Markoč, M., Krstajić, J. (2024). Multicriterial analysis of agroecological vineyards in Montenegro: How motivation affects viticulture? Agriculture and Forestry. 70 (3): 173-184. https://doi.org/10.17707/AgricultForest.70.3.12

DOI: 10.17707/AgricultForest.70.3.12

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MULTICRITERIAL ANALYSIS OF AGROECOLOGICAL VINEYARDS IN MONTENEGRO: HOW MOTIVATION AFFECTS VITICULTURE?

SUMMARY

Viticulture in Montenegro relies on various traditional and extensive practices that promotes sustainability and resilience in winemaking industry. Even though agro-ecological management systems protect natural habitats and landscapes, there is an evident lack of connection between farmers and other stakeholders in Montenegrin pilot area. This is the first multi-criterial research within winemaking industry in Montenegro that have taken into consideration both natural and social context in order to propose innovative solutions that may enhance the agro-ecological transition in viticulture. Tailored research methodology enabled analysis of the Main Agro-ecological Structure (MAS) development of each farm, as well as the analysis regarding perception of favorable conditions for Territorial and Environmental Context to agro-ecological transition (TEC). The results of the research show that the pilot area is extremely favorable for agro-ecological transition due to the high degree of vulnerable environmental protection and presence of various ecosystem services. However, this study identified low degree of motivation among farmers due to complex administrative bureaucracy procedures connected to subsidy schemes, high production costs, complex terrain configuration followed by low infrastructure development, inadequate collaboration with HORECA sector leading to stock risks, social conflicts leading to negative competitiveness, lack of interest among youth to join the sector and insufficient networking with public authorities in joint development of territorial strategies and action plans. Introduction of innovative agro-ecological practices followed by raising the awareness among farmers about benefits of the studied management systems on their production performances will increase their internal motivation and thus create sustainable ambience in domain of viticulture that will act appealing for young farmers to initiate or improve their agri-business.

Keywords: agroecology, viticulture, motivation

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Notes: The authors declare that they have no conflicts of interest. Authorship Form signed online.

Received:21/04/2024 *Accepted:26/09/2024*

INTRODUCTION

Agroecology involves various approaches to solve actual challenges of agricultural production. However, agroecology initially dealt primarily with crop production and protection aspects, in recent decades, new dimensions such as environmental, social, economic and ethical are becoming relevant (Wezel *et al.*, 2009). The definition of agroecology introduced all the participants in the food system and this included the importance of re-establishing the close relationships between the people who grow the food and the people who eat it, while reducing the negative impacts of the intermediary system between the two. Agroecology became a way of building relationship-based market systems that are equitable, just, and accessible for all (Gliessman, 2007). According to Gliessman (2018), agroecology is the integration of research, education, action and change that brings sustainability to all parts of the food system: ecological, economic, and social. To improve its sustainability, viticulture should increase the provision of ecosystem services to decrease its use of inputs and the resulting environmental impact while maintaining high socioeconomic performance (Gary *et al.*, 2017). Romero *et al.* (2022) emphasize that the establishment of sustainable production patterns based on socio-economic and environmental criteria is a key strategy in progression toward viable and competitive wine production. Furthermore, this research demonstrates the necessity of establishing systems that make cultivation sustainable by promoting the quality of the wine grape and by implementing working methods with favorable social, economic, and environmental consequences for rural populations and the environment. Ranzani et al. (2023) shared that organic wine producers' attention to environmentally conscious production should be complemented by financial incentives or regulatory support, by involving policy-makers and sharing technical assistance to promote landscape enhancement and encourage sustainable land use practices in viticulture areas. Furthermore, consumer awareness on organic wines produced in sustainable agro-ecosystems and carbon footprint information could help create demand for such products. The MAS can be useful tool in the planning processes of the farms because it allows the quantification of the internal and external corridors, including natural vegetation; as well for defining the context of landscape management because it shows a series of cultural relations (economic, social, symbolic and technological) that are normally overlooked by the partial analysis of landscape ecology (León-Sicard *et al.*, 2018).

Viticultural tradition in Montenegro dates back before the Roman period, as stated by Maraš *et al.* (2015). Wine production in Montenegro is based on the autochthonous grape varieties Vranac and Kratošija that make Montenegro recognizable in the wine world (Sošić *et al.*, 2023). Viticulture and winemaking of Montenegro is still mainly based on autochthonous grapevine varieties ('Vranac', 'Kratošija', 'Krstač' and 'Žižak'). The available literature data indicate a long tradition and an important breeding history of grapevine evaluation in Montenegro, especially concerning 'Vranac' and 'Kratošija'. Among the producers of grapes and wine dominant position in Montenegro has the

company "13. Jul – Plantaže" (94.5% of the total production, i.e. quantity of 145.000 hl of all types of wine) (Pajović-Šćepanović *et al.,* 2016). However, intensive development of viticulture and winemaking sector is taking place in the last decade in Montenegro, with increasing surface under vineyards, as well as the number of wineries and the number of wine types. The study of Pajović-Šćepanović *et al.* (2016) stated that technological conditions of production in the company "13. Jul – Plantaže" fully meet internationally accepted standards, while the other, small producers (family businesses) technology of wine production ranges from the use of modern equipment to the traditional methods of production. Smallholder agroecosystems that use agroecological practices and are surrounded by a moderately heterogeneous matrix have better attributes to initiate the agroecological transition process at the community level (Salazar-Rojas *et al.,* 2023). For the production practice in the agro-ecological conditions of the Podgorica subregion, the optimum loading is 16 buds per vine because it enables obtaining high yields as well as good quality of grapes for the Cardinal variety (Popović *et al.,* 2023.). Sošić *et al.* (2023) concluded that polyphenolic content of the analyzed wines, including other chemical characteristics, indicates that these Montenegrin autochthonous varieties can produce wines of exceptional properties and very good quality.

The last three decades have seen a significant increase in number of farm families diversifying their on- and off-farm production. The factors for diversification include environmental pressures, climate change, a decline in terms of trade in agriculture, low-income elasticity in commodities markets, and over-reliance on raw products (McGehee *et al.,* 2007). Kuznetsova *et al.* (2018) emphasized that in order for the agro-industrial complex to become a real driver for the development of other sectors of the economy, it is necessary to intensify investments in the fixed capital of the industry and improve the development of rural social infrastructure, to solve the problem of chronic poverty, with a priority focus on the growth of professionalism, productivity and wages, and a reduction in staff turnover. Despite the favourable natural conditions, especially for organic viticulture, a comparison of land use in the last two decades shows the abandonment and overgrowth of vineyards in the higher, so-called vineyard sites (Topole *et al.,* 2023).

In modern conditions, an integrated approach and systematic improvement of the social and economic situation is required, especially in rural areas, without which it is impossible to develop the country's agriculture and improve the quality of life. Besser and Mann (2015) concluded that farmers' work satisfaction is positively affected by farm income proxies and monetary return, as well as by other quality factors besides economic returns, thus indicating importance of both internal and external motivation factor in the overall farmers' satisfaction.

MATERIAL AND METHODS

Participants and Procedure

This study was conducted with the ten owners of agro-ecological vineyards in the area of Crmnica, Municipality of Bar, Montenegro. The average

farm area was 1.25 ha, the smallest farm had 0.31 ha, while the largest one had 1.9 ha. Each of the onsite interview lasted from 1.5 to 2 hours. The average age of the participants was 44.67 years. The experience in viticulture varied, with 19.4% having the experience less than 5 years, 16.7% less than 10 years, 20.4% less than 15 years, and 43.5% more than 15 years of experience in viticulture. In terms of education, 11.1% completed high school, 56.5% hold an undergraduate degree, 23.1% hold master's degree, and 9.3% hold a PhD. Nine participants were Montenegrin (one is Russian) and all of them are Orthodox. The survey was conducted in two rounds, in May 2021 and May 2022, in order to compare the results and to evaluate the degree of agro-ecological transition and awareness raised in the Pilot area.

Instruments

In order to implement Multi-criteria analysis of the agro-ecological vineyards in Montenegrin pilot area (Crmnica), participants were requested to fill out surveys during the onsite visit, consisting of the analysis of the Main Agroecological Structure (MAS) development of each farms, as well as the analysis regarding perception of favorable conditions for Territorial and Environmental Context to agro-ecological transition (TEC).

This section shows the useful data for analysis of MAS development, with the final ranking that set up the starting point for the agro-ecological transition for each company, and traces a basic scenario for the entire Pilot area (Crmnica). The MAS can be seen as the internal configuration or spatial arrangement of the farm and the connectivity between its different sectors, patches and corridors of vegetation or productive systems and the exchange with external environment. Taking into consideration the internal configuration of the farm, in particular, the observation focuses on the degree of openness and on the exchange relationships (between the different living species and between the different cultural contaminations) that the same farm maintains with environment. The more the farm presents an articulated arrangement of its spaces, able to alternate different crops, preserve the presence of trees and hedges, keep functional small ditches and water bodies, the more will be able to offer vital connection systems, both internally and externally, with the surrounding environment. Furthermore, thanks to the qualitative questions included in the interview, it is possible to trace a first indicative identikit of the typical Crmnica farm. Considering the fragmented nature of the vine plots, even within the same company properties, the indicators CMELS, EEC, EIC, DEC and DIC, had been considered referring to the largest portions of the farm (Table 1), if exceeded 66% (2/3) of the overall land area. Otherwise, it was necessary to calculate the average value of an analysis conducted separately for each individual farm’s portions until at least 50% (half) of the total land area has been investigated.

The last four questions of the survey regarding Territorial and Environmental Context to the agro-ecological transition (TEC) allowed us to deepen perception regarding certain issues that external factors may cause to the agricultural holding, and vice-versa, regarding impacts that agricultural holding has on external environment. In particular, the two issues that we investigated

were: the perception of the territorial context and its agro-ecological vocation (first two indicators: Economy and Production (EP) and Networks, Relations and Social recognition (NRS)); the perception of the degree of environmental impact of agricultural activity and its management (last two indicators: Compounds Toxic for the Environment and Human Health (CTEHH) and Farm Waste Management (FWM)). Both questions were useful for assessing whether the wider territorial context is favorable or not to the agro-ecological transition. The perception scales have been based on the satisfaction level, where 0 represents "no satisfaction at all" and 4 represents "highest satisfaction possible".

Table 1: The 10 MAS indicators

Indicator	Acronym	Description
Connection with the main ecological landscape structure	CMELS	Assesses the distance of the farm in relation to the nearby fragments of natural vegetation, mainly forest covers and bodies of water.
Extension of external connectors	EEC	Evaluates the percentage of the linear extension of live fences located in the perimeter of the farms.
Extension of internal connectors	EIC	Evaluates the percentage of the linear extension of the rows of vegetation but internally.
Diversification of external connectors	DEC	Evaluates the diversity of live fences or hedges located in the perimeter of the major agro-ecosystem.
Diversification of internal connectors	DIC	Evaluates the diversification of internal living fences.
Use and Soil Conservation	USC	Evaluates the distribution percentage of different covers within the farm and the conservation of the soil (evidences of erosion).
Management of Weeds	MW	Evaluates the management practices and systems of weeds control.
Other management Practices	OP	Evaluates the types of production systems (ecological, conventional or in transition) of each farm.
Perception – Awareness	PA	Evaluates the degree of conceptual clarity and awareness of producers regarding agro-biodiversity.
Level of Capacity of Action	CA	Evaluates the capacities and possibilities of farmers to establish, maintain or improve their MAS

The final ranking of the MAS development level of the interview farmers is obtained by combining it with the interpretation scale presented in the methodological document and reported below, as Table 2:

Table 2: Scale of MAS interpretation

MAS development	Value
High developed	80 – 100
Moderately developed	60 – 79
Slightly developed	40 – 59
Weakly developed, with cultural potential	20 – 39
Weakly developed, without cultural potential	10 – 19
No agro-ecological structure	1 - 9

The final calculation of the MAS was obtained by adding the resulting value of each of the aforementioned indicators, according to the following formulation:

$$MAS = CMELS + EEC + EIC + DEC + DIC + USC + WM + OP + PC + CA$$

The final ranking of the degree of vocation of the Territorial and Environmental Context of the Pilot Area to the agro-ecological transition is shown below (Table 3) combining it with the scale of interpretation present in the methodological document:

Table 3: Scale of TEC interpretation

MAS development	Value
Extremely favorable context for agro-ecological transition	49 – 62
Favorable context for agro-ecological transition	33 – 48
Unfavorable context for agro-ecological transition	17 – 32
Very difficult context for agro-ecological transition	1 - 16

The final calculation of the TEC is obtained by adding the resulting value of each of the indicators, according to the following formulation:

$$TEC = EP + NRS + CTEHH + FWM$$

RESULTS AND DISCUSSION

The Main Agro-ecological Structure (MAS) development

Connection with the main ecological landscape structure (CMELS)

Almost all of the selected farms are surrounded by natural elements. The different types of natural elements are mainly contiguous or even overlapping. This characteristic is the peculiarity of the landscape, where the terraces planted with vines alternate with large wooded areas, which often delimit the different properties. All of the farms have a high possibility for biotic interrelationships or even a high degree of biological connectivity with different natural elements (forests, shrubs, water sources – lake, rivers, streams etc.) located nearby the farms, while the vicinity between the natural elements ranges from less than 150 meters up to 450 meters.

Extension of external connectors (EEC)

The external connectors within the farms create discontinuity between the cultivated surface and the external environment, thus constituting the perimeter made up of "living" elements, among which the woods and hedges are the most present ones. Among "non-living" elements, the most present are asphalted roads, the mule tracks and dry stone walls, a distinctive feature of grapevine growing area of Crmnica (Figure 1).

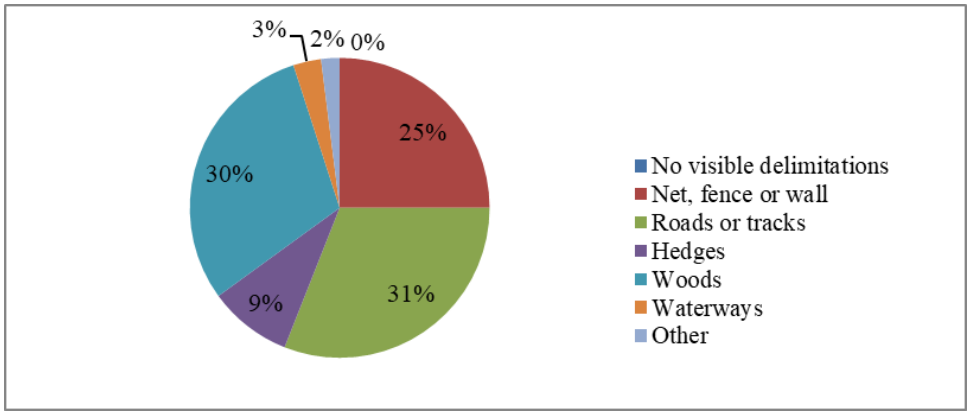

Figure 1: Percentage composition of external perimeter

Extension of internal connectors (EIC)

Internal dividers of the farms are the elements separating different parcels that belong to the same property. However, "living elements" are rare, except of a bit more present hedges (Figure 2). With the exception of three farms, the forest and waterways could not be identified. The "non-living" elements are widely present, such as asphalted roads, old stony mule tracks, as well as net and fences (dry stone walls).

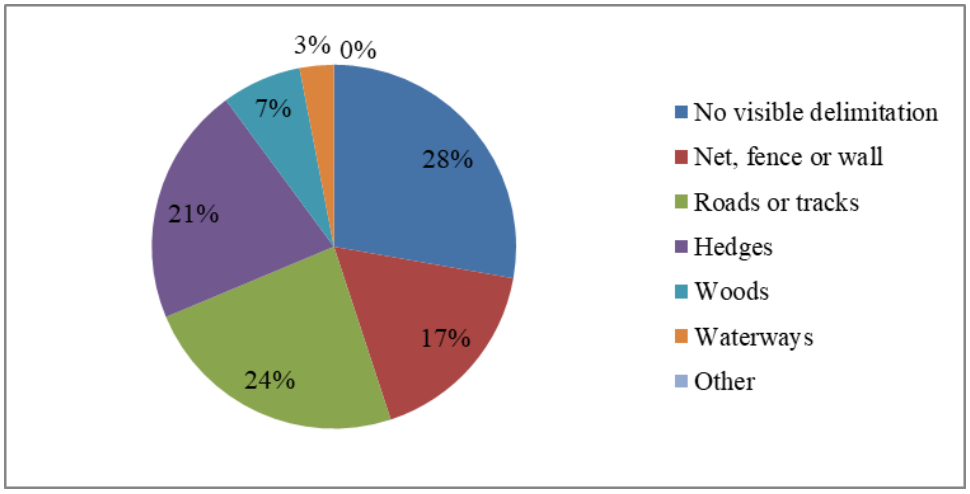

Figure 2: Percentage composition of internal dividers

Diversification of external connectors (DEC)

The degree of diversification of the "living" elements on the farm's perimeter is very high within all the farms surveyed; and therefore, there are greater connection functions. These data confirm the high capacity of biotic interrelations between external and internal environment. The living perimeter present in all the areas analyzed is characterized by the presence of over 4 different tree species, or several layers of vegetation, of at least two rows of vegetation (8 farms) or by the presence of 2 to 3 different tree species, with at least two layers of vegetation, of at least two rows of vegetation (2 farms). There were no single species-layer-row cases; neither was a case without any living elements present, thus ensuring great interconnection function.

Diversification of internal connectors (DIC)

Widespread presence of "living" dividers in 5 out of 10 cases, 4 cases of quite widespread and sporadically widespread presence of biotic interrelationships between the crops and internal dividers and only 1 case of marginal presence of such relations, show great chances for agro-ecological activity. There is only 1 farm with presence of over 4 different tree species – several layers of vegetation – at least two rows of vegetation; 7 farms with the presence of 2 or 3 different tree species – at least two layers of vegetation – 1 or 2 rows of vegetation and 2 farms with mainly single species internal connectors, distributed in a single row. It should be emphasized that sporadic incidences were not taken into consideration, but only multi-layered structure, with multiple rows and species.

Use and Soil Conservation (USC)

The small sized and scattered plots, ingrained traditional extensive agricultural practices in Crmnica pilot area allowed diverse cultivation systems. Even though the grapevine is the leading plant species in this area, other Mediterranean fruit species such as pomegranate, figs, kiwi, peaches, apples, sporadical citrus trees and olive fruits, but also vegetables are cultivated as well. In certain cases, these examples cannot be characterized as poly-culture, due to sporadic and individual cases of other plants. All of the 10 farms have been characterized by the presence of at least two crops and there is no example of monoculture farm. Even though majority of the farms are located on the slopes and heavily accessible terrains, erosion is absent or limited and not very significant (8 farms). Traditional practices of building dry stone walls and terraces as anti-erosion measures limited the negative impact of erosion and enabled successful grapevine growing with efficient fertilization and irrigation of the crops.

Management of Weeds (MW)

Weed management, influenced by particular orographic conditions and the context of high slopes, takes place in most cases with the use of hand-operated machinery and tools (brush cutters), and without the support of agricultural vehicles such as tractors. At 6 out of 10 farms, there is neither presence of random strips nor areas of weeds, due to exclusively mechanical management.

Two out of 10 farms use chemicals combined with mechanic management. There is no exclusively chemical management of weed in any of the selected farms.

Other management practices (OP)

None of the companies involved in the multi-criteria survey is awarded with an organic certification. Only one farm is categorized as "conventional" farm even though there are no intensive agri-technical measures implemented in here, but the presence of chemical weed management and regular pests and disease protection with non-selective pesticides is practiced. The majority of the winemakers interviewed adopt integrated agricultural practices (90%) that emerged from ingrained traditional extensive practices regarding soil management, pruning techniques, rainfed agriculture, limited use of pesticides and similar.

Perception – Awareness (PA)

Even though the farmers show high degree of sensitivity towards the sustainable agriculture and environmental responsibility, it was noticed that farmers have a low motivation for implementing agro-ecological practices in order to shift their production to more sustainable approach. Furthermore, this pilot area became one of the leading tourism destinations within Bar municipality, and therefore it is necessary to raise the awareness and farmers' knowledge about biodiversity protection (flora and fauna, as well as water and soil resources). Finally, it is necessary to show the farmers that integrated agriculture and agro-ecological principles are not an additional financial nor labor burden for their performance. In order to fulfil these goals, participation of all the stakeholders is mandatory, such as integration of advisory services, local authorities and relevant ministries. Their contribution have to be given through various subsidy schemes as well as to overcome administrative bureaucratic procedures through the formation of working groups that would regularly visit the farms and work onsite with farmers who have low information skills or language barriers in order to identify their needs, propose the solutions and lead them through the process which will result with raised awareness among farmers and higher percentage of available funds withdrawal. This strategy would enhance both the internal and external motivation among experienced farmers, but also among young and interested beginners that initiate agricultural business.

Level of Capacity of Action (CA)

All participants believe that additional workload is necessary for agro-ecological production and therefore it has discouraging and demotivating impact. Furthermore, 80% of the farmers emphasize lack of economic and financial resources for their transition, 60% of them finds it unavailable to accentuate poly-cultivation. Encouraging data is that even 80% of the farmers is motivated to shift to organic farming. Furthermore, farmers are aware of the fact that customers prefer home-made products, made of domestic varieties by using traditional practices. Therefore, there is a high potential for agro-ecological transition; however, individual efforts will not gain a willing progress, but a multi-side contribution is strongly recommended (Figure 3).

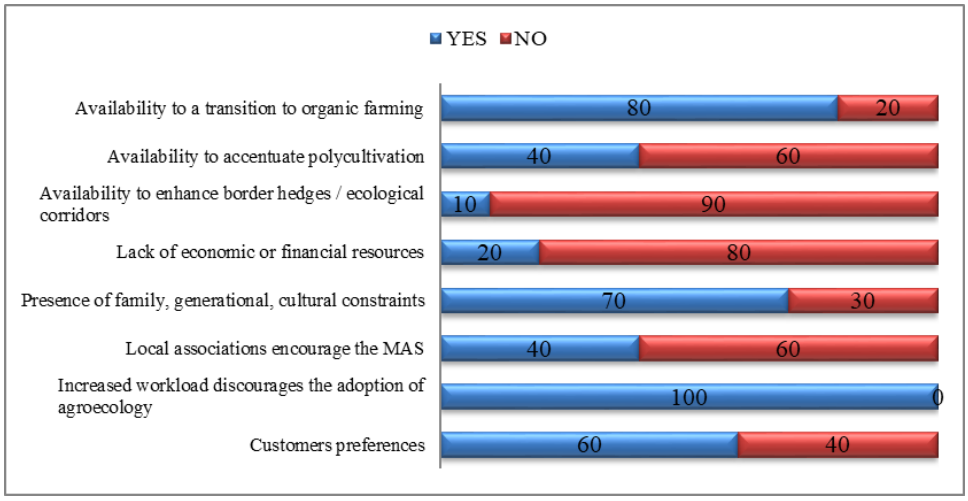

Figure 3: Capacity for Action

Regarding MAS analysis, all of the selected farms are devoted to the agro-ecological transition and adoption of ecological principles. Therefore, 2 out of 10 farms are classified as "high developed", while 6 holdings are "moderately developed" in an interval of just 8 points. Only one farm was at the lower limit of the "slightly developed" category, while one farm is "moderately developed" (upper limit of "slightly developed" category).

Territorial and environmental context (TEC)

Economy and Production (EP)

Farmers are mostly satisfied with "grape quality" and "wine quality". It is widely known that farmers from Crmnica region are very confident in the quality of their final products and therefore, the prices are often very high. Therefore, income from wine production in this area is slightly higher than the income coming from other agricultural activities. Even though most of the farmers are satisfied with their yield, it can be significantly improved by adopting certain innovative practices and diversifying their production that would have a positive environmental impact.

Network, Relations and Social recognition (NRS)

The perception of the social context also represents a useful indicator to understand if territory of Crmnica can be suitable for an agro-ecological transition (Figure 4). There is an evident intolerance and negative competition between local grapevine growers and wine producers. Furthermore, the role of the grapevine grower as the protagonist in rural development is not sufficiently recognized by the competitive authorities. Farmers increased their marketing skills by introducing accommodation facilities within their holdings. However, there is a problem with grey economy and "selling the products at the doorstep". Therefore, it is necessary to create a stronger network between small producers and HORECA sector. Regarding the small sized farms and high prices of

mechanization and processing equipment, higher sustainability and productivity could be reached through farmers clustering and common resources sharing.

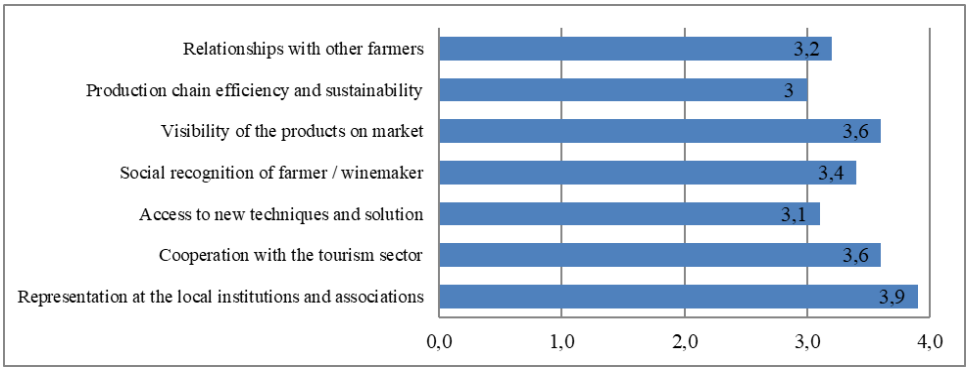

Figure 4: Network, relations and social recognition perception

Compounds Toxic for the Environment & Human Health (CTEHH)

There are no problems related to toxicity (high concentrations of nitrates or phosphates in both groundwater and surface water and soil) for both the environment and humans.

Farm Waste Management (FWM)

Waste management practices are related with producing organic manure through the composting of pruning residues.

Nine out of ten farms have been categorized as "extremely favorable" for agro-ecological transition regarding the perception of the territorial context.

CONCLUSIONS

Multicriteria analysis of agroecological vineyards in Montenegrin pilot area of Crmnica revealed great potential for agroecological transition of the whole area. However, this comprehensive analysis emphasized further analysis social factors impact, since low motivation of experienced winemakers have been identified. Therefore, this conclusion leads us to reject the hypothesis that agroecology transition is dependent from natural factors only. It's worth noting that this study has some limitations, such as a small sample size. Therefore, further research with a larger and more diverse sample, including other Montenegrin viticulture zones, may be needed to gain a deeper understanding of the potential links between agroecological transition and overall satisfaction of both young and more experienced farmers.

ACKNOWLEDGEMENTS

This research has been performed during the implementation of the project *"ECOlogocal VINEyards Governance Activities for Landscape's Strategies – ECOVINEGOALS"* that has been financed through the program "Supporting Agroecological Transition in Adriatic-Ionian Viticulture" INTERREG V-B Adriatic-Ionian (ADRION) Program 2014-2020.

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