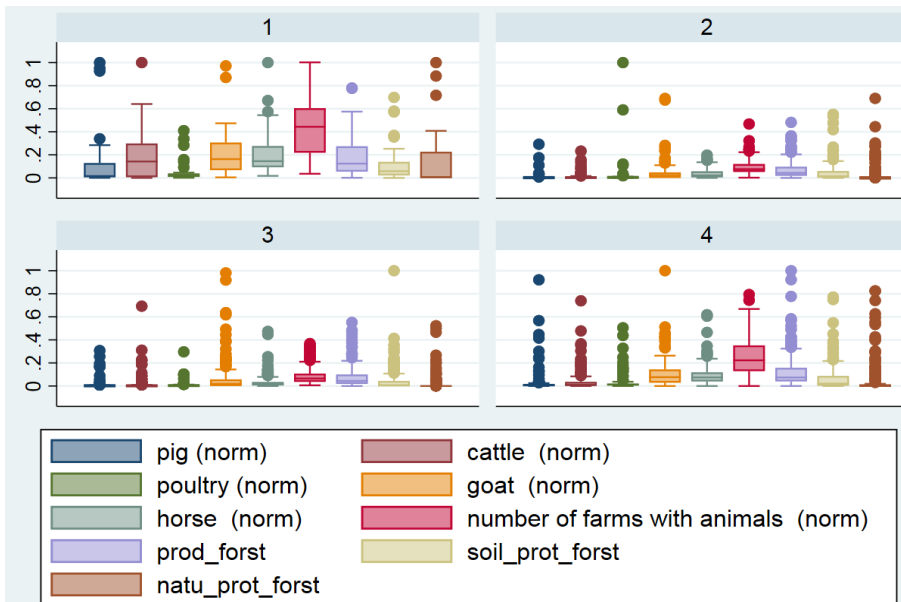
Source: Based on the HCSO settlement data of 2018 and the Agricultural Census data of 2010

Figure 2 c: Boxplot of variables of four resource clusters of South Transdanubian settlements



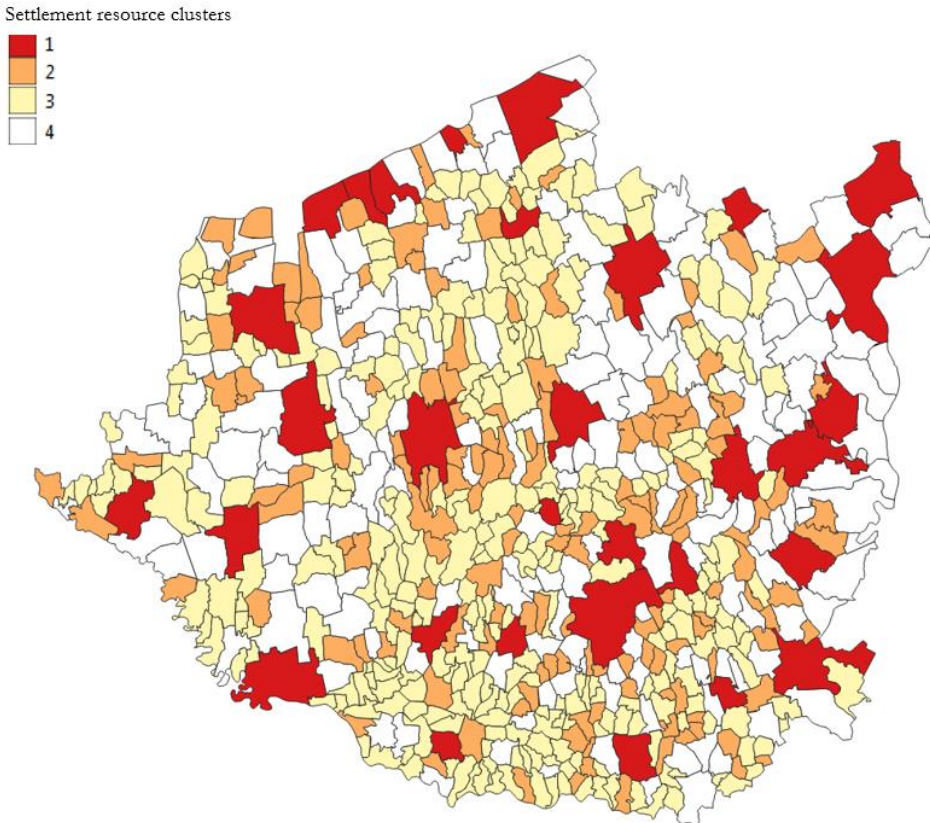
Source: Based on the HCSO settlement data of 2018 and the Agricultural Census data of 2010

Figure 2 d: Boxplot of variables of four resource clusters of South Transdanubian settlements



Source: Based on the HCSO settlement data of 2018 and the Agricultural Census data of 2010

Figure 3: Settlements' resource clusters in the Southern Transdanubian region (based on 43 variables, n=656)



Source: Based on the HCSO settlement data of 2018 and the Agricultural Census data of 2010

Most of Cluster 3 settlements (Limited resources) are situated along the north-to-south oriented zone in the middle of the region (internal periphery) and in the peripheral parts near Croatian border. Some further conglomerations are dispersed in the region's territory, which is worth a further analysis.

Settlements in the cluster of agriculture related strength are all over the region, they are spatially determined by the availability of agricultural resources. The concentrated capacities settlements counterbalance the spatial structure where cluster 3 settlements are rarely present.

DISCUSSION

The clusters of resource availability of settlements in the Southern Transdanubian region can be described as the following.

Few *Strong and capable cities* (n=31) are accompanied by mainly *Agricultural villages* (Small villages with agricultural and processing industrial capacities) (n=155) and

there are settlements (n=170) with *Concentrated capacities* (Areas with significant livestock and processing industry, relatively high number of large and medium sized enterprises). Majority of the region's territory (n=299) has *Limited resources* (Small villages with very limited resources).

Our results are partly in line with the categories of beneficiary districts defined by the government regulation taking four groups of 24 indicators (including living conditions, as well). The findings of the current study suggest that the beneficiary approach based on district level may need a more differentiated viewpoint in the assessment and planning of heterogeneous districts development.

The development concepts of the counties making up the Southern Transdanubian region identifies core zones for various kinds of development targets (Horváthné *et al.* 2021). Although it was not discussed in detail above, the geographic pattern of the settlements belonging to the four resource clusters might point out for the need of a different approach.

CONCLUSIONS

The applied cluster analysis method was successful in classifying all the Southern Transdanubian settlements. The classification was performed on the theory basis of available local capital and resources of the settlements.

Various planning concepts and strategies targeting Southern Transdanubia (county concepts, regional economic development zones, tourism related developments, etc.) consider the centrum – periphery model and relies on the pull effect of central areas, cities. However, the expected (pulling) role of central areas is not confirmed clearly. Development concept of territories, zones assume similarity of these areas, but our findings show that the resource availability is heterogeneous considering the settlement level.

Scope of further research can be to reveal the spatial patterns of similar or heterogeneous (administrative) territories. The adsorption capacity for development funds could be also worth studying from the point of view of available local capital, which can be supported by the above introduced resource based classification of the settlements.

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Corresponding author:

Bernadett HORVÁTHNÉ KOVÁCS

Hungarian University of Agricultural and Life Sciences, Kaposvár Campus H-7400 Kaposvár, Guba Sándor u. 40.

e-mail: horvathne.kovacs.bernadett@uni-mate.hu

ORCID: <https://orcid.org/0000-0002-2038-6428>

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ANNEX

Calinski - Harabasz pseudo F values of clusters 2 to 6

Number of clusters	Calinski/ Harabasz pseudo-F
6	246.35
5	235.83
4	269.69
3	309.23
2	314.44

CLASSIFICATION OF THE DEVELOPMENT AREAS OF THE SOUTH TRANSDANUBIAN REGION (HUNGARY)

**Bernadett HORVÁTHNÉ KOVÁCS, Diána KOPONICSNÉ GYÖRKE,
Bernadett NAGY, Kinga SZABÓ**

Hungarian University of Agriculture and Life Sciences, Kaposvár Campus H-7400 Kaposvár, Guba Sándor u. 40.

ABSTRACT

The Hungarian Government decided on the establishment of the South Transdanubian Economic Development Zone. The identification of the areas formed by clustering settlements of similar features will help better target development goals and funds to the region. The development concepts of the counties (forming the region) were reviewed and each of the 656 settlements of the region were put into categories. The categories were formed according to the county concepts; classification of the space followed all of the area classifications mentioned in them: development goals, priorities, strategic categories or sectoral targets. It has been found that 291 settlements have not been targeted by the county concepts at all. Further 177 ones are classified as deprived areas either because of their peripheral situation or their underdevelopment status by law. 62 settlements are mentioned as ones to be targeted with either economic development programmes or classified as growth zones. The latter category consists of 26 settlements, which are either growth, industrial, innovative or logistic centres according to the development concepts. Tourism related developments are targeted and may be outbreak points in 176 settlements. The threat to the development of rural areas due to shrinking medium sized cities must be addressed. Our review and classification of South Transdanubian Region's settlements adds the value of the multifaceted approach through the application of the county development concepts.

Keywords: planning, settlements; QGIS; classification; spatial heterogeneity

JEL codes: R58, O2, R11

INTRODUCTION

The EU's cohesion policy has been widely acknowledged as a major driver of reform for domestic regional policies aimed at supporting regional development. However, there are substantial differences across EU member states in terms of knowledge and institutional settings as well as the objectives and foci of regional policies (Varjú, 2021). Hence, the approach, the applied methods and materials to support regional planning vary from country to country. In addition, the developers of a given regional development always update their methods in the light of the newer and newer available data and current development policy priorities.

The Hungarian Government decided on the establishment of the South Transdanubian Economic Development Zone with its Government Decree of

1569/2020 (IX. 4). The creation of economic development zones enables the historical regions, which form economically and culturally unified areas, to develop as internationally competitive economic units. According to the government's intentions, economic development zones will play a key role in strengthening the economy and in the rapid recovery of its growth after the Covid-19 pandemic.

The classification of the spaces of the South Transdanubian Region brings closer to the targeted and efficient use of financial resources (funds) within the zone by identifying the coverage, heterogeneity and resource absorption capacity of these areas.

The aim of this article is to create a regional mapping of the diverse development areas in order to contribute to forming the South Transdanubian regional economic development zones, which the decision makers can build upon their future plans and development documents.

The article will introduce briefly the main dimensions of the counties' development concepts in order to give a basis for the classification process of development areas. We discuss which areas are targeted with what kind of development goals or classified in any other way as single territories.

With the help of the analysis, it is possible to suggest which categories of space / settlement can be formed, to which the development proposals can be applied, and how the peripheries can be defined. Furthermore, those areas of settlements will be highlighted as neglected peripheries where no specific development goals are targeted, therefore are facing deprivation.

MATERIALS AND METHODS

We would like to contribute to the above mentioned with the results reported in this study by the classification of the development areas of the South Transdanubian Region. For this purpose the development goals, strategic points and priorities named by the development documents of the three counties of the region, and the development areas and other priority areas mentioned in the concepts were the basis of our classification.

The development concepts of Somogy, Baranya and Tolna were reviewed and used to define the categories of development areas for each of the 656 settlements of the South Transdanubian Region. Each settlement was allocated dummy variables of all categories mentioned by name in the counties' development concept, including spatially defined and sectoral areas as well. A cross sectional database of 656 settlements was created which included originally the dummy variables for these categories. In some cases, very rare special development programmes were merged into a single variable. For example, the low number of settlements under innovation, growth, logistics or industry development was merged into a single variable (Gr/ind/log/innov). In the next phase the law-determined classifications of the settlements were also included - only in those counties where the county concept mentioned this classification as part of it. The categories for Complex development and Beneficiary were joined also. In this way, no, single or multiple classes were given to settlements and we showed the spatial pattern of these classes as well as indicated how diverse some of these areas were.

The regions' settlement level shape file was downloaded (*data2.openstreetmap.hu*, 2020) and merged with the settlement data file containing the variables of development categories.

The dummy variables used for the classification of settlements are shown in *Table 1*.

Table 1: Variable list

Variable name	Long name or target of development	Number of settlements
BKÜK	Balaton Kiemelt Üdülőkörzet	40
KDKT	Közép Duna-menti Kiemelt Térség	62
Tourism	Tourism	176
CB	Cross-border	83
Complex/Benef	Complex development programme AND Beneficiary programme (merged variable)	94
Econ	Economic development	49
Gr/ind/log/innov	Growth Industrial Logistics Innovation (merged variable)	27

Settlements with more than one development goal or classification category were classified as mixed categories. The mixed categories were created with the excel function CONCATENATE and it was also indicated on the map of the results. The database was imported to QGIS, and a map showing the joint classification of development regions was created (*Barna, 2020*).

The frequency numbers for categories were reported with pivoting the exported excel data table

County development concepts from the point of view of classification

The region includes 3 counties: Somogy, Tolna and Baranya and is very heterogeneous from the point of view of development; it is made up of a number of development areas at the administrative level. 656 settlements (41 towns and 615 villages) can be found in the region on a 14 198 km² large territory with 894 223 inhabitants, more than half of which (333 settlements) are social, economic and infrastructural beneficiaries [105/2015. (IV. 23.) Government Decree], while 265 (40.4%) belong to the group of settlements with significant unemployment [105/2015. (IV. 23.) Government Decree]. The South Transdanubian Region is bordered by lake Balaton in the North, river Danube in the East, the Croatian border line following River Drava in the South (*Figure 1*), which limits the peripheries' expansion.

Figure 1: Location and natural borders of the South Transdanubian Region (NUTS2)



Source: Szabó (n.d.)

Government Decree of 290/2014 (26.11.2014) on the classification of beneficiary districts defines as beneficiary areas those districts the complex indicator of which is lower than the average of the complex indicator of all districts; it defines as districts to be developed with a complex programme those districts within the beneficiary districts which have the lowest complex indicator and are home to 10% of the cumulated population of the country.

When defining development goals, priorities and strategies, county concepts are based on the resources that can be allocated according to the legal delimitations on the one hand, and on the resources of regions and settlements on the other hand, and are identified as either comparative advantages or uniform development goals.

In the following, we summarise the main classification categories of the concepts; all information was extracted by using the terms for priority, strategy, development goal of the concepts.

Classifications of the Development concept of Somogy County

The central region of the county is the county town Kaposvár and its surroundings, where the level of development is better than the county average (*Somogy County Local Government, 2021*). It has been continuously developing, although still not visible sufficiently either in the international or the national socio-economic space.

An important internationally noticed area that is one of the tourist attractions of rural Hungary is the shore of lake Balaton and its settlements, which are also defined by the law (Act CXII of 2000).

The county's periphery in the South (bordering Croatia) is the area of the districts of Barcs and Csurgó. This area is the target of a particularly disadvantaged area to be developed by a targeted development programme, as specified in the legislation.

The Inner Somogy area, settlements situated further from Kaposvár as rural villages, is characterised by low social and economic relations to Kaposvár. This area has a determining city, Nagyatád.

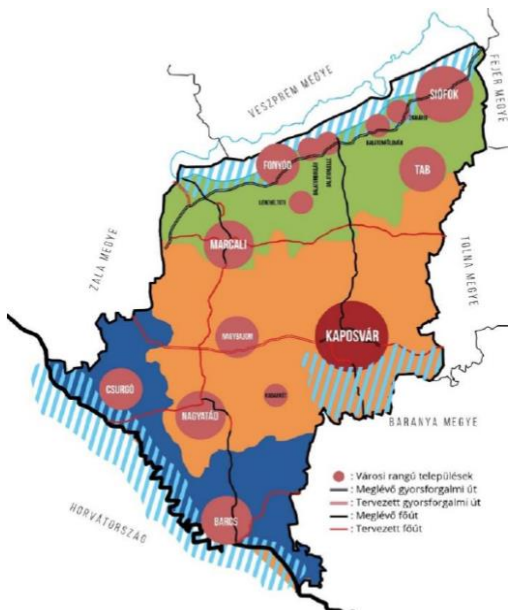
Within the above area, Zselic stands out with its superficial tourism endowments. Being close to Kaposvár, this area and Kaposvár could well be a tourism development micro region.

The development concept of the county states that the above area is uniform mainly in terms of applicable measures, only the city-village status of the settlements and the potentials for tourism are differentiating.

Besides tourism development, industrial initiatives are needed in major cities such as Kaposvár, Nagyatád, Siófok, Marcali and Tab.

The areas defined by the county development concept can be seen in *Figure 2*.

Figure 2: The development areas of Somogy county



Source: *Somogy County Local Government (2021)*

The objectives of the development concept of Somogy County define five major areas. These are the BKÜK, Kaposvár and its surroundings, the development of district centres and towns, rural life quality, complex development of border settlements.

The area of BKÜK - Lake Balaton Special Holiday Area (Act CXII of 2000 on the Adoption of the Spatial Planning Plan of the Lake Balaton Special Holiday Area and on the Establishment of the Balaton Spatial Planning Regulations) indicates 40 settlements within Somogy County (*Table 2*).

Table 2: BKÜK settlements in Somogy

Ádánd	Andocs	Balatonberény	Balatonboglár
Balatonendréd	Balatonfenyves	Balatonföldvár	Balatonkeresztúr
Balatonlelle	Balatonmárfiafürdő	Balatonőszöd	Nikla
Nyím	Ordacsehi	Öreglak	Pusztaszemes
Ságvár	Sávoly	Sérsekszőlős	Siójut
Som	Somogybabod	Somogymeggyes	Somogysámson
Somogyszentpál	Somogytúr	Somogyvár	Szántód
Szegeerdő	Szólád	Szőlősgyörök	Tab
Táska	Teleki	Tikos	Torvaj
Visz	Vörs	Zala	Zamárdi

Source: Act CXII of 2000

Kaposvár and its surroundings are the most capable areas of development.

The development of district centres and towns focuses on breakout points which ensure to slow down or stop the declining economic conditions of the area. These include Kaposvár, Siófok, Nagyatád in the field of tourism and industry, Marcali, Tab in primary industrial development and Fonyód, Balatonboglár, Balatonlelle, Balatonföldvár, Zamárdi, Igal in primary tourism development.

The complexly targeted areas of Csurgó and Barcs need the approach of circular economy and related measures; the towns of Nagybajom and Kadarkút also belong here. Although these are situated in the district of Kaposvár, they do not belong to the gravity of Kaposvár.

Rural life quality, the complex development of border settlements target to reduce the territorial imbalances. It defines renewable energy, food, tourism, climate resilience (agriculture) as breakout points.

Classifications of the Development concept of Baranya County

According to the development concept (*Baranya County Local Government, 2021*) for 2021-2030 - in accord with the earlier definitions of development areas - the following areas are targeted with single complex programmes (*Figure 3*).

The periphery of Baranya in the western, south-west and north-west borders of the county are deprived areas to be developed under a complex development programme, including the Sellyei, Szigetvári, Hegyháti, Szentlőrinci districts, where

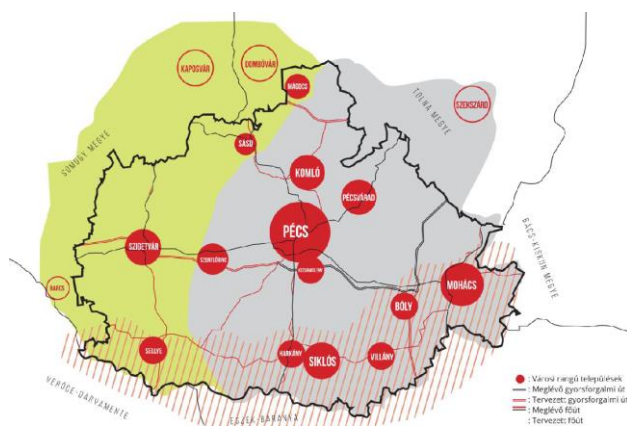
local resources have to be taken into account. In the district centres industrial development programmes are needed.

The centre of the county and its eastern part, Pécs-Komló, Kozármisleny, Szentlőrinc, Pécsvárad, Mohács, Siklós, Harkány, Villány, Bóly are defined as a growth area, which is targeted with an economic restructuring programme.

Some developments are based on local strategies, such as the Pécs, Komló, Pécsvárad-Bóly-Mohács axis as an industrial - logistics zone, the Szigetvár-Szentlőrinc-(Siklós) agro-food and light industry axis, and the Harkány-Siklós-Villány-Mohács one as a micro destination of health-gastro-tourism. It is also evident that the Pécs-Mecsek-Szigetvár triangle is a specifically targeted one.

These two larger areas described above are basically defined by their socio-economic and infrastructural factors. Another area that was included already in the 2013 concept of the county needs further consideration. It is a cross-county and a cross-border area including the Southern-Baranya border area (from Ormánság to Mohács) and the villages situated to the south from the Villány hills (settlements in the south of Sellye, Siklós, Mohács districts).

Figure 3: The development areas of Baranya County



Source: *Baranya County Local Government* (2021)

The strategic objectives are defined in seven points accordingly.

The development of local economies, creating circular economies built on the endogenous resources of the settlements. This strategy counts on local endowments and the integrated development of the local economy. Strengths of these areas can be settlements with functions of local logistics and market organizations, with (micro)regional roles, which will be further supported. It is important to develop community based energy supply systems and diverse competencies of the population through education.

In case of micro regional economies ready for sustainable growth the breakout points can be health, environment, cultural and creative, food industries, mechatronics, electronics and informatics. These areas are relatively rich in small and

medium enterprises. From the point of view of tourism, the Pécs-Villány area of tourism [Government Decree of 429/2020. (IX. 14.)] is one of the 11 nationally defined areas of tourism. This includes Pécs, Villány, Harkány, Siklós, the settlements of lake Orfű and east-Mecsek landscape protection area and Duna-Dráva National Park, where the tourism related resources of the period 2021-2027 will be available.

Human resource development is a crucial point in order to meet the current and future market demands.

Social inclusion, elimination of income instability, market demanded education and equal opportunities (of public services, education and housing) are especially important development targets in the county. The social capital can be improved by integrating local communities.

The sustainable use of strategic resources includes water friendly technologies, climate resilience housing, buildings, the ensuring of environmental communal infrastructure, waste water solutions, secondary raw materials from waste, sustainable energy mix.

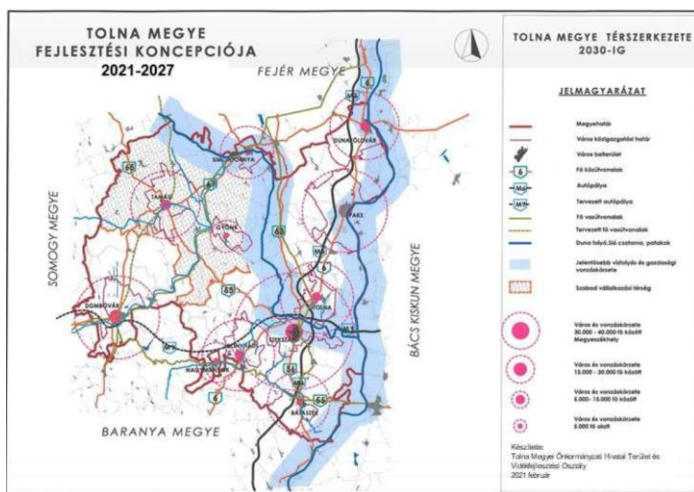
The improvement of mobility and availability helps create liveable and available environment, the availability of employers and services, alternative transportation.

In order to reach the status of an international growth centre, the development of transportation and border crossing are necessary in the county.

Classifications of the Development concept of Tolna County

There is an East-West demarcation (*Tolna County Local Government, 2021*) in the county (*Figure 4*). The Paksi, Szekszárdi and Tolnai districts are most developed, while the settlements further from the motorway are lagging behind. The later ones include one-third of the county (Tamási District) and the small settlements in the Dombóvári and Bonyhádi districts. New, efficient spatial development measures are necessary in order to reduce the development gap and help catching up.

Figure 4: The development areas of Tolna County



Source: *Tolna County Local Government (2021)*

A special area of the county is the Közép-Duna Menti Kiemelt Térség (Central Danube Region Priority Area), where 62 settlements belong to the county (Bonyhádi district 3 settlements, the entire Paksi, Tolnai, Tamási districts: 15, 4 and 32 settlements respectively, and the Szekszárdi district with 8 settlements).

The demarcations of territorial development strategies and goals follow the administrative boundaries more closely than in the case of Somogy and Baranya Counties.

The Tamási district is a complex programme development area.

The Dombóvári district and Economic Stimulus Programme targets of Hőgyész are beneficiary areas. Catching-up settlements are Értény and Gyulaj. (Government Decree of 1404/2019 (VII.5.) Government Decree on the definition of tasks is related to the new Roma Strategy of 1426/2019 (VII.26).)

Four priorities are defined in the county concept.

Complex territorial development programmes of the county targets are the free enterprise zone (Tamási District), the Central Danube Region Priority Area, the recreation areas of the Danube and the Sió, the functional and social development of the settlements, and the local leading programmes.

The strengthening of the economy is based on stronger RDI potential, the development of industrial parks and logistics centres and their services, enterprise development (including sectoral approach too, e.g. tourism) the improvement of the competitiveness of agricultural production, promoting local sales, the use of social economy instruments, stronger economic and knowledge based cooperation of actors. There are county zones defined accordingly, such as the development target zones for Innovation technology, Logistics and Tourism.

Environment, energy and transportation priority covers the development of spatial availability and mobility, demand-driven community transport services, climate resilient investments, sustainable use of lands, mitigation of environmental damages, local natural resources based energy production, improvement of energy efficiency.

The society has to be targeted with formulating a demand driven vocational education and training and adult education, equal opportunities of quality education and health and social services, improved availability of public services, employment, self-employment, community development, strengthening local identity and values.

It was visible after the review of the development concepts of the three counties that the spatial development was not only planned in an uncoordinated manner, but the goal of developments was also diverse and in many cases had not defined the resources.

In this context, the formulation of the regional picture is not easy. The result of the regions' development areas is sometimes scattered (only settlements define the demarcation line for the area of development), sometimes fits into administrative micro regions but many times does not, and there are also larger areas defined to meet specific development aims (axis, core and peripheral areas).

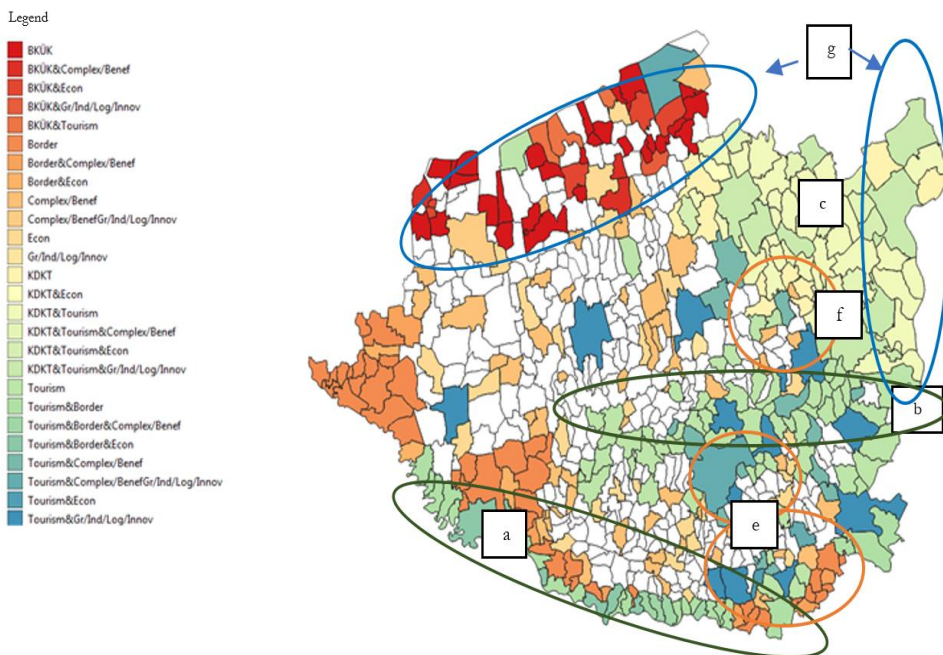
RESULTS AND DISCUSSION

The definition of the development of micro regions in the South Transdanubian Region was based on county development concepts and the classifications named in these documents. Due to the fact that the county concepts follow the classification

of the areas in a multifaceted way, there are geographic, law-determined and sectoral categories as well in the results (Figure 5).

The final classification indicates either single, in many times dual or even multifaceted development objectives at settlement level - depending on how many kinds of development areas the given settlement belongs to. Due to the above mentioned, labelling is also complex, our intention was to show how diverse the development goals were within the region and also to indicate those areas that could be handled as uniform despite belonging to different administrative areas.

Figure 5: The classification of development areas in Southern Transdanubia



The complex picture of South Transdanubia is colourful, most of the settlements are targeted with tourism development projects. They can be found (green-to-blue colours) *a* along river Drava and *b* along the Zselic - Mecsek - Gemenc zone in East - West direction and *c*) on a large area of Tolna county. Either to the North or South of *zone b*, the majority of the settlements are not dedicated to specific development objectives. Exceptions are the administrative centre town of Baranya and some of the centre towns of the districts with a limited number of neighbouring settlements. Settlements with tourism related development objectives mentioned in the Tolna County Concept seems to be dedicated to this objective if other local resources are not available for almost all of the county's territory, or in the area of the Danube zone.

The above mentioned area of settlements with administrative centre roles and some further settlements in the border zone form some cluster-like areas (*e*) in the middle and on the crescent of the southern-west part of Baranya. Innovation is also

a priority field here. The settlements targeted with economic development in Tolna (*f*) also seem clustering, but in a much smaller area than in Baranya.

In Somogy, there are only a few settlements that are considered as targets of economic development through implementing industrial programmes (darker blue). These are district centres and the capital of Somogy, which do not define clusters. In the zones of Balaton and the Danubethe settlements are eligible for further specific programmes (*g*).

It has been found that 291 settlements have not been targeted by the county concepts at all. Further 177 ones are classified as deprived areas either for their peripheral situation or because of their underdevelopment status by law (*Table3*). 62 settlements are named as ones to be targeted with either economic development programmes or classified as growth zones.

Table 3: Number of South Transdanubian settlements targeted with single or mixed development objectives

Development objectives	Number of settlements
Not specified	291
BKÜK	28
BKÜK+Complex/Benef	3
BKÜK+Economic	5
BKÜK+Growth/Ind/Innov/Logist	1
BKÜK+Tourism	3
Border	43
Border+Complex/Benef	6
Border+Economic	3
Complex/Benef	55
Complex/Benef+Growth/Ind/Innov/Logist	1
Economic	32
Growth/Ind/Innov/Logist	1
KDKT	10
KDKT+Economic	1
KDKT+Tourism	33
KDKT+Tourism+Complex/Benef	8
KDKT+Tourism+Economic	2
KDKT +Tourism+Growth/Ind/Innov/Logist	8
Tourism	60
Tourism+Border	22
Tourism+Border+Complex/Benef	4
Tourism+Border+Economic	5
Tourism+Complex/Benef	14
Tourism+Complex/Benef+Growth/Ind/Innov/Logist	3
Tourism+Economic	1
Tourism+Growth/Ind/Innov/Logist	13

The latter category consists of 26 settlements, which are either growth, industrial, innovative or logistic centres according to the development concepts. Tourism is a value and may be an outbreak point in 176 settlements.

There is a definite difference between the county concepts in terms of defining the territory of development zones - Somogy tends to set the centres as targets of development and expects the neighbourhood to get pulled by its centres, while in case of Baranya the zones of development consist of a couple of surrounding settlements. Tolna is found to lack both concepts, large parts of its territory are generally targeted or classified as to be developed - mostly in a complex way, and we could not see bigger cities with specific programmes (e.g. built on local resources). Both in Tolna and Somogy, the development concepts emphasise the lagging behind areas of settlements.

CONCLUSIONS

Our findings match some earlier studies on the spatial structure of the development in the South Transdanubian Region. Having analysed the small towns' role in regional development *Horeczki* (2014) illustrated two types of outlook for them: those with little economic role; and another group that has individual product or service, which may be a breakout point. *Jarjabka & Balogh* (2019) named environmental industry and health industry as breakout points through better circumstances for innovation, which was also reflected in the county concepts (especially that of Baranya county). The innovation based economic reform in the region was approached by a model for comparing economic policy scenarios in support of the S3 strategy in the 2014-2020 period (*Polónyi-Andor et al.*, 2020). However, the (small) cities' capabilities for development or for playing central role in the development of micro regions are not clear (*Horváthné et al.*, 2017) and may not be maintained if considering the perforated spatial structure of the region (*Máté et al.*, 2017).

The threat to the development of rural areas due to the shrinking medium sized cities must be addressed. Our review and classification of the Southern Transdanubian settlements adds the value of the multifaceted approach through the application of the county development concepts.

The research is possible to be extended with the analysis of the effect of available local resources in order to understand and evaluate the reasonability of local resource based development in the region. It may also reflect on the gaps of planning at administrative regional level versus locally available resources, local capital elements.

ACKNOWLEDGEMENT

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Corresponding author:

Bernadett HORVÁTHNÉ KOVÁCS

Hungarian University of Agricultural and Life Sciences, Kaposvár Campus H-7400 Kaposvár, Guba Sándor u. 40.

e-mail: horvathne.kovacs.bernadett@uni-mate.hu

ORCID: <https://orcid.org/0000-0002-2038-6428>

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ANALYSIS OF THE POSSIBILITY OF SWITCHING TO AGROFORESTRY IN ZSELIC

Róbert BARNA¹, Bence BÉRCES², Katalin TÓTH¹,

¹Hungarian University of Agriculture and Life Sciences Campus Kaposvár, H-7400 Kaposvár, Guba Sándor u. 40.

²KOMETA 99 Zrt. H-7400 Kaposvár, Pécsi u. 67-69.

ABSTRACT

Agroforestry solutions offer better use of disadvantaged agricultural land. Steep slopes and the constant risk of game damage are not conducive to agriculture. On slopes, the cost of machine operating hours is higher than on plane areas, and machines also wear out faster due to higher loads. Varied topography, steep slopes and deep valleys characterize the examined Zselic hills. There is typical forest management on the steep slopes that results in higher opportunity for game damage in the agricultural areas surrounded by forests. There are steep slopes under agriculture cultivation too that involve high operating costs. In our article, we examined whether the actual steep areas under current agricultural cultivation (slope > 12%) are large enough to consider switching to agroforestry. We have found that a quarter of all agricultural areas included in the examination is located on steep slopes, where it is worth considering switching to game damage-resistant agroforestry.

Keywords: agricultural cultivation, steep slope, game damage, agroforestry, Zselic

INTRODUCTION

Agroforestry solutions

If we believe the forecasts, by 2050, the global food demand will have risen by 60%. Because of this, we must use sustainable technology for the agriculture to be able to supply the rising population with food (*van Kernebeek et al., 2016*). The idea of agroforestry - which could be the tool for creating sustainable, environmentally friendly agriculture – is stated by the European Parliament as: „The agroforestry is a land use and farming system in which the woody vegetation is in conscious connection with the crops or with the grazing livestock on the same field while permanent forest stocks are not created. The trees can be placed scattered, in rows or in groups, while grazing is possible between them on the parcel (silvoarable (crops and forest), silvopastoral (grazing and forest), grazed or alley cropped fruit plantation) or on the edges of the adjacent parcels (tree rows and hedges)” (1305/2013/EU regulation).

These systems contribute to nature protection in a number of ways, such as integrating cropland with trees, creating a mosaic landscape structure, reducing soil erosion and deflation, promoting biodiversity, and binding carbon. (*Sharma et al., 2016*)

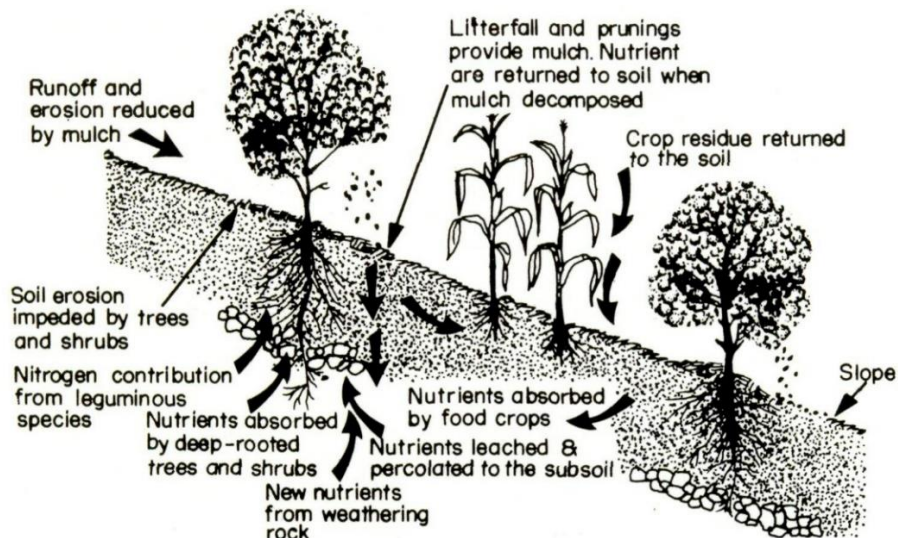
The practice of the combination of trees with agriculture or livestock measures an estimate of 1 billion hectares worldwide, of which 15.4 million hectares are agroforestry in the EU. In most of the areas, i.e. 15.1 million hectares, trees are combined with animal husbandry, while the remaining 358,000 hectares are integrated into arable crop production. (Augère-Granier, 2020) 38,100 hectares of Hungary is affected by agroforestry (den Herder et al, 2016).

Agroforestry on the slopes

The land may suffer serious damage if in the absence of proper protection and prevention it loses a part of its fertile soil: rainfall, wind, erosion all could cause scars on the topsoil, which can lead to the deeper absorption of the agricultural chemicals and fertilizers to the point where the crop cannot even reach it. Thus, the chemicals can reach further to the ground waters. The trees with their penetrating roots, however, not only protect the soil from erosion – holding the deep layers together – but also, as a safety net, gather the micro- and macro materials washed deep which the crop could not absorb. (Zamożny, 2018).

One of the first documented cases of alley cropping was published in Nigeria in 1983: in order to stabilize the soil on the steep croplands they planted rows of a ligneous mimosoid tree (*L. leucocephala*) between the rows of crops. Thanks to the fast growth of the mimosoid, it was possible to use the product of several annual prunings as mulch (Figure 1) (Sumberg & Okali, 1984). The ligneous mimosoid's deep roots bound the soil and the mulch used to cover the soil protected it from deflation and erosion. As the mulch degrades, it releases nutrients into the soil – or the mulch can also be used as forage (Stepler & Nair, 1987).

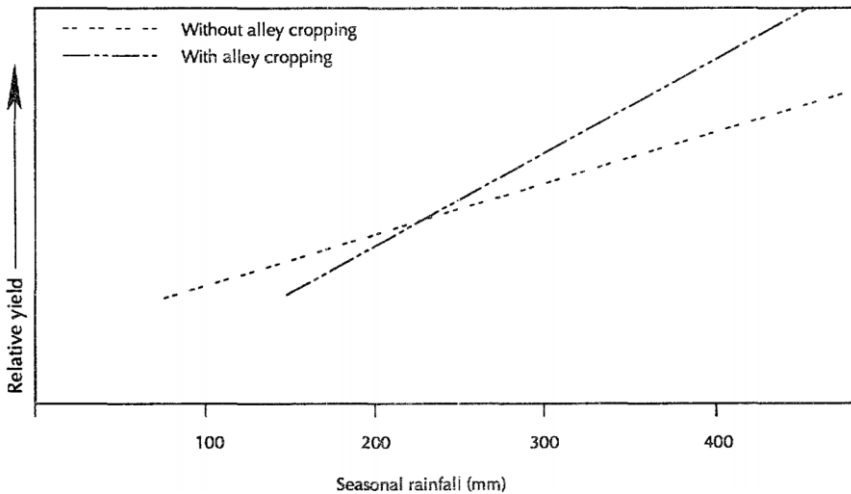
Figure 1: Schematic representation to show the benefits of nutrient cycling and erosion control in an alley-cropping system.



Source: Kang et al. (1986, p. 18.)

There are several factors which may limit the realization of positive effects. The most important of those is soil moisture. In the subtropical regions the higher annual rainfall and humidity leads to more potential harvests and green mass. In contrast, in the temperate zone the annual rainfall is unimodal and tends to fall over a 4-month period. Naturally, the rainfall has an effect on the relative yield which can be increased further with alley cropping (Figure 2). (Nair, 1993)

Figure 2: A generalized picture of crop (maize) yield, with and without alley cropping, in relation to rainfall during the cropping season under semi-arid conditions



Source: Nair (1990, 40. p.)

Characterization of slopes

The topography consists of an endless multitude of slopes. To characterize the slopes, the slope angle, i.e. the deviation from the horizontal position, can be given in degrees. In practice, the slope is usually given as a percentage. This is one hundred times the quotient of the slope height and the slope base, for example, if the terrain rises 10 meters at a distance of 100 meters, we are talking about a 10% slope (Mélykúti, 2010). In geodesy, 5 spatial categories are named as a function of percentage slope (Table 1).

Table 1: Classification of slope categories

Slope category	Slope gradient (%)	Classification
I.	0-5.0	plane
II.	5.0-12.0	slightly sloping
III.	12.0-17.0	sloping
IV.	17.0-25.0	slightly steep
V.	25.1-	steep

Source: Márkus & Sárközy (1986)

The machine cost of agricultural cultivation depends on the soil type and the slope of the field. The exact extent of this can only be determined by using values measured in precision farming. For costs without measurement, the current Government Decree (Government Decree 60/1992. IV. 1.) on the amount of fuel and lubricant consumption of road motor vehicles and certain agricultural, forestry and fishery power engines eligible without certification” provides guidance. The slope interpretation of the topography in the Decree is given in *Table 2*. Interestingly, although the values within the category are the same in both cases, the current regulation does not name slopes above 17.0 percent. Perhaps they did not want to specifically support farming in areas with higher slopes.

Table 2: Interpretation of topography by slope

Denomination	Slope gradient (%)
Flat area	0-5.0
Slight sloping area	5.1-12.0
Sloping area	12.0-17.0

Source: Annex 4 to Decree 60/1992. (IV. 1.) Government Decree.

The regulation establishes four categories depending on the slope and soil binding (*Table 3*). The legislator classified the soil binding in four categories based on Arany’s binding number: loose, medium-bound, bound, highly bound soils.

Table 3: Interpretation of territorial categories

Territorial category	Topography and constraint
I.	flat, medium-bound soil
II.	flat, bound soil slight slope, middle bound soil
III.	flat, loose sand and very bound soil slight slope, bound soil slope of mid-bound soil
IV.	mild slope, loose sand, and well-bound soil sloping, bound and highly bound soil

Source: Annex 4 to Decree 60/1992. (IV. 1.) to the Government Decree

The cost of work performed by agricultural machinery is, at best, a value determined by instruments. Failing this, the value of the cost increases due to soil and topography can be calculated by using multiplication rates. The multiplication rates express how many times the cost is eligible for category I:

- The multiplier for area category I. is 1.
- The multiplier for area category II. is 1.12 for surface works and 1.16 for tillage.
- In area category III., the multiplier is 1.24 for surface works and 1.38 for tillage.
- In area category IV., the multiplier is 1.44 for surface works and 1.72 for tillage. (Erdeiné Késmárki-Gally & Rák, 2020)

In addition to increasing costs, environmental protection must also be an important consideration. Sloping areas also require more careful cultivation due to the risk of erosion, such as not plowing downhill.

Agroforestry solutions can be used to farm on larger slopes, which can have the added benefit of being less sensitive to game damage. In the Zselic settlements of Kaposvár Forestry, only about a third of all areas are suitable for agricultural cultivation. (Barna *et al.*, 2021) Due to the large, extensive forests nearby, game damage is also an increased threat. In addition, some of the arable land in the hilly area is on slopes. In this study, we examine the area in which it would be more appropriate to apply agroforestry solutions. For this, we recommend areas with a slope greater than 12%.

MATERIALS AND METHODS

In our study we analysed the settlements in the Zselic area of the Kaposvár Forestry (SEFAG Zrt. – SEFAG Forest Management and Wood Industry Share Co.): Bószénfa, Cserénfa, Gálosfa, Hajmás, Kaposgyarmat, Sántos, Simonfa, Szentbalázs and Zselicszentpál (*Figure 3*).

For the analysis we used the download free map layers of Open Street Map (*Geofabrik GmbH*, 2021). From the Corine Land Cover database created by the European Union, the former FÖMI (now Lechner Tudásközpont – Lechner Knowledge Centre) produced an improved land cover map called CLC-50, which was also used (*Lechner Tudásközpont*, 2021), and SEFAG Zrt. provided a map of the area under its care.

For the topography characterization, we used the EUDEM 1.1 version, freely available in the European Union's Copernicus programme (*Copernicus Land Monitoring Service*, 2021). From this a slope map was produced.

A map of the Game Management Landscape Center (commonly known as the Deer Farm) area was produced in a previous study (Barna & Nagy, 2021).

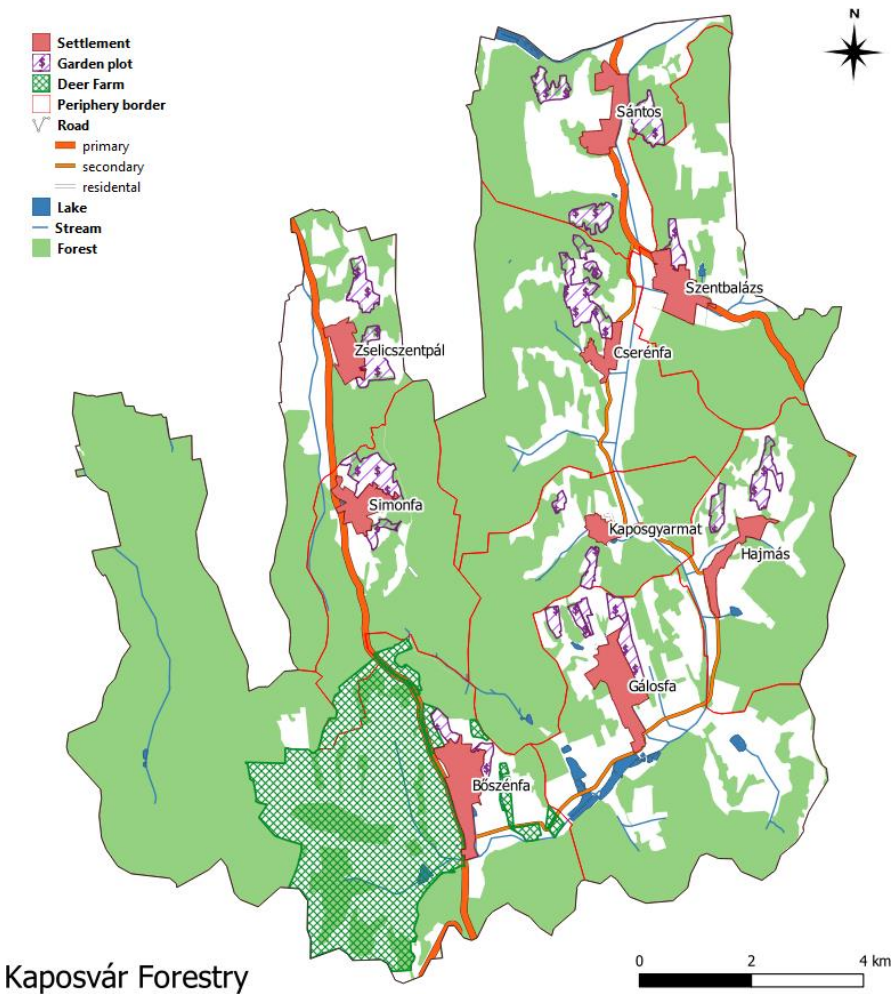
QGIS 3.16 software was used for spatial operations.

RESULTS

Only one part of the study area is suitable for agriculture. It is necessary to extract the inland areas, the enclosed gardens, the forests and the ponds from the total area. The Deer Farm (Game Management Landscape Center) also lies within the study area. Its area is subject to special farming practices that can be considered as agroforestry, so the area of the Deer Farm should be also extracted from the area suitable for agriculture. After these deductions, the remaining areas, marked in white on the map (*Figure 3*), are suitable for agricultural cultivation.

Figure 4 is a more transparent map created from *Figure 3*. The brown areas show which parts of the total area are suitable for agriculture. Although the map could be improved, as the dams among the fish ponds are still brown, the size of these dams is negligible and they do not significantly distort the results. Only 3188.18 ha (21.6%) remain after deductions as agricultural land from the total area of 14749.20 ha.

Figure 3: The map of study area



In the slope map of EUDEM, a special colour indicates slopes steeper than 12% (Figure 5). The map clearly shows the varied surface of the hilly landscape. The steeper areas are forested, but there are also quite a few agricultural lands steeper than 12%.

As a last step, the slope conditions of areas suitable for agricultural cultivation were examined. For this purpose, the map of agricultural areas and the slope map have been merged. The slope of the agricultural areas marked in pink in Figure 6 is greater than 12%. While this is not the vast majority of agricultural land, it is still a large area overall.

The total area of agricultural land with a slope of less than 12% is 2350.80 hectares. The remaining 845.30 hectares with a steep slope represent 26.5% of the total agricultural area. Due to the steep slope, it is advisable to consider the application of agroforestry solutions on more than a quarter of the area currently under agricultural cultivation (Figure 6).

Figure 4: The areas which are suitable for agriculture

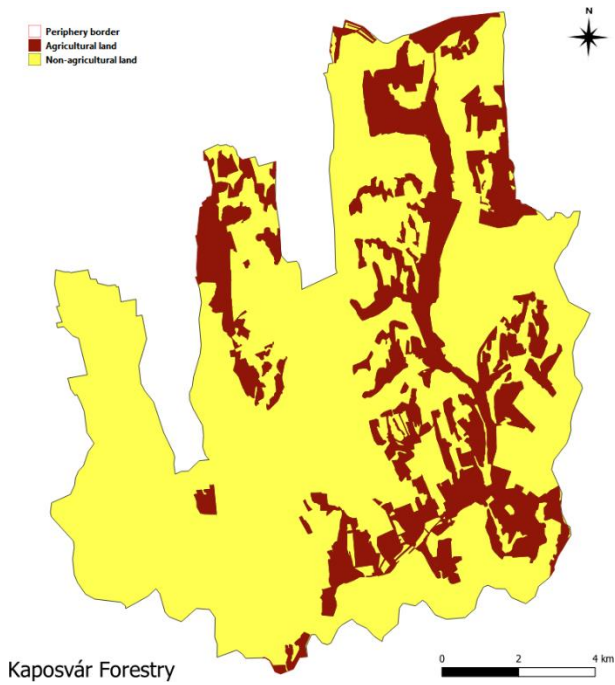


Figure 5: Slope map (%) of study area

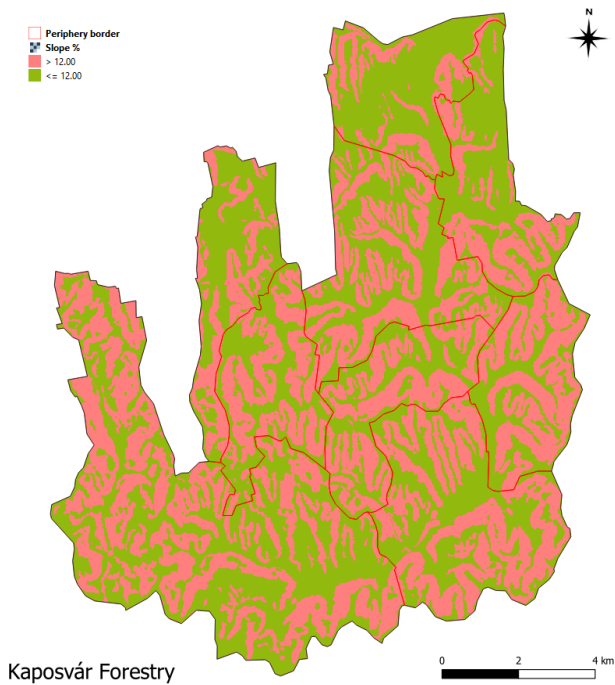
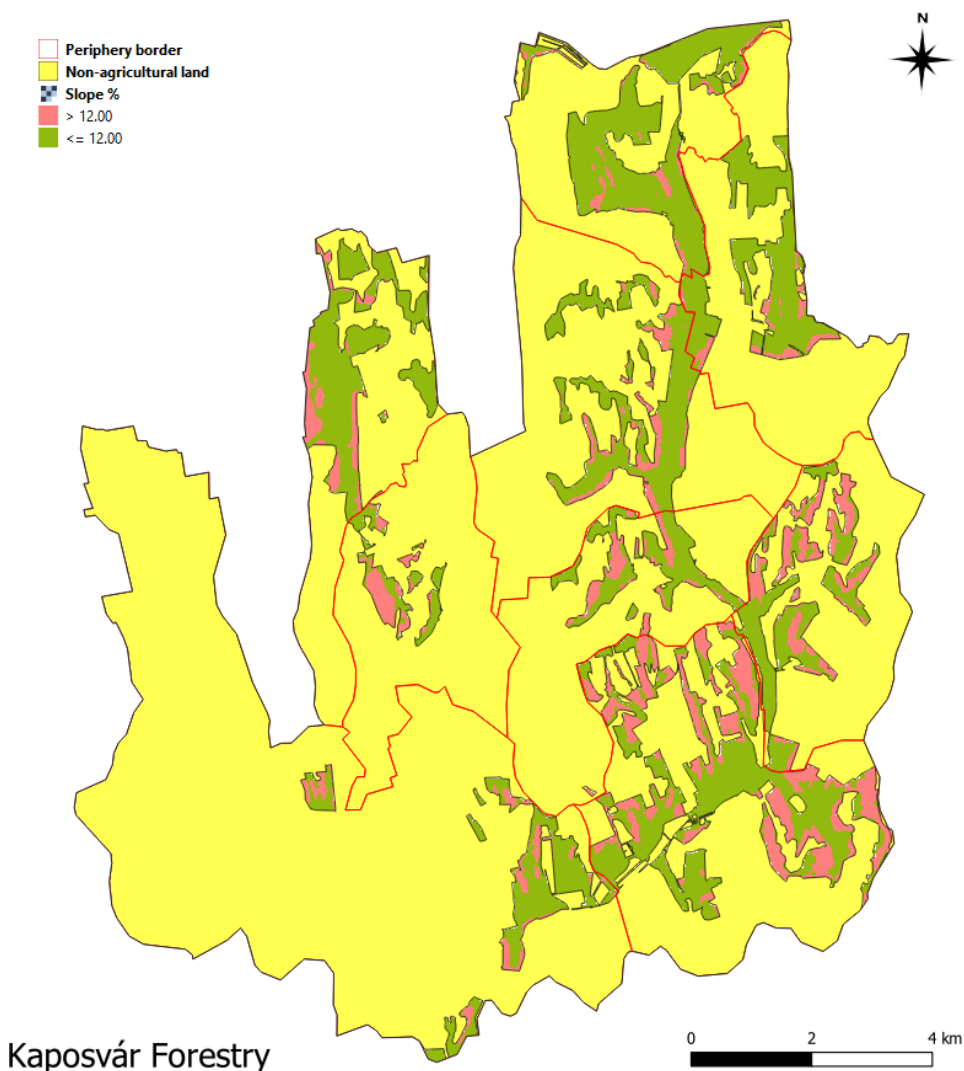


Figure 6: The areas proposed for agro-forestry management



CONCLUSIONS AND SUGGESTIONS

Steep slopes make up a significant part of the study area. They are mainly used for forestry, but more than a quarter of the areas suitable for agriculture are steeper than 12%. We suggest that farmers on such steep hillsides use agroforestry as a transition between forestry and agriculture. This would both reduce machinery costs and be environmentally beneficial by preventing erosion. Another argument in favour of the switchover is the high risk of game damage next to forested areas, which could be reduced by less sensitive crops.

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Corresponding author:

Róbert BARNA

Hungarian University of Agriculture and Life Sciences Campus Kaposvár

H-7400 Kaposvár, Guba Sándor u. 40.

e-mail: barna.robort@uni-mate.hu

ORCID: <https://orcid.org/0000-0003-3578-2180>

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SUSTAINABLE INNOVATION IN WINE INDUSTRY A SYSTEMATIC REVIEW

Valéria LEKICS

Hungarian University of Agriculture and Life Sciences, H-7400 Kaposvár, Guba Sándor u. 40.

ABSTRACT

The article analyses the literature on sustainable innovation in wine industry, applying the systematic review approach. The recent review provides answer to the questions: What kind of innovations wineries implement in order to operate sustainably? What are the driving forces of these innovations and how do these effect company performance? We find that the majority of the innovations are process or product oriented focusing on the cultivation and winemaking process or on the product itself. The key motivation factors of innovations are managers'/owners' commitment, consumer needs and export orientation, networking. Costs of investments, lack of information and knowledge, negative managers'/owners' attitude, inadequate regulations, profit pressure from shareholders, uncertainty are the main barriers of innovations. Sustainable innovations effect positively companies' performance. Economic performance is measured by competitiveness, new markets, volume of export, costumers' loyalty, operational risk, strong brand and eco-efficiency. Environmental performance is measured by lower environmental impact, better product and company image, higher level of reputation. The review of innovation and performance interaction may allow drawing policy implications for future actions.

Keywords: sustainable innovation, wine, motives, barriers, company performance

INTRODUCTION

Winemaking is one of the eldest human activities, its cultural importance exceeds market terms. The sector had to be renewed several times during history, one example is the epidemic of phylloxera at the end of the 19th century.

The wine sector has a wide-ranging socio-economic importance: viti- and viniculture are deeply embedded in culture and religion. Vineyards, wine-press houses and cellars formulate the very basics of the rural landscape. Wine is a high value added product, and an export-import article of a great importance. Vine cultivation and wine making are knowledge intensive agricultural and food sectors.

These days humanity faces a global ecological crisis. *Steffen et al.* (2015) found that the three most irreversible „planetary boundaries” are unbalanced biogeochemical (Phosphorous and Nitrogen) flows, biodiversity loss and land system change. Surprisingly, climate change „only” comes at the fourth place in the list of most severe global problems (*Steffen et al.*, 2015).

Global environmental problems challenge viti- and vinicultural enterprises greatly. Increase in temperatures and extreme agroclimatic events are expected to

cause damage to vine stocks. Pests and diseases are likely to cause problems. The suitable location for vine is expected to shift to higher altitude and latitude as well. Actors of vine and wine sector have to mitigate the negative impact of their activities on the environment (mitigation strategy) on the one hand, and they have to adapt themselves to changing climatic conditions (adaptation strategy) on the other hand. Mitigation measures are reducing carbon and water footprint, increasing energy efficiency, utilizing renewable energy sources and process residues to produce biofuels, new packaging alternatives to minimize weight. Adaptation measures are the use of cover crops, irrigation, changes in the geography of wine, introduction of new vine varieties in the maintained area (Carroquino *et al.*, 2020; Király, 2017). The search for sustainable solutions may hide innovative solutions for wine businesses.

The international wine market is characterized by strong competition, changing consumer attitudes and it needs to stimulate the actors of the wine market to continuous improvements. Innovation is indispensable to survive, improve, grow and to continuously assure the ability to generate profit in this turbulent environment (Gilinsky *et al.*, 2008).

Schumpeter emphasized the role of entrepreneurship and innovation in economics in the early 20th century. He pointed out that entrepreneurs can alter the competitive market through new products and processes, which is a result of their successful innovation. He underlined the relevance of entrepreneurship to the development of innovation. His classification of innovation activities specifies product innovation (focusing on new product development), process innovation (focusing on new production methods), marketing innovation (focusing on new markets), supply innovation (focusing on new sources of raw materials) and organizational innovation (focusing on new organizational structures) (Schumpeter, 1934).

Sustainable businesses of the wine sector „are committed to behave ethically and contribute to economic development while improving the quality of life for the workforce, their families, the local and global community as well as future generations” (Cralc & Verecke, 2004). Thus sustainable innovations generate new solutions to improving companies’ performance in environmental, economic and social terms at the same time (Elkington, 1998). This kind of modernization requires strategy and system oriented leadership, and can lead to success if the whole structure of the organization is involved in the development process (Kneipp *et al.*, 2019).

The rate of adoption of innovations depends on their several perceived attributes. Relative advantage of a certain development (profit, cost efficiency) effects positively its adoption. Incentives in form of direct or indirect payments of cash are able to speed up the diffusion of agricultural innovations. Compatibility of an innovation with former ideas, beliefs can either foster or hinder its rate of adoption. The complexity of an innovation effects negatively its rate of adoption, as understandable, easy to use solutions are preferred for implementation. Trialability of innovations relates positively to their adoption rate. If the results of the innovation are visible or can be communicated to others, the rate of its adoption rises (Rogers *et al.*, 2019). These factors have a complex effect with different intensity on the rate of adoption.

Although literature suggests that companies can benefit from the implementation of sustainable innovation, empirical results are still inconclusive. Several studies have

investigated the application of sustainable innovation practices in the wine sector, but there are still gaps regarding wineries' performance. In addition, there is a lack of comprehensive overview on the innovation in the wine sector. Thus, the aim of the study is to provide a systematic review on sustainable innovation of wineries with special emphasis on the classification innovation activities, motifs and barriers of adoption and the effect of innovation on the performance of businesses.

METHODS AND RESULTS

The systematic review approach has become an increasingly popular research tool in social science including economics and business studies. However, the use of systematic review is still rare in wine business research. The first step of the systematic review is to formulate research questions. The next phase is to design a review protocol describing the research strategy, the criteria for inclusion and quality assessment, the process for screening, data extraction, synthesis and reporting. The third step is to summarize and discuss the main findings of the relevant literature (Xiao & Watson, 2019). This rigorous protocol minimizes researcher bias occurring in data selection and analysis. It also provides validity, reliability and repeatability for the study, upon which comprehensive scientific report on literature of a specific theme can be filed (Tranfield *et al.*, 2003).

The selection process

We focus on studies exploring sustainable innovations of vineyards and wineries. We investigate the sustainability issues in the triple bottom line context.

Search strings were created with the words *sustainable*, *innovation*, *viticulture*, *viniculture* and their synonyms as follows:

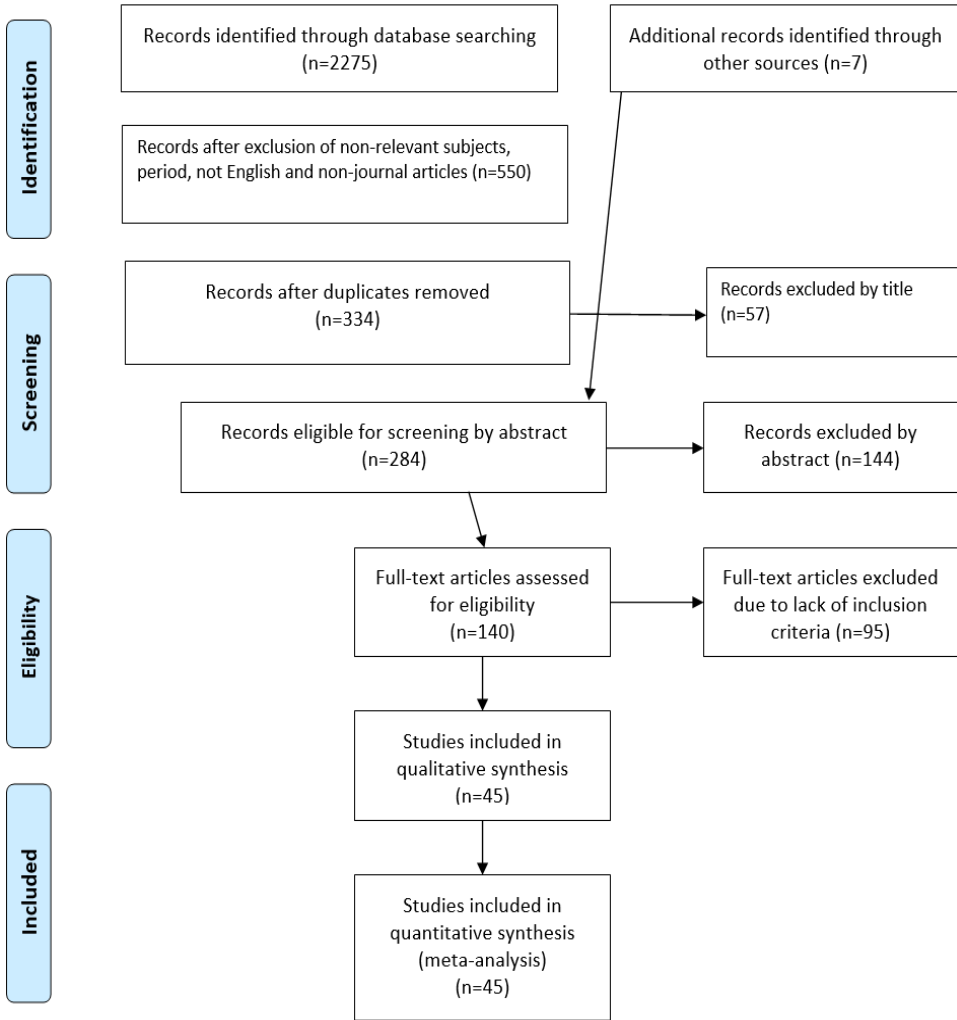
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sustainab* OR green* OR eco* OR environment* AND innovat* OR  
chang* OR improve* wine* OR vine* OR grape* OR oenolog* OR  
viticultur* OR vinicultur*
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The systematic search for literature was based on the two electronic databases Web of Science and Scopus in February 2021. The search provided 1239 results in Scopus and 1036 results in Web of Science, altogether 2275 results. After refining the search with the inclusion of the research area of environmental studies, agricultural economics policy, agriculture multidisciplinary, social sciences interdisciplinary, ecology, development studies, business, management, operations research management science, economics, multidisciplinary sciences, business finance and behavioral sciences, and inclusion of journal articles published between 2000 and 2020 in English language, the number of results for screening has decreased to 550.

The screening process of the literature is illustrated on *Figure 1*.

216 articles appeared in both databases, so they were excluded as duplicates. 57 articles were excluded because of the title and 144 articles because their abstract did not show a high level of importance with the research topic. We read the full text of 140 articles and excluded 95, because they did not focus exclusively on vineyard's or winery's innovation. Finally, we find 45 articles for detailed analysis (See Annex).

Figure 1: The selection protocol of the literature



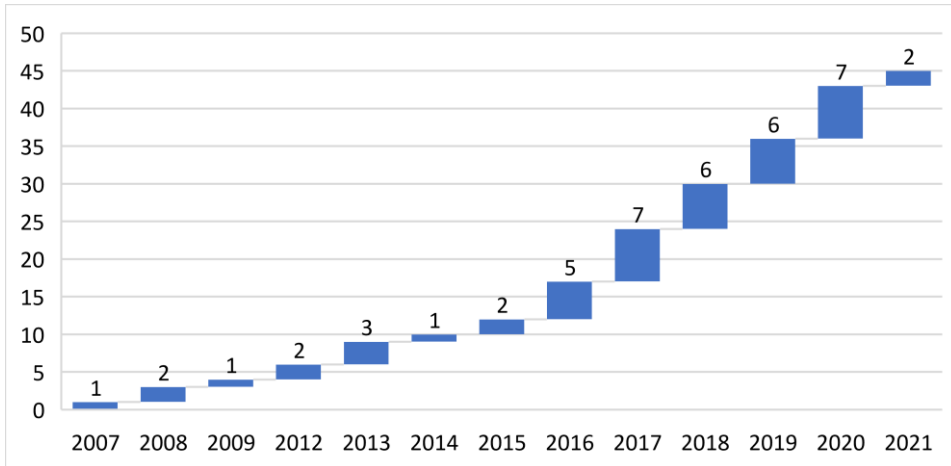
Data analysis

We classify the articles, based on the following characteristics: publication year, research focus, research area, theoretical background, research question, research method, sample size, type and variables of analysis, types of innovation, driving forces and barriers of innovation, effect of innovation on performance (yes, no, not significant), findings.

Topicality of the research theme and regional focus of the research

The number of articles exploring sustainable innovation in viti- and viticulture has been increasing since 2000 (Figure 2).

Figure 2: Number of articles between 2007-2021



The rising research interest might be triggered by the expansion of New world wine on the international market. Australia has tripled its wine production and geared up to 7.5 times its wine export between 1992- 2004 (*Smith & Marsh, 2007*). Smith and Marsh regard technological innovation and capability creation, developments in collaboration and associational structure, processes of industry dynamics and consolidation as the main driving forces of dynamic growth in the wine sector.

The success of New world wines effected unfavorably the production and export indicators in the “Old world” (=Europe): only Spain could double its indicators, France and Germany could achieve a modest growth, but Italy bore a regression in the indicators (*OIV, n.d.*). Research on innovation in wine sector focuses therefore on Old world; primarily on Italy and Spain (*Figure 3* and *Figure 4*).

Figure 3: Geographical focus of the articles (Countries)

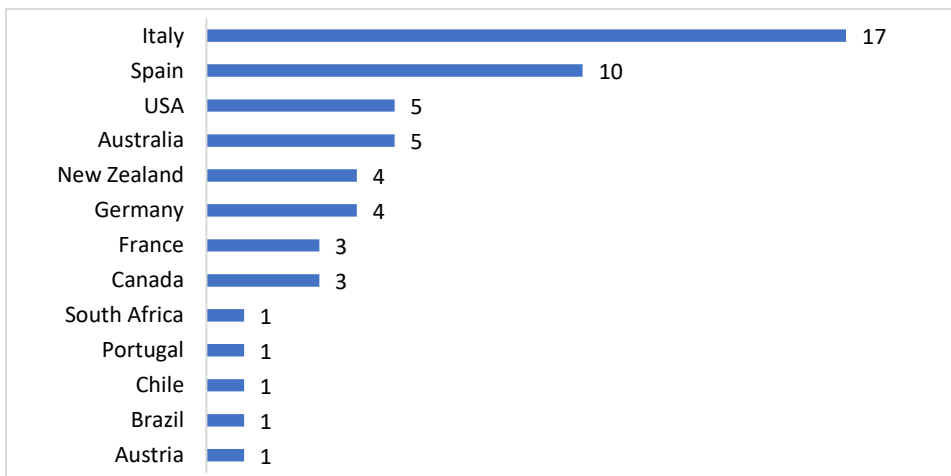
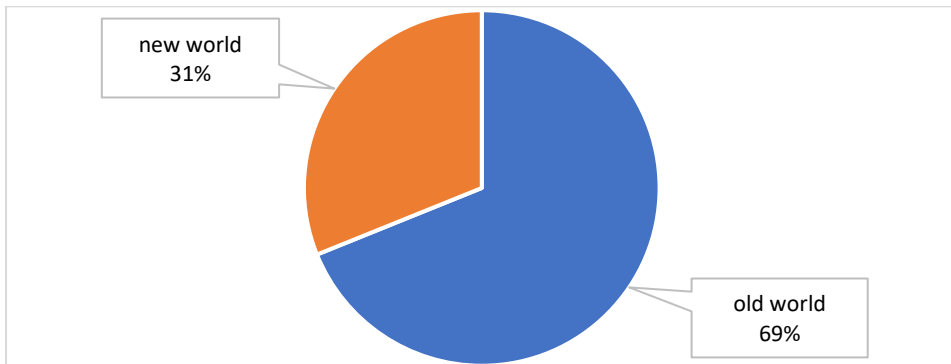
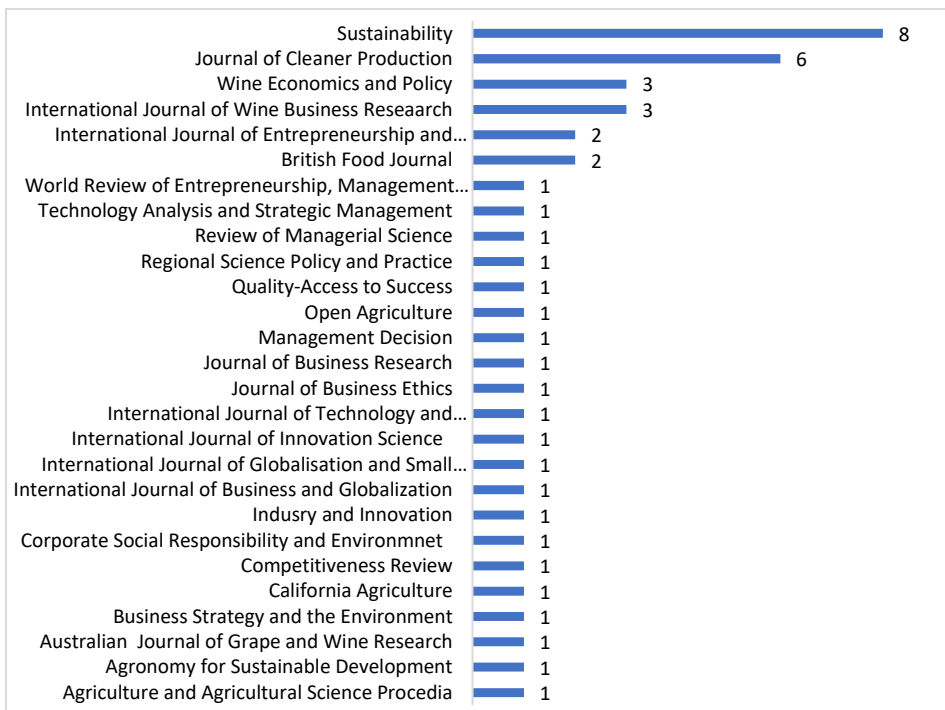


Figure 4: Geographical focus of the articles (Europe – outside Europe)



A wide range of disciplines is dealing with the research topic; more than a half of the analyzed articles were published in the following 6 journals: Sustainability, Journal of Cleaner Production, Wine Economics and Policy, International Journal of Wine Business Research, International Journal of Entrepreneurship and Small Business, British Food Journal. Additional 21 journals provided 1-1 article for this review (Figure 5). The number and diversity of journals dealing with the research topic demonstrate its multidisciplinary feature.

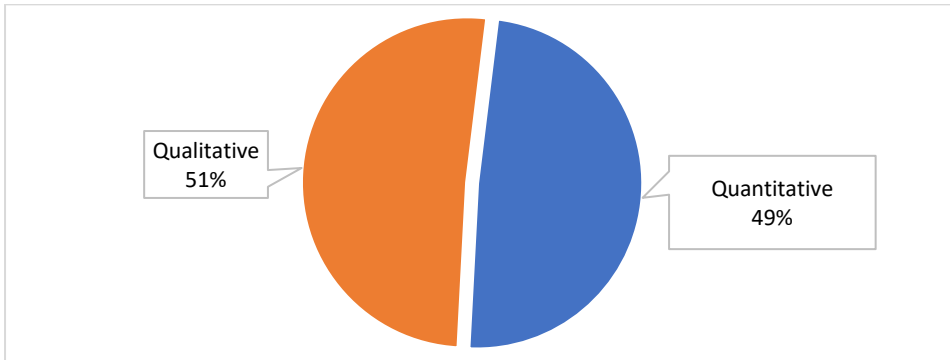
Figure 5: Journals of the articles



Research methodology and analysis

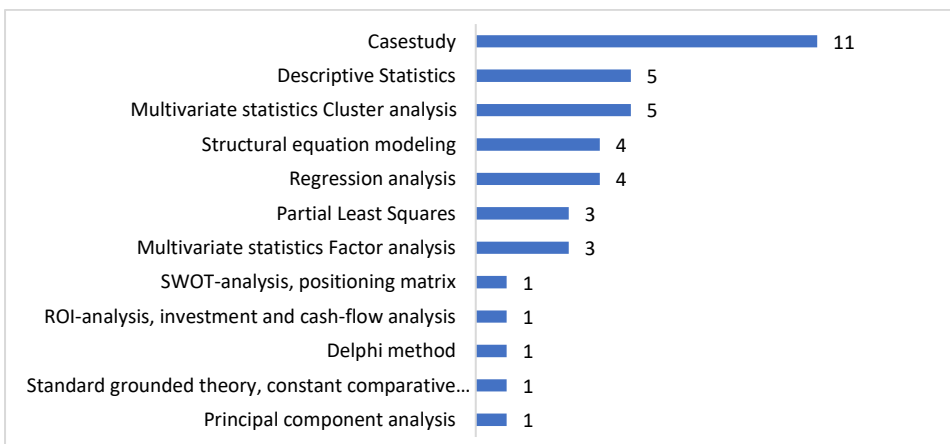
93% of the reviewed studies gathered primary data for the research via questionnaires. 51% of the studies applied qualitative and 49% applied quantitative methods for the analysis (Figure 6).

Figure 6: Distribution of methodology applied



Case study is the most frequently applied method (5, 8, 9, 13, 15, 19, 22, 23, 25, 34, 41) (Figure 7). This qualitative research method is also suitable for showing the effect of hard-to-quantify variables like tradition or generational succession and innovation. A lot of research used descriptive statistics to show relationships between variables (6, 10, 12, 25, 32). Multivariate statistical methods are frequently applied; factor analysis is appropriate to arrange and analyse groups of factors motivating or hindering innovation (2, 4), cluster analyses enable clustering and analysis of vineyards or wineries upon their relation to innovation activities (2, 4, 11, 14, 33). Regression analysis is a well suited method to survey how a company's feature, employee's ability, knowledge network or demand factors effect innovation (3, 27, 30, 38).

Figure 7: Distribution of articles by methods



Sustainable innovation in the viti- and vinicultural sector

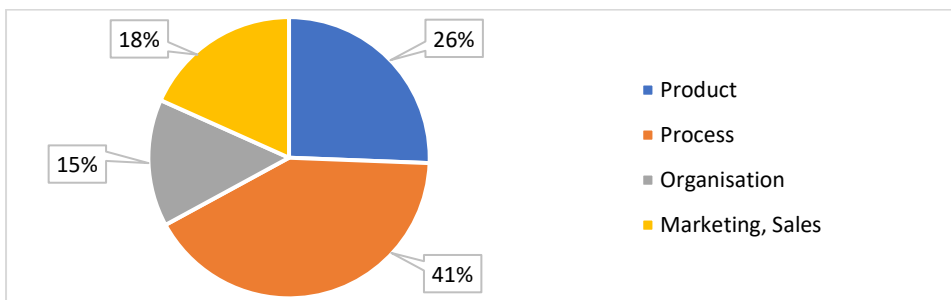
In papers a total of 5300 enterprises and their innovation practices were surveyed worldwide. The majority of the articles differentiate product and process oriented innovation (2, 7, 23, 26, 27, 28, 34), a smaller part of literature differentiates according to the functional unit of its orientation; viti- or vinicultural innovation (3, 15, 37).

We classify innovations following the classical typology (*Schumpeter, 1934*): product innovation, process innovation, marketing innovation and organizational innovation. The most frequently implemented product innovations were planting of new vine varieties, improving product characteristics, applying product labels, participating in voluntary certification, broadening the wine assortment, producing high quality wine with less alcohol content, charging premium price, introducing packaging alternatives, new design of bottles and labels. Most of the innovations are process oriented and intend to improve the sustainability of the process of vine cultivation and wine making. The most frequently recognized process innovation activities were integrated viticulture management, organic farming, introducing environmental management systems (EMAS, ISO 14000), vine and plot monitoring, eliminating chemicals from pest control, use of sexual confusion, interrow plantings to avoid insecticides and assure soil retention, use of mulches, less use of machinery, applying renewable energy; solar energy and utilization of biomass, efficient use of water, energy and materials, waste and wastewater treatment, recycling.

We find innovation focusing on marketing and sales of the companies: „Our sellers are our ambassadors” slogan emphasizes the importance of sales representatives in the transmission of a firm’s value to the consumer (34), raising the importance of cellar door sales and wine tourism (33), optimizing the distribution channel, the connection to short supply chain (11), green marketing (36).

Organizational and structural innovation enable businesses to correspond to the environmental and social needs via restructuring the organization of the company or developing a sustainable business model (34, 35): new management positions will be created (e.g. environmental manager), favoured position of research and development and HR activities within the organization, adopting team work management, training and raising the environmental awareness of the employees, integration of new channels of communication like Facebook, Instagram into the firm’s communication strategy (*Figure 8*).

Figure 8: Types of innovation



In the next step we have classified the motives (*Table 1*) and barriers (*Table 2*), which may foster and hinder a company's innovation according to their source; internally determined and externally determined factors.

Table 1: Driving forces of sustainable innovation

Internal driving factors	External driving factors
<ul style="list-style-type: none"> - Owners' managers' awareness - Generational succession - Strategic approach in management - Cost reduction - Improving product and service quality - Risk avoidance: need for safety and security - Vision of a sustainable business - Minimizing ecological footprint - Tradition - Structural characteristics (size, corporate organization) - Absorptive capacity - Knowledge exchange - Quality and Environmental Management Systems - Voluntary certifications 	<ul style="list-style-type: none"> - Market trends, consumer needs - Competition - Customer expectation - Industry initiatives - Export orientation - Government regulations (supportive) - Subsidies - Climate change - Networking and cooperation with customers, suppliers, research institutes, government organizations, marketing agencies - Supporting national wine strategy - Sectoral infrastructure

Table 2: Barriers of sustainable innovation

Internal barriers	External barriers
<ul style="list-style-type: none"> - Owners' managers' negative attitude - Cost of innovation - Lack of (environmental) knowledge - Lack of information - Financial risk - Tradition - Dependence on technology suppliers - Organizational restraints - Resistance of (key) employees - Time intensity 	<ul style="list-style-type: none"> - Government regulations (inadequate) - Pressure from shareholders - Uncertainty and risk - Lack of technical and financial support - Insufficient public financing - Bureaucracy - Sectoral economic culture - Short-term perspective in economic thinking - Greenwashing

The viti- vinicultural companies are value-oriented businesses, their development strategy is oriented by ethical considerations (*Schimmenti et al., 2016; Remaud et al., 2012*); the owners' and managers' awareness, tradition (*Vrontis et al., 2016*) and the intention of preserving biodiversity (*Fiore et al., 2017*). Sustainable innovations have

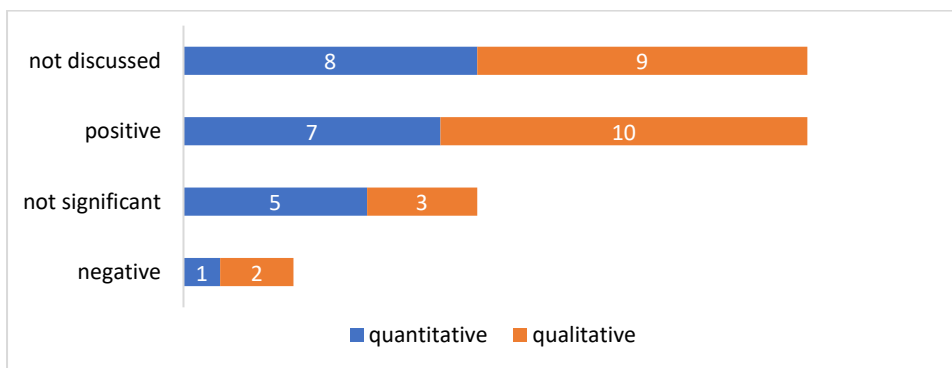
to effect companies' performance positively, too (Forbes & De Silva, 2011; Cullen et al., 2013). Forbes and Cullen explored the development intentions of farmers having been engaged in Greening Waipara project in New Zealand, and stated that only those development actions would be realized, where benefits exceeded costs.

We have investigated the articles according to the effect of the innovation on business performance. More than a half (62%) of the studies analyse the effectiveness of development actions and 61% of them stated a positive impact. We assume a demonstrative intension of the researcher (they want to prove the effectiveness of sustainability) and (with cost-efficiency analysis) well supported investment decisions behind this number. More than half of the studies analyzing the effectiveness of sustainable innovation apply qualitative methods (54%). It can be seen obviously, since many of the indicators expressing effectiveness are difficult to quantify; such as image or reputation (Figure 9).

Performance perceptions can be altered by certain business models. Guerrero-Villegas et al. (2018) found a divergence between objective performance in its conventional sense and subjective performance concerning the managers' way of thinking of performance and disclosed that innovation influenced subjective performance directly and indirectly, with the mediation of CSR (Corporate Social Responsibility) the objective performance. Consequently, if managers want to achieve greater performance, they need to implement innovation activities enhanced by CSR practices (Guerrero-Villegas et al., 2018).

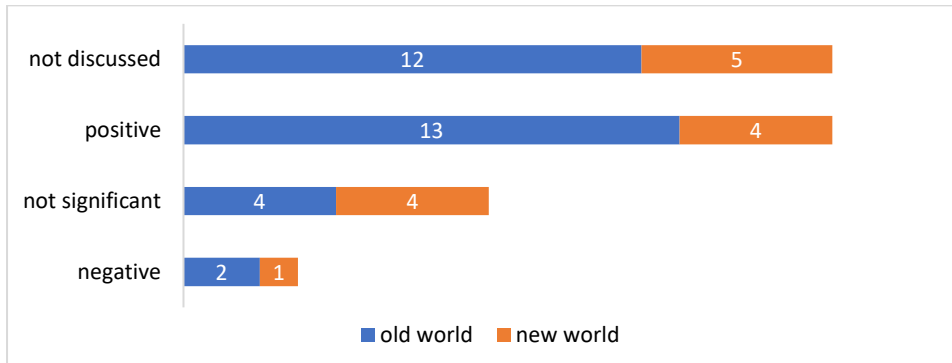
We have classified performance indicators by sustainability criteria: 1) economic performance is indicated by competitive advantage, economic efficiency, cost efficiency, profitability, growth, increase in sales, stronger brand, pricing power, increase in value added, new markets, export, customers' loyalty, lower level of risk (legal and regulatory, commercial risk), improved management system 2) environmental performance is indicated by levels of GHG (greenhouse gases), waste and noise emissions, consumption of water, energy and raw materials, integration of environment into productive processes, value capture image, reputation and 3) social performance is indicated by employee recruitment, creation of job positions, greater professionalization.

Figure 9: Effect of innovation on performance by type of analysis



Innovations of Old world wineries will be more frequently analyzed by their effect on company performance than those of the New world. We suppose the expansion of New world wine in the international market for the main reason (Figure 10).

Figure 10: Effect of innovation on performance by type of analysis



SUMMARY AND CONCLUSION

The paper overviews the state of art of research on sustainable innovation in the wine sectors to gather current evidence and identify the gaps for future research. A robust protocol of the systematic review and a rigorous procedure selected 45 studies which contributed to identify the barriers to sustainable innovation creation and diffusion in the wine sector.

Two-thirds of the studies were published in the past 5 years. This is both evidence of the early and partial nature of the findings, and also of the potential, importance of this research subfield. This research attention coincides with the fact that in the last decade the importance of new wine world increased.

One of the major success factors implying this expansion is innovation. Innovations with a firm’s resources and development capacities are able to build organizational resilience, which is essential for the long-term sustainability of businesses (Golicic et al., 2017).

The literature shows that the sustainable innovation in the wine sector is about the creation or adoption of new ideas and technologies. Various studies point to the on-going importance of diverse capacity for innovation embedded in and constituted by dynamics between geographical, socio-economic, political and legal subsystems. Several factors appear as predominant barriers to innovation across different settings and geographical areas. If owners and managers are not committed to sustainability, the major driving force of environmental and social improvements fail. In such cases other factors like resource deficiency in terms of finance, information gap or inadequate government regulations will be perceived as (more) momentous drawbacks to innovate in sustainability.

The manager’s awareness is also crucial to manage sustainable development as a strategy and to integrate innovation into the overall structure of the company. This

embeddedness can be forced by several sustainable management standards and tools; guidelines and self-assessment handbooks for farmers. Two examples are the Farm-A-Syst in California (Obmart, 2008) or Best Management Practices in Southern Spain (Triviño-Tarradas *et al.*, 2020).

The additional advantage of the application of Best Management Practices is that it does not require desperate changes in the current cultivation and production process. It is also relatively cheap and easy to apply and results in indirect benefit, like increase in productivity and quality (Barba-Sánchez *et al.*, 2012). Measuring and comparing results of overall sustainable innovations require indicators. There is an excessive need for a sustainability indicator that covers both mitigation and adaptation in the wine sector (Carroquino *et al.*, 2020).

Local and small-scale innovations are of high importance. The collaborative business model is favorable for this kind of innovation, since its complexity requires local experiments that are easily applicable and enable interaction with local actors (Losada *et al.*, 2019).

The role of networking and cooperation in wine eco-system is emphasized in a lot of research; regional and functional cooperation are of high importance for the wineries' development ability. Eco-innovation multiplies its effect if customers are involved (Frigon *et al.*, 2020). The propensity to eco-innovate correlates positively with networking. Businesses cooperating with supply-chain members (vertical collaboration) and with competitors (horizontal collaboration) adopt ecological innovations more easily and faster. Wineries' R&D effort correlates positively with their innovative behavior as well (Stasi *et al.*, 2016).

Additional factors motivating sustainable innovation are consumer expectations, market needs and export orientation. It is not surprising that subsidies and governmental regulations only enhance the adoptions ability when managers' and owners' sustainability commitment would be otherwise low. (Carroquino *et al.*, 2020).

Some factors may have positive and negative effects. Tradition for example forces innovation in case it refers to high quality wine, production process or historical terroir. Nevertheless, it hinders development in case it is interpreted as a rigorous process, norm: „It's an innovation recovering the ancient wine making method” (28) (Vrontis *et al.*, 2016). Legal setting and governmental regulations have also dual effect on innovations: they may motivate the adoption of sustainable practices if they are simple, easy to comply with. Inadequate regulation on the other hand may hinder the willingness to innovate.

Managers' and owners' awareness of sustainability, their commitment to run the business in a sustainable way are the most important driving forces for sustainable improvements, as their negative attitude is the major barrier to ethical innovations. Ambitious goals, proactive and innovative managerial attitude are able to effect the companies' performance positively, as proven by the reviewed literature. Sustainability innovators should work as change agents to solve the “wicked problem” of finding ways of climate mitigation and address other challenges of unsustainable development.

The considerable need for finance and knowledge, the importance of supporting national wine strategy and legal setting related to sustainable innovation are the most relevant implication for government organizations and policy makers.

Sustainability is an environmental issue with a very narrow attention to its social aspects in the recent study of the wine sector. In this review of literature, we identified a wide range of sustainable innovation activities and their (positive, negative or not significant) effect on business performance in its economic and environmental sense. Socio-cultural aspects deserve more emphasis regarding that heritage as the fourth aspect of sustainability in viti- and viticulture. Future research in the area should focus on documenting best practices systematically. In order to assess development activities with their impact more precisely we would gather numerical data. This quantification of sustainable innovations and performance indicators enables us to study the relation between them more exactly.

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Corresponding author:

Valéria LEKICS

Hungarian University of Agriculture and Life Sciences
Doctoral School in Management and Organizational Sciences
H-7400 Kaposvár, Guba Sándor u. 40.
ORCID: <https://orcid.org/0000-0003-2188-3634>
e-mail: dabibere@t-online.hu

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ANNEX

Final articles of the structured literature review

#	Authors	Article Title	Journal	Year	Region	Research method	Sample	Type of analysis	Profit effect
1	Dressler, M.	Motivating sustainable entrepreneurship: The deployment of a visual navigation tool	World Review of Entrepreneurship, Management And Sustainable Development	2021	Germany	questionnaire: structured face-to-face interviews	50	qualitative	0
2	Marques, KS; Lermen, FH; Gulate, AC; de Magalhaes, RF; Danilevicz, AMF; Echeveste, MES	Inside of an innovation ecosystem: evidence from the Brazilian wine sector	Australian J. of Grape And Wine Research	2021	Brazil	questionnaire: semi-structured interviews	138	quantitative: multivariate statistics; factor analysis, cluster analysis	2
3	Frigon, A; Doloreux, D; Shearmur, R	Drivers of eco-innovation and conventional innovation in the Canadian wine industry	J. of Cleaner Production	2020	Canada	firm-level survey: questionnaire via computer-aided telephone interviewing (CATI)	151	quantitative: logistic regression	n.d.
4	Javier Carroquino; NievesGarcia-Casarejos; Pilar Gargallo	Classification of Spanish wineries according to their adoption of measures against climate change	J. of Cleaner Production	2020	Spain	questionnaire: semi-structured and in-depth interviews	87	quantitative: multivariate statistics; factor analysis, cluster analysis	n.d.
5	Pucci, T; Casprini, E; Galati, A; Zanni, L	The virtuous cycle of stakeholder engagement in developing a sustainability culture: Salcheto winery	J. of Business Research	2020	Italy	primary data source: interviews and informal speeches, secondary data source: articles, reports	1	qualitative: longitudinal, single case study	2
6	Dressler, M.	The entrepreneurship power house of ambition and innovation: Exploring German wineries	Int. J. of Entrepreneurship And Small Business	2020	Germany	questionnaire; online interviews	>300	quantitative: descriptive statistics: correlation, and variance analyses	2
7	Perretti, B.	Economic sustainability of quality wine districts in the South of Italy. The case of Vulture	Int. J. of Globalisation And Small Business	2020	Italy	survey with face to face interviews	1	quantitative: ROI-analysis, investment and cash-flow analysis	2
8	Trivino-Tarradas, P; Carranza-Canadas, P; Mesas-Carrascosa, FJ; Gonzalez-Sanchez, EJ	Evaluation of Agricultural Sustainability on a Mixed Vineyard and Olive-Grove Farm in Southern Spain through the INSPIA Model	Sustainability	2020	Spain	survey with face to face interviews	1	qualitative: case study	n.d.
9	Chaminade, C; Randelli, F	The Role of Territorially Embedded Innovation Ecosystems Accelerating Sustainability Transformations: A Case Study of the Transformation to Organic Wine Production in Tuscany (Italy)	Sustainability	2020	Italy	questionnaires and face to face semi-structured interviews, document analysis, participant observation	1	qualitative: single case study	n.d.
10	Merot, A.; Alonso Ugaglia, A.; Barbier, J.-M.; DePhomme, B.	Diversity of conversion strategies for organic vineyards	Agronomy for Sust. Development	2019	France	questionnaires: semi-directive interviews	16-13	quantitative: descriptive statistics	2
11	De Steur, Hans; Temmerman, Hélène; Gellynck, Xavier; Canavari, Maurizio	Drivers, adoption, and evaluation of sustainability practices in Italian wine SMEs	Business Strategy And The Environment	2019	Italy	Standardized survey (questionnaire)	64	quantitative - multivariate statistics: cluster-analysis	n.d.
12	Galletto, L; Barisan, L	Carbon Footprint as a Lever for Sustained Competitive Strategy in Developing a Smart Oenology: Evidence from an Exploratory Study in Italy	Sustainability	2019	Italy	questionnaire: in-depth face-to-face interviews	10	quantitative: descriptive statistics	2

#	Authors	Article Title	Journal	Year	Region	Research method	Sample	Type of analysis	Profit effect
13	Losada, R.; Gómez-Ramos, A.; Rico, M.	Rural areas receptivity to innovative and sustainable agrifood processes. A case study in a viticultural territory of Central Spain	Regional Science Policy And Practice	2019	Spain	semi-structured questionnaire: MESMIS evaluation framework incorporating the principles of participatory action research (PAR)	1	qualitative: case study	2
14	Doloreux, D; Kraft, L	A Taxonomy of Eco-Innovation Types in SMEs: Exploring Different Firm Profiles in the Canadian Wine Industry	Sustainability	2019	Canada	questionnaire: computer assisted telephone interview	151	quantitative: principal component analysis and cluster analysis	2
15	Cantino, V; Giacosa, E; Cortese, D	A sustainable perspective in wine production for common-good management: The case of Fontanafredda biological reserve	British Food J.	2019	Italy	questionnaire: primary data from semi-structured in-depth interviews with managers, secondary data from company's materials	1	qualitative: case study	2
16	Guerrero-Villegas, J; Sierra-Garcia, L; Palacios-Florencio, B	The role of sustainable development and innovation on firm performance	Corp Social Responsibility And Environmental Management	2018	Spain	questionnaire	121	quantitative: partial least squares (PLS), a variance-based structural equation modeling technique	2
17	Siepmann, Laura; Nicholas, Kimberly A.	German winegrowers' motives and barriers to convert to organic farming	Sustainability	2018	Germany	questionnaire and semi-structured interviews	8	qualitative	n.d.
18	Anunziata, Eleonora; Pucci, Tommaso; Frey, Marco; Zanni, Lorenzo	The role of organizational capabilities in attaining corporate sustainability practices and economic performance: Evidence from Italian wine industry	J. of Cleaner Production	2018	Italy	questionnaire adressed to CEOs	357	quantitative: structural equation modelling	2
19	Ratten, V	Eco-innovation and competitiveness in the Barossa Valley wine region	Competitiveness Review	2018	Australia	questionnaire: semi-structured interviews	16	qualitative: exploratory case study approach	2
20	Baird, T; Hall, CM; Castka, P	New Zealand Winegrowers Attitudes and Behaviours towards Wine Tourism and Sustainable Winegrowing	Sustainability	2018	New Zea.	questionnaire	145	qualitative: explorative survey	2
21	Junquera, B; Barba-Sanchez, V	Environmental Proactivity and Firms' Performance: Mediation Effect of Competitive Advantages in Spanish Wineries	Sustainability	2018	Spain	questionnaire (Computer Assisted Telephone Interview addressed to company managers or environmental manegers)	142	quantitative: structural equation modelling (SEM) methodology with the partial least squares (PLS) technique	1
22	Pereira, A; Turnes, A; Vence, X	Barriers to shifting to a servitized model of crop protection in smallholding viticulture	J. of Cleaner Production	2017	Spain	questionnaire: semi-structured interviews	10	qualitative: exploratory case study	n.d.
23	Aldecoa, María José Fernández; Vaillant, Yancy; Lafuente, Esteban; Gómez, Jorge Moreno	The renaissance of a local wine industry: The relevance of social capital for business innovation in DOQ El Priorat, Catalonia	Wine Economics & Policy	2017	Spain	1) semi-structured interviews to wine producers 2) direct observation and 3) analysis of documentary sources	25	qualitative: case study technique of exploratory-descriptive scope	n.d.
24	Graca, AR; Simoes, L; Freitas, R; Pessanha, M; Sandeman, G	Using sustainable development actions to promote the relevance of mountain wines in export markets	Open Agriculture	2017	Portugal	Criteria-based self-assessment (fulfilled by an in-house multidisciplinary team)	1	qualitative	1
25	Fiore, M; Silvestri, R; Conto, F; Pellegrini, G	Understanding the relationship between green approach and marketing innovations tools in the wine sector	J. of Cleaner Production	2017	Italy	structured online questionnaire	204	quantitative: Pearson's Correlation matrix, explorative case study	n.d.
26	Olarte-Pascual, C; Oruezabala, G; Sierra-Murillo, Y	Innovation ecosystem: A trigger for new product development? Exploring the acceptance of a sparkling red wine amongst Spanish small business actors	Int. J. of Entrepreneurship And Small Business	2017	Spain	questionnaire: semi-structured interviews	13	qualitative: empirical study	2

#	Authors	Article Title	Journal	Year	Region	Research method	Sample	Type of analysis	Profit effect
27	Muscio, A; Nardone, G; Stasi, A	How does the search for knowledge drive firms' eco-innovation? Evidence from the wine industry	Industry & Innovation	2017	Italy	questionnaire (CATI survey addressed to company managers)	330	quantitative : probit regressions and one zero-inflated negative binomial (hereafter ZINB) regression	n.d.
28	Golicic, SI; Flint, DJ; Signori, P	Building business sustainability through resilience in the wine industry	International J. of Wine Business Research	2017	USA, Australia, New Zealand, Italy, Germany, France	questionnaires and in-depth interviews, observations and archival documents	141	qualitative: standard grounded theory, constant comparative method	2
29	Schimmenti, E., Migliore, G., Di Franco, C.P., Borsellino, V.	Is there sustainable entrepreneurship in the wine industry? Exploring Sicilian wineries participating in the SOSTain program	Wine Economics & Policy	2016	Italy	questionnaire (direct interviews with managers)	3	qualitative: descriptive survey	1
30	Stasi, Antonio; Muscio, Alessandro; Nardone, Gianluca; Seccia, Antonio	New Technologies and Sustainability in The Italian Wine Industry	Agriculture & Ag. Science Procedia	2015	Italy	questionnaire (Computer Assisted Telephone Interview addressed to company managers)	334	quantitative: logit regression	n.d.
31	Barba-Sanchez, V; Atienza-Sahuquillo, C	Environmental Proactivity and Environmental and Economic Performance: Evidence from the Winery Sector	Sustainability	2016	Spain	questionnaire (Computer Assisted Telephone Interview addressed to company managers or environmental managers)	312	quantitative: structural equation modelling (SEM) methodology with the partial least squares (PLS) technique	1
32	Galbreath, J; Charles, D; Oczkowski, E	The Drivers of Climate Change Innovations: Evidence from the Australian Wine Industry	J. of Business Ethics	2016	Australia	survey questionnaire	207	quantitative; descriptive statistics and multivariate statistics: factor-analysis	1
33	Alonso, AD; Bressan, A	Micro and small business innovation in a traditional industry	Int. J. of Innovation Science	2016	Italy	questionnaire	211	quantitative: cluster-analysis	n.d.
34	Vrontis, D	Tradition and innovation in Italian wine family businesses	British Food J.	2016	Italy	questionnaire: semi-structured interviews, direct observations,	1	qualitative: case study (Double-level codification, categorization, and contextualization)	2
35	Hatak, I; Floh, A; Zauner, A	Working on a dream: sustainable organisational change in SMEs using the example of the Austrian wine industry	Review of Managerial Science	2015	Austria	Delphi method	13	qualitative Delphi method	n.d.
36	Bellia, C; Pilato, M	Competitiveness of Wine Business within Green Economy: Sicilian Case	Quality-Access To Success	2014	Italy	questionnaire - face to face interviews	25	qualitative: SWOT-analysis, positioning matrix	2
37	Forbes, S.L; Cullen, R; Grout, R	Adoption of environmental innovations: Analysis from the Waipara wine industry	Wine Economics & Policy	2013	New Zealand	structured questionnaire	14	qualitative	0
38	Leenders, MAAM; Chandra, Y	Antecedents and consequences of green innovation in the wine industry: the role of channel structure	Tech. Anal. & Strategic Management	2013	USA, Canada, South Africa, Australia, New Zealand	international survey, questionnaire	123	quantitative; multivariate statistics: factor-analysis, regression analysis	1
39	Giuliani, E	Clusters, networks and firms' product success: an empirical study	Management Decision	2013	Chile, Italy	structured questionnaire	73	quantitative	n.d.
40	Atkin, T; Gilinsky, A; Newton, SK	Environmental strategy: does it lead to competitive advantage in the US wine industry?	Int. J. of Wine Business Research	2012	USA	questionnaire: web-based survey	98	quantitative: multivariate statistics	1
41	Barba-Sanchez, V; Martinez-Ruiz, MP; Jimenez-Zarco, AI; Megicks, P	Good environmental practices in a traditional wine producer: An opportunity for global competition	Int. J. of Business & Globalisation	2012	Spain	questionnaire - in dept interviews	1	qualitative: case study	2

#	Authors	Article Title	Journal	Year	Region	Research method	Sample	Type of analysis	Profit effect
42	Saint-Ges, V; Belis-Bergouignan, MC;	Ways of reducing pesticides use in Bordeaux vineyards	J. of Cleaner Production	2009	France	questionnaire and multivariate statistics	753	quantitative	0
43	Gilinsky, A; Santini, C; Lazzaretti, L; Eyler, R	Desperately seeking serendipity Exploring the impact of country location on innovation in the wine industry	Int. J. of Wine Business Research	2008	USA, Italy	questionnaires and in-person interviews		qualitative	1
44	Ohmart, C	Innovative outreach increases adoption of sustainable winegrowing practices in Lodi region	California Agriculture	2008	USA	questionnaire: mail and telephone survey Total Design Method	>700	qualitative: descriptive study	n.d.
45	Smith, K.; Marsh, I.	Wine and economic development: Technological and corporate change in the Australian wine industry	Int. J. of Technology & Globalisation	2007	Australia	descriptive study		qualitative	n.d.