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Factors influencing farmers' adoption and willingness to accept sustainable production practices in Istria County, Croatia

Čimbenici koji utječu na prihvaćanje i spremnost poljoprivrednika za usvajanje održivih proizvodnih praksi u Istarskoj županiji, Hrvatska

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ABSTRACT

To ensure food security and mitigate environmental degradation caused by conventional farming, the adoption of sustainable production systems or practices is essential. Despite the availability of diverse sustainable agricultural practices, their widespread adoption remains limited. Thus, this study aimed to assess the importance of socioeconomic and socio-demographic characteristics of farmers, as well as farm characteristics, on their interest in transitioning to Sustainable Production Systems (SPS) or adopting Sustainable Agricultural Practices (SAP). Additionally, the study evaluated the motivational factors affecting farmers' WTA for some of the SPS or SAP in Istria County, Croatia. A survey was conducted on 172 farms in Istria County. The data were analysed using descriptive statistics, ANOVA to identify statistical differences, and chi-square tests to determine associations between variables. The results indicate that nearly half of the respondents were interested in transitioning to SAS or adopting SAP. Higher education levels significantly correlate with a greater interest in adopting SAS or SAP. When farmers were offered benefits such as financial support during the trial period, sales assistance, and product marketing, the WTA was significantly higher. Applying Rogers' Diffusion of Innovations (DOI) theory, the study highlights the importance of perceived relative advantage, compatibility, and trialability in adoption decisions. Despite the several limitations of this study, the findings underscore the need for integrated approaches combining education, financial incentives, and technical support to achieve widespread adoption of sustainable agriculture.

Keywords: sustainable agricultural practices, sustainable agricultural systems, willingness to accept, diffusion of innovations theory, Istria County, adoption factors

SAŽETAK

Kako bi se osigurala sigurnost hrane i ublažila degradacija okoliša uzrokovana konvencionalnim uzgojem, usvajanje održivih proizvodnih sustava ili praksi je ključno. Unatoč dostupnosti različitih održivih poljoprivrednih praksi, njihova široka primjena ostaje ograničena. Stoga je cilj ove studije bio procijeniti važnost socioekonomskih i socio-demografskih karakteristika poljoprivrednika, kao i karakteristika gospodarstava prema interesu za prelazak na sustave održive proizvodnje (SPS) ili usvajanje održivih poljoprivrednih praksi (SAP). Dodatno, studija je procijenila motivacijske čimbenike koji utječu na voljnost prihvaćanja poljoprivrednika u nekim od SPS ili SAP u Istarskoj županiji, Hrvatska. Istraživanje je provedeno na 172 gospodarstva u Istarskoj županiji. Podaci su analizirani korištenjem deskriptivne statistike, ANOVE za utvrđivanje statističkih razlika i hi-kvadrat testa za određivanje povezanosti između varijabli. Rezultati pokazuju da je

gotovo polovica ispitanika bila zainteresirana za prijelaz na SAS ili usvajanje SAP-a. Razine visokog obrazovanja značajno koreliraju s većim interesom za usvajanje SAS-a ili SAP-a. Kada bi poljoprivrednicima bila ponuđene potpore kao što su financijska potpora tijekom probnog razdoblja, pomoć u prodaji i marketingu proizvoda, spremnost na prihvaćanje praksi bi bila znatno veća. Primjenjujući Rogersovu Teoriju širenja inovacija (DOI), studija naglašava važnost percipirane relativne prednosti, kompatibilnosti i probnosti u odlukama o usvajanju. Unatoč nekoliko ograničenja ove studije, nalazi naglašavaju potrebu za integriranim pristupima koji kombiniraju obrazovanje, financijske poticaje i tehničku podršku kako bi se postiglo šire prihvaćanje održive poljoprivrede.

Ključne riječi: održive poljoprivredne prakse, održivi poljoprivredni sustavi, spremnost na prihvaćanje, teorija širenja inovacija, Istarska županija, čimbenici posvojenja

INTRODUCTION

The sustainability of conventional agriculture is increasingly questioned due to its significant negative impacts on the environment and human health. These impacts are primarily manifested through adverse effects on biodiversity, soil and water quality, overexploitation of natural resources, and contributions to climate change (Gerhardt, 1997; Haas et al., 2001; Coulibaly et al., 2021; Priya and Singh, 2022). Conventional farming practices degrade soil resilience, leading to issues such as soil erosion, compaction, structural degradation, nutrient depletion, and soil salinity (Gerhardt, 1997; Fließbach et al., 2007; Dara, 2019). This deterioration affects hydrological dynamics (Dara, 2019; López-Vicente and Wu, 2019; Srinivasarao et al., 2021) and contributes to greenhouse gas emissions that exacerbate global climate change (Reicosky et al., 2000; Lynch et al., 2021). Moreover, the impacts of climate change, including elevated temperatures and altered precipitation patterns, further threaten long-term agricultural productivity (Lynch et al., 2021).

To address these challenges, there is a growing need for the adoption of sustainable agricultural systems (SAS) and sustainable agricultural practices (SAP). These methodologies include, for example, crop rotation, intercropping, organic farming, integrated pest management, and zero tillage, all of which have demonstrated potential in enhancing agricultural sustainability (Brodt et al., 2011; Velten et al., 2015; Piñeiro et al., 2020; Lynch et al., 2021; Boufous et al., 2023). According to FAO (2023), sustainable agriculture promotes long-term soil fertility and productivity while maintaining economic viability through the promotion of various sustainable practices. Sustainable practices aim to balance productivity with environmental stewardship, focusing on areas such as pest control, mechanization, soil fertility, and soil conservation (Brodt et al., 2011; Pittelkow et al., 2015; Sims and Kienzle, 2017; Nyanga et al., 2020). Literature emphasizes the importance of practices that enhance soil quality and health, biodiversity preservation, and pollution reduction, while practices related to water and biomass crops receive comparatively less attention (Prager and Posthumus, 2010; Priya and Singh, 2022; Boufous et al., 2023). Efforts to enhance soil quality at the EU level are also supported by initiatives like the EU Soil Strategy for 2030 and the forthcoming soil health law (European Commission, 2022).

Despite the availability and regional adaptation of diverse SAPs, their widespread adoption remains limited, varying significantly by geographic area and specific practices (Dessart et al., 2019; Piñeiro et al., 2020; Serebrennikov et al., 2020). This variability has spurred extensive research of the factors determining SAP adoption, including analyzing adoption patterns (Chatzimichael et al., 2014; Villanueva et al., 2017; Dimal and Jetten, 2020;), factors influencing WTA (Feng et al., 2018; Boufous et al., 2023) and methodological approaches for estimating Willingness to Accept (WTA).

One of the methodological approaches employed to understand the adoption of sustainable agricultural practices (SAP) is Rogers' Diffusion of Innovations (DOI) theory. This theory has been used to examine farmers' perspectives on cover cropping, highlighting key elements of the DOI theoretical framework such as

relative advantage, compatibility, complexity, trialability, and observability to explain adoption patterns and to identify the factors that influence farmers' decisions to adopt new practices (Lavoie et al., 2021). This theoretical framework helped to identify the factors that influence farmers' decisions to adopt new practices and provides insights into how these practices can be more effectively promoted.

Behavioral preferences were also shown to be influenced by psychological, economic, sociological, anthropological, and agricultural extension factors and thus played a significant role in SAP adoption of SAP (Nguyen et al., 2019; Piñeiro et al., 2020; Anibaldi et al., 2021; Coulibaly et al., 2021). SAS and SAP adoption, and WTA have been influenced by numerous factors identified in various studies, which can be categorized into farmer-related, farm-related, psychosocial, and exogenous factors (Coulibaly et al., 2021; Boufous et al., 2023). Consistently significant factors for SAS and SAP adoption and WTA include socioeconomic variables (Prager and Posthumus, 2010; Garbach et al., 2012; Serebrennikov et al., 2020) such as education (Wang et al., 2019; Boufous et al., 2023), interaction with extension agents (Corsi and Muminjanov, 2019; Priya and Singh, 2022), farming experience (Adeola, 2010; Coulibaly et al., 2021), farm size (Rajendran et al., 2016), labor availability (Lemken et al., 2017), environmental awareness (Rajendran et al., 2016), and incentives (Duru et al., 2015; Mamine and Minviel, 2020). Short-term economic incentives showed to be particularly effective in motivating SAP adoption (Garbach et al., 2012), while long-term benefits for the farm and environment also play a crucial motivating factor (Piñeiro et al., 2020).

Due to the complexity and interrelations of various factors influencing the adoption of sustainable agricultural practices and willingness to accept (WTA), this study aimed to assess the importance of socioeconomic and sociodemographic characteristics of farmers, as well as farm characteristics, on their interest in transitioning to Sustainable Production Systems (SPS) or adopting Sustainable Agricultural Practices (SAP). Additionally, the study evaluated the motivational factors affecting farmers' WTA for some of the SPS or SAP in Istria County, Croatia.

MATERIALS AND METHODS

The research was conducted in Istria County, one of the 21 counties in the Republic of Croatia. Istria County covers an area of 2,820 square kilometers, representing 4.98% of the total area of Croatia. According to the APPRRR (2020), there are 6,063 agricultural households in Istria County, compared to 170,837 agricultural households in Croatia as a whole.

Field data collection was carried out in 2019, using a survey method on a random sample of farmers. The contact list of farmers from the county was obtained from membership lists of local agricultural associations, as well as from publicly available sources, including agricultural directories and the Internet. It is acknowledged that not all farmers are members of agricultural associations, which could introduce some selection bias. Efforts were made to mitigate this by including publicly available contact information. The sample was designed to include both crop and livestock farmers from different parts of Istria County to ensure regional representation.

Farmers were individually contacted to inform them about the research. After farmers agreed to participate, an appointment for the researcher's visit to the agricultural farm was scheduled. Upon arrival at the farm, the purpose of the research was explained again, and the survey questionnaire was described. It was ensured that all respondents had a clear understanding of what sustainable agricultural production systems and sustainable agricultural practices entail by providing a standardized explanation before starting the questionnaire.

The questionnaire consisted of 2 open-ended and 30 closed-ended questions. The questions were divided into sections covering the sociodemographic characteristics of the respondents, characteristics of their agricultural operations and production methods, and questions about their interest in willingness to adopt one of the

sustainable agricultural production systems or practice, and the importance of various benefits for the adoption of these systems and practices. Responses to the closed-ended questions were in the form of single-choice, multiple-choice and a 5-point scale with modalities, where 1 indicated "complete distrust" and 5 "complete trust."

A total of 172 farmers were willing to participate in the research, and the same number of questionnaires were used in the data analysis. According to Cohen's guidelines for determining effect size and power of a test, a medium effect size (d = 0.5) requires a sample of approximately 64 participants per group to achieve a power of 0.80 at a significance level of 0.05 (Cohen, 1988). Given the total population of 6,063 farmers, a sample of 172 farmers in this study is considered sufficiently large to ensure adequate power to detect differences in attitudes towards sustainable agricultural production systems.

The research data were analyzed using Statgraphics v. 16.1.11 statistical software. Microsoft Excel was used for the graphical representation of the data. Descriptive statistics were used to summarize the basic characteristics of the data. A chi-square test was conducted to examine the relationship between socioeconomic, sociodemographic, and farm characteristics and the adoption of Sustainable Agricultural Practices (SAP) or Sustainable Production Systems (SPS), as well as to analyze the association between the provision of necessary conditions and farmers' willingness to adopt SAP or SPS. Subsequent data analysis included one-way ANOVA, and a post hoc Tukey test of significance was applied at the level of $P \leq 0.05$ (Field, 2005) to determine statistical differences in the WTA one of the SAS or SAP according to the importance of individual benefits when switching to sustainable production systems.

This study utilized the Diffusion of Innovations (DOI) theory (Rogers, 2003) as its theoretical framework in the discussion section. The DOI theory posits that the adoption of innovations, such as sustainable agricultural practices (SAP), is influenced by several factors, including the perceived attributes of the innovation: relative advantage, compatibility, complexity, trialability, and observability. These attributes influence individuals' decisions to adopt or reject an innovation. Because the DOI framework was applied in this study after conducting the survey, the survey questions were not initially developed based on DOI theoretical constructs. Nevertheless, key constructs from the DOI theory could be scientifically acceptable to infer the presence of certain attributes from the results without direct calculation as long as the conclusions are reasonable and grounded in both the data and the theoretical framework as in the present study e.g., the significant relationship between variables allows for reasonable conclusions about specific attributes from (DOI) theory. These five attributes provided a more comprehensive understanding of the factors influencing innovation adoption, namely farmers' decisions in Istria County.

The DOI theory attributes used in this study are:

- Relative Advantage: Assessed through questions/ statements related to the perceived benefits of adopting SAP over conventional practices.
- Compatibility: Evaluated through questions/ statements assessing how well SAP fits with existing values, experiences, and needs of farmers, and whether they would transition to a SAS or adopt SAP.
- Complexity: Measured by questions/statements on the perceived difficulty of understanding and implementing SAP, whether farmers would transition to a SAS or adopt SAP, and what barriers they perceive in understanding and applying sustainable practices.
- Trialability: Investigated through questions/ statements about opportunities to experiment with SAP on a limited basis.
- Observability: Explored through questions/ statements regarding the visibility of the results of adopting SAP to others.

This study is examining the adoption of SAS or SAP, and WTA. By examining SAS and SAP, the study investigates the impact of socioeconomic, sociodemographic, and farm

characteristics on the adoption of sustainable practices. Examining the WTA in this study, the conditions under which farmers are willing to accept new practices are explored.

RESULTS

Description of the sample

The sociodemographic data analysis in this study showed that male farm owners predominate (79.7%) and most belong to the middle age range (41-55 years) in 43.6% of cases, followed by the younger age range (26-40 years) in 30.2% of cases. About half of the owners have a high school education level (50.5%), followed by those with a higher education level (37.8%). Formal education in the field of agriculture was present in 37.8% of the farm owners, while 62.2% of the owners had formal education in other fields (Table 1).

Most of the farms from this study were managed as family farms (81.2%). The length of engagement in agricultural production was 4-15 years in 45.3% of cases, followed by those farming for more than 20 years (39.5%). The number of farm members is mainly 1-3 (83.1%), while yearly earnings from agricultural production are up to 6000 EUR in 47.1% of cases. The proportion of earnings from agricultural production in the total annual household income is up to 25% in 43.6% of cases (Table 2).

Interest in transitioning to SAS or adopting SAP

Nearly half of the respondents (47.1%) were interested in transitioning to any of the sustainable production systems (SPS) or adopting some of the sustainable agricultural practices (SAP), followed by those who were either not sure (38.2%) or were not interested (14.7%).

Table 1. Sociodemographic characteristics of farm owners (N = 172)

Variables		N	%
Gender	Female	35	20.3
	Male	137	79.7
Age	18 -25	5	2.9
	26-40	52	30.2
	41-55	75	43.6
	56-70	31	18.0
	71 and more	9	5.2
Level of education	Elementary school	20	21.5
	High school	87	50.6
	University and more	65	37.8
Education in the field of agriculture	Yes	65	37.8
	No	107	62.2

Source: Authors

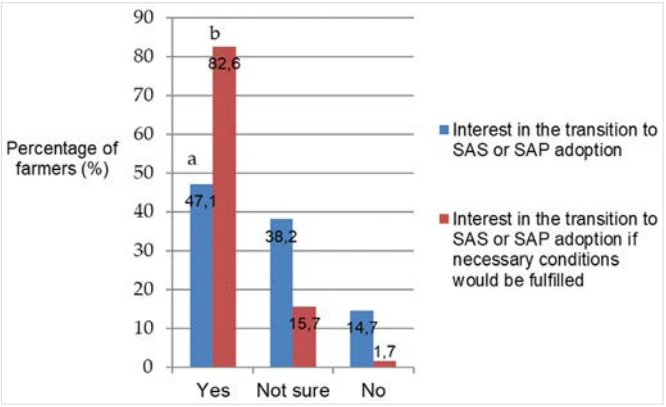
Table 2. Characteristics of the farms (N = 172)

Variables		N	%
Organizational form	Family farm	138	81.2
	Craft	20	11.6
	Company	12	7.1
Length of engagement in agriculture (years)	0 - 3	9	5.2
	4 - 10	43	25.0
	11 - 15	35	20.3
	16 - 20	17	9.9
	More than 20	68	39.5
Number of farms' member	1 - 3	143	83.1
	4 - 5	20	11.6
	More than 5	9	5.3
Annual income from agriculture (thousand EUR)	0 - 6	81	47.1
	6 - 20	54	31.4
	20 - 40	14	8.1
	40 - 100	12	7.0
	More than 100	11	6.4
Share of income from agriculture in total household income (%)	0 - 25	75	43.6
	26 - 50	45	26.2
	51 - 75	21	12.2
	76 - 100	31	18.0

Source: Authors

When farmers were asked whether they would be willing to accept a SAS or SAP if provided with the necessary conditions, a significantly higher percentage (82.6%) expressed willingness to accept (WTA) SAS or SAP compared to their general interest (47.1%). A Chi-square test of independence was performed to examine the relationship between the provision of necessary conditions and farmers' willingness to adopt SAS or SAP. The test revealed a highly significant difference between the two conditions ($\chi^2 = 51.556$, $P < 0.001$), indicating

that providing necessary conditions significantly increases farmers' WTA sustainable production systems or practices (Figure 1). The percentage of farmers who were not WTA was negligible (1.7%), indicating that, with the necessary conditions, SPS or SAP would significantly dominate the agricultural landscape in the region.



* The different letters above bars indicate a significant difference between the two conditions ($P < 0.05$)

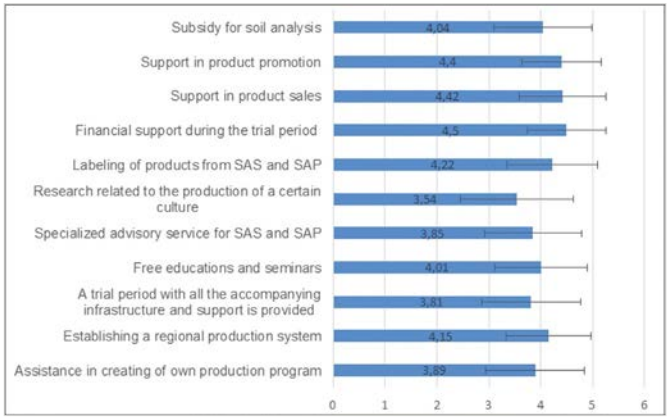
Figure 1. Interest in transitioning to any of the Sustainable Production Systems (SPS) or adopting some of the Sustainable Agricultural Practices (SAP), without and with the provision of necessary conditions

The impact of selected factors on adopting SPS or SAP

The results showed that only the relation between education and interest in transitioning to any of the SPS or interest in adopting some of the SAP was significant, χ^2 (4, N = 172) = 15.64, P = 0.04. Farmers with higher levels of education were more likely to adopt SAP or SPS. The factor of age showed a higher level of association with interest in transitioning to SPS or adopting SAP compared to other factors, although this association was not statistically significant. Characteristics that were scarcely correlated with interest in transitioning to any of the SPS or adopting some of the SAP included smaller-sized farms, higher income earned outside of the farm, and a lower proportion of income from agriculture in the total household income.

The importance of motivation factors on WTA

In addition to identifying the relationship between socioeconomic, sociodemographic, and farm characteristics on adoption of sustainable agricultural practices, farmers were asked to rate the importance of individual motivation factors on WTA some of the SAS or SAP on a scale from 1 to 5. The three most important factors were financial support during the trial period, followed by sales assistance and product marketing (Figure 2).



* The bars indicate the mean values with standard deviations

Figure 2. Importance of selected motivational factors for WTA, some of SAS or SAP

Analysing the differences among farmers regarding their interest in adopting SAP and SPS concerning the factors important to them, significant differences were found for two factors (Table 3). Farmers interested in adopting SAP or SAS considered Assistance in creating their own production program as an important benefit compared to those who do not intend to adopt the SAP and SPS without certain benefits. Farmers who were uncertain about transitioning to a sustainable system consider Product labelling indicating the use of sustainable production systems to be significantly more important compared to those who have no interest in transitioning to sustainable production systems. The results suggest that the group of farmers uncertain about transitioning to SAP and SPS considers product labelling important, probably as an indirect way of economic benefit and/or as a way to lower the risk of transition.

Table 3. Willingness to accept SAS or SAP according to the importance of selected benefits available to farmers

Benefit	Willingness to accept SAS or SAP	Mean	F	Sig.
Assistance in creating of own production program	Yes*	4,11	5,33	0,006
	No*	3,44		
	Not sure	3,85		
Establishing a regional production system	Yes	4,11	0,645	0,526
	No	3,44		
	Not sure	3,85		
A trial period with all the and accompanying infrastructure support is provided	Yes	3,77	0,532	0,589
	No	3,76		
	Not sure	3,92		
Free educations and seminars	Yes	3,98	0,079	0,924
	No	4,00		
	Not sure	4,04		
Specialized advisory service for SAS and SAP	Yes	3,76	0,684	0,506
	No	4,00		
	Not sure	3,89		
Research related to the production of a certain culture	Yes	3,50	2,243	0,109
	No	3,96		
	Not sure	3,42		
Labelling of products from SAS and SAP	Yes	4,16	3,836	0,024
	No*	3,88		
	Not sure*	4,42		
Financial support during the trial period	Yes	4,42	1,057	0,350
	No	4,44		
	Not sure	4,60		
Support in product sales	Yes	4,31	1,052	0,351
	No	4,44		
	Not sure	4,51		
Support in product promotion	Yes	4,37	0,718	0,489
	No	4,28		
	Not sure	4,48		
Subsidy for soil analysis	Yes	4,03	1,347	0,263
	No	4,32		
	Not sure	3,95		

Significant differences between groups are indicated by the symbol *(Tukey post-hoc test, the degree of statistical significance $P \leq 0.05$).

DISCUSSION

The relatively high percentage of farmers (47.1%) interested in transitioning to any of the Sustainable Production Systems (SPS) or adopting some of the Sustainable Agricultural Practices (SAP), without any provided benefits, could be attributed to their sociodemographic, socioeconomic and farm characteristics. Although the only significant association in this study was between education and interest in transitioning to SPS or adopting SAP, factor age showed a higher association, while factors smaller-sized farms, higher external income, and a lower proportion of agricultural income showed scarce association.

Higher levels of education have often been associated with a greater willingness to adopt sustainable practices such as soil and water conservation measures (Gebrezgabher et al., 2015; Wang et al., 2019; Boufous et al., 2023), manure and fertilizer measures (Gebrezgabher et al., 2015), transition to organic farming (Läpple and Van Rensburg, 2011; Tiffin and Balcombe, 2011), conservation farming, and the use of SAP in general (Läpple and Kelley, 2015). Farmers with higher levels of education tend to be more aware of the advantages associated with sustainable agriculture, encompassing environmental, economic, and social benefits (Maini et al., 2021). This awareness can serve as a driving force for the adoption of SAP or SPS. Additionally, educated farmers may more easily familiarize themselves with new technological practices, have improved access to information, and exhibit critical thinking abilities and greater awareness of agricultural policies (Maini et al., 2021; Mapanje et al., 2021; Nyang'au et al., 2021). The significant relationship between higher education levels and the likelihood of adopting SAP or SPS in this study aligns also with the Complexity and Relative Advantage attributes of Rogers' Diffusion of Innovations (DOI) theory. Educated farmers may find sustainable practices easier to understand and implement, and they may better recognize the environmental, economic, and social benefits.

Age, as one of the most studied factors with inconsistent results (Knowler and Bradshaw, 2007; Coulibaly et al., 2021), could have a positive or negative significant impact on WTA (Chatzimichael et al., 2014; Gebrezgabher et al., 2015; Case et al., 2017; Serebrennikov et al., 2020). Younger farmers exhibit a higher affinity for adopting SAP or SPS compared to older farmers (Case et al., 2017; Wang et al., 2019) because they may be more open to innovation, have received more exposure to modern agricultural techniques during their formal and informal education, and thus are more likely to adopt SAP or SPS (Rajendran et al., 2016). According to Rogers' Diffusion of Innovations (DOI) theory, younger farmers' greater openness to innovation and better access to information enhance the perceived relative advantage and compatibility of SAP and SPS, facilitating their adoption. Younger farmers may also have lower risk aversion (Serebrennikov et al., 2020; Bonke et al., 2021), and better access to resources such as financial capital and technological tools, and improved access to information (Rajendran et al., 2016; Nigussie et al., 2017; Serebrennikov et al., 2020). Age could also have a positive non-linear effect (Chatzimichael et al., 2014) and a negative impact on WTA (Gebrezgabher et al., 2015; Feng et al., 2018). The results from our study are in line with those showing an association between age and WTA, although the association in this study was not significant.

Farm experience has been found to have a significant positive effect on the adoption of sustainable agricultural practices (Adeola, 2010; Barnes et al., 2018; Vaiknoras et al., 2019; Coulibaly et al., 2021). However, the results from the present study show a non-significant, scarce association between farming experience and adoption of sustainable agricultural practices. One possible reason for this could be the relatively high percentage of highly educated farmers and diversified income sources, which might lower the risks associated with transitioning to SAS or SAP. Farm experience has been found to have a significant positive effect on the adoption of SAP (Adeola, 2010; Barnes et al., 2018; Vaiknoras et al., 2019; Coulibaly et al., 2021).However, the results from the present study show no association between farming experience and the adoption of sustainable agricultural practices.

One possible reason for this could be the relatively high percentage of farmers with formal education and diversified income sources, which might lower the risks associated with transitioning SPS or SAP. According to the DOI theory, the perception of an innovation's attributes, such as relative advantage, compatibility, and complexity, plays a critical role in its adoption. In this context, formal education and diversified income sources may enhance the perceived relative advantage and compatibility of sustainable practices while reducing their perceived complexity, thereby compensating for the lack of farming experience.

The relatively high percentage of farmers willing to adopt SAP or SPS in our study might be influenced by an additional factor. This assumption is supported by the fact that farmers in Istria County have already been using SAP to some extent voluntarily (Zec Vojinovic et al., 2019). One of the reasons could be access to information about new technologies and practices from neighbouring countries such as Italy, Slovenia, France, Austria, and Germany, which farmers often visit to improve their production systems (personal communication). Information dissemination at the local level in Istria County through various campaigns and activities led by NGOs, municipal authorities (e.g., "Rovinj Eco-friendly agriculture"), county authorities (e.g., "Istria bio region"), the Institute of Agriculture and Tourism, and the Department of Agriculture at the University of Applied Sciences of Rijeka (personal communication) could also play a significant role. However, these activities were more informational and theoretical rather than practical training and consultancy. Understanding the sources of information that influence farmers' decisions is critical. Although this study did not explore specific sources, it is suggested that exposure to sustainable practices in neighbouring countries and local educational campaigns plays a significant role. According to Rogers' Diffusion of Innovations (DOI) theory, such exposure through communication channels enhances the perceived relative advantage, compatibility, and observability of sustainable practices, thereby facilitating their adoption. The fact that farmers must be informed about and adequately trained in new technologies (Udimal et al., 2017; Serebrennikov et al., 2020; Mapanje et al., 2021; Mgomezulu et al., 2023) might partly explain the relatively high percentage of farmers interested in adopting SAS or SAP in their production processes, regardless of socioeconomic, sociodemographic, and farm characteristics in this study. The findings from this study reveal a substantial increase in farmers' willingness to accept (WTA) Sustainable Production Systems (SPS) and Sustainable Agricultural Practices (SAP) when provided with the necessary benefits. Specifically, WTA, some of the SPS or SAP rose significantly to 82.6% when necessary conditions were provided, compared to a general interest level of 47.1%. These results suggest that providing the necessary conditions and support could lead to a widespread adoption of sustainable practices among farmers in Istria County. The negligible percentage of farmers who were not willing to accept (1.7%) further underscores the potential for sustainable agriculture to dominate the agricultural landscape in the region. This indicates a strong likelihood that conventional farming practices would become almost obsolete, paving the way for a significant shift towards sustainable production systems. The findings align with the principles of Rogers' Diffusion of Innovations theory, which posits that perceived relative advantage, compatibility, and reduced complexity can significantly influence the adoption of new practices. In this context, the necessary conditions likely reduced perceived barriers and increased the perceived benefits of adopting SPS and SAP, thus driving higher adoption rates. The results from this study correlate with many previous findings that show financial support is necessary to enhance the WTA and adoption of SAP and SPS (Zemo and Termansen, 2018; Carlisle et al., 2019; Piñeiro et al., 2020; Bonke et al., 2021; Mgomezulu et al., 2023). Boufous et al., (2023) stated that farmers would adopt SAP only if they receive financial support. Some authors argue that direct financial support is critical only for the initial temporary adoption of SAP or SPS (Adeola, 2010) or in the first phase of transition because incentives directly influence WTA by reducing the associated risks (Chatzimichael et al., 2014). On the other hand, some

authors suggest that it is more effective to combine incentives with information dissemination about SAP or SPS (Chatzimichael et al., 2014). Nevertheless, spreading information about SAP or SPS motivates farmers to adopt the practices even more than incentives (Lohr and Salomonsson 2000).

DOI theory helps explain the findings of this study by highlighting the role of financial support in reducing the economic risks associated with adopting new practices, thereby increasing the perceived relative advantage of Sustainable Agricultural Practices (SAP). Financial support during the trial period allows farmers to test SAP with minimal financial risk, enhancing the trialability of these practices. This trialability aspect is crucial as it enables farmers to experiment with sustainable practices without compromising their financial stability, thus increasing their WTA. According to DOI theory, when the relative advantage and trialability of an innovation are high, adoption rates are likely to increase.

The impact of education about SAS and SAP on WTA is not significant when divided into its elements, but consultancy training is a significant factor for WTA (Adeola 2010). This finding underscores the importance of training and extension services for the adoption of SAP (Corsi and Muminjanov, 2019; Serebrennikov et al., 2020; Mapanje et al., 2021; Mgomezulu et al., 2023). Training helps farmers gain knowledge about new practices and their practical implementation, thereby enhancing the probability of WTA and implementing SAP or SPS (Aryal et al., 2018; Mapanje et al., 2021; Sapbamrer and Thammachai, 2021). According to Rogers' Diffusion of Innovations (DOI) theory, training and consultancy can increase the perceived relative advantage and compatibility of new practices by providing farmers with the necessary knowledge and skills. This enhanced understanding reduces the perceived complexity of adopting new practices, which is a critical factor for their widespread adoption. The farmers in our study identified support through the establishment of a regional production system and assistance in creating their own production programs as important benefits. These findings suggest that structured training programs could significantly enhance WTA.

Such training programs could be organized at national and local levels by authorities, NGOs, institutions, and the private sector (Carlisle et al., 2019). While farmers in our study did not view education and seminars as detrimental, they did emphasize the importance of support during the transition period. Further information dissemination, training provision, and financial incentives are likely to increase farmers' motivation to adopt SAP and SPS.

The DOI theory suggests that effective training and support programs not only improve farmers' knowledge but also enhance the perceived trialability and observability of sustainable practices. This comprehensive approach ensures that farmers can experiment with new practices without significant risks, making the transition to sustainable agriculture more feasible and attractive.

CONCLUSIONS

The findings of this study revealed several key insights into the demographic and socioeconomic characteristics of farmers in Istria County and their attitudes toward adopting sustainable agricultural systems (SAS) or sustainable agricultural practices (SAP) and willingness to accept (WTA).

Middle-aged male farmers with high school educational levels predominate in Istria County, followed by those with higher educational levels. Most of the farmers have farming experience ranging from 4 to 15 years and formal education in fields other than agriculture. The proportion of income from agricultural production, in most of cases, is up to 25% of their total annual household income.

Nearly half of the respondents (47.1%) showed interest in transitioning to SAS or adopting SAP. The relatively high interest in adopting SAS or SAP can be attributed to activities, campaigns, and the dissemination of information by various entities in Istria County. The lower risk associated with the adoption of SAS or SAP for family farms, where the majority of income is generated outside agriculture, combined with the higher educational

levels and younger ages of the owners, also contributes to this interest.

A significant relationship was found between education and interest in adopting SAS or SAP, indicating that more educated farmers are more inclined to adopt these practices. This suggests that education reduces perceived complexity and enhances the perceived relative advantage of sustainable practices. The significant role of education in this study suggests that initiatives to improve farmers' knowledge about sustainable practices could be crucial in increasing adoption rates.

Notably, if provided with the necessary support and conditions, a significantly higher percentage (82.6%) expressed willingness to adopt SAS or SAP. The three most important individual motivation factors for WTA were financial support during the trial period, sales assistance, and product marketing. Farmers interested in adopting SAS or SAP, even without providing motivation factors, viewed assistance in creating their own production programs as a crucial benefit, suggesting the importance of offering special education and training, compared to those who did not intend to adopt SAP and SPS. This support should include financial assistance during the trial period, sales assistance, product marketing, product labelling, and production management support. Additionally, providing information dissemination, training, and assistance, such as creating personal production plans, would further enhance WTA.

The significant role of education highlights the need for initiatives to improve farmers' knowledge about sustainable practices, which could be crucial in increasing adoption rates. Creating an enabling environment with financial incentives, technical support, and marketing assistance is essential to reduce the risks associated with transitioning to sustainable practices. Furthermore, understanding the sources of information that influence farmers' decisions is critical. Although this study did not explicitly explore where farmers obtain their information, it is suggested that exposure to sustainable practices in neighbouring countries and local educational campaigns plays a significant role.

Integrating elements of Rogers' Diffusion of Innovations (DOI) theory helps explain the varying levels of interest and adoption of sustainable practices among farmers in Istria County. This theoretical framework emphasizes the importance of perceived relative advantage, compatibility, complexity and trialability in the adoption process. Sociodemographic and socioeconomic factors, such as education, age, and income diversification, influence these perceptions while financial support enhances these attributes, playing a significantly important role in promoting the adoption of SAP and SPS. These insights highlight the need for targeted educational initiatives and comprehensive support systems to facilitate the widespread adoption of sustainable practices.

In conclusion, the findings from this study underscore the need for integrated approaches combining education, financial incentives, and technical support to achieve widespread adoption of sustainable agriculture that could significantly dominate the agricultural landscape in the region.

Limitations and suggestions for future research

Despite the valuable insights provided by this study, several limitations should be noted. Firstly, the sample size, although statistically sufficient, may not capture the full diversity of farming practices and attitudes in Istria County. Secondly, the reliance on self-reported data may have introduced response bias, as participants might have provided socially desirable rather than accurate answers. Thirdly, the survey questions were not designed based on Rogers' Diffusion of Innovations (DOI) theory; instead, DOI was used for interpreting the results. This retrospective application of the theory might limit the robustness of the theoretical conclusions.

Future research could address these limitations by employing larger sample sizes and using longitudinal or mixed-method approaches to gain a more comprehensive understanding of the dynamics involved in adopting sustainable practices. Additionally, directly investigating the sources of information that influence farmers' decisions could help tailor communication strategies

more effectively. Future studies should also consider designing survey questions grounded in DOI theory to strengthen the theoretical framework and ensure more precise interpretations.

Practical implications

To enhance the adoption of Sustainable Agricultural Systems (SAS) and Sustainable Agricultural Practices (SAP), several strategies can be utilized. These include providing financial incentives during the trial period, robust support for product sales and marketing, and assistance in creating tailored production programs. Additionally, targeted educational programs, workshops, and access to information on the benefits of sustainable agriculture are crucial for improving farmers' knowledge and increasing adoption rates.

Policymakers, stakeholders, and agricultural advisors should focus on creating an enabling environment that reduces risks and increases the perceived benefits of adopting SAS and SAP. By integrating comprehensive support systems that combine education, financial incentives, and technical support, they can significantly enhance the adoption of sustainable agriculture practices.

Contribution to academic international discourse

The research results contribute to the international discourse by providing insights into the factors influencing farmers' interest in transition to SAS or adoption of SAP and WTA in a specific regional context. Although the specific cultural and economic conditions of Istria County might differ from other regions, the identified drivers and barriers to adopting sustainable practices can inform similar efforts globally. The emphasis on education and supportive policies can be universally applied to encourage sustainable agricultural transitions, and stakeholders can design more effective interventions that are adaptable to different cultural and economic contexts.

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