

UDC 338.43:63

ISSN 0352-3462



ЕКОНОМИКА ПОЉОПРИВРЕДЕ ECONOMICS OF AGRICULTURE



Vol.LXXIII, №3 (673-1012), 2026

BELGRADE



UDC 338.43:63

ISSN 0352-3462



ЕКОНОМИКА ПОЉОПРИВРЕДЕ ECONOMICS OF AGRICULTURE



Journal is indexed and abstracted in Emerging Sources Citation Index.

73.

Према категоризацији МЕЂУНАРОДНИ ЧАСОПИСИ ДОМАЋИХ ИЗДАВАЧА
РЕФЕРИСАНИ У WOS - JCR М категорија према најповољнијем рангу JCR
индикатора (IF2, IF5 или JCI у 2024. години) - подаци видљиви у EleČas сервису
на KoBSON-y (https://kobson.nb.rs/servisi/pretrazivanje_casopisa.84.html),

“Економика пољопривреде”

је сврстана у категорију **М 23 - Међународни часопис за 2025. годину**
<https://nitra.gov.rs/images/nauka/Kategorizacija%20naučnih%20casopisa/2025-12-26/Medunarodni%20casopisi%20domaćih%20izdavaca%20referisani%20u%20WoS-JCR.pdf>

Београд, јул - септембар 2026. године
Belgrade, July - September, 2026

Часопис
◇ ЕКОНОМИКА ПОЉОПРИВРЕДЕ ◇

Journal
◇ ECONOMICS OF AGRICULTURE ◇

Основан 1954. године / Established 1954

ИЗДАВАЧИ / PUBLISHERS

Научно друштво аграрних економиста Балкана, Београд
The Balkan Scientific Association of Agrarian Economists, Belgrade

Институт за економику пољопривреде, Београд (Србија)
Institute of Agricultural Economics, Belgrade, (Serbia)

Академија економских наука, Букурешт (Румунија)
Academy of Economic Studies, Bucharest (Romania)

Национални институт за економска истраживања „Costin C. Kiritescu“ –
Румунска академија, Букурешт (Румунија)
National Institute for Economic Research “Costin C. Kiritescu” -
Romanian Academy, Bucharest (Romania)

EDITOR-IN-CHIEF

Prof. Drago Cvijanovic, Ph.D., University of Kragujevac,
Faculty of Hotel Management and Tourism, Vrnjci Spa, Serbia

Адреса уредништва / Editorial office

Београд, Волгина 15; тел/факс (+381)11/6972-848; E-mail: economicsofagriculture@ea.bg.ac.rs
Belgrade, Volgina 15; phone/fax (+381)11/6972-858; E-mail: epoljoprivrede@gmail.com

<http://ea.bg.ac.rs>

EDITORIAL TEAM

Editor in Chief:

Prof. Drago Cvijanović, Ph.D. – University of Kragujevac, Faculty of Hotel Management and Tourism in Vrnjačka Banja, Serbia

ASSOCIATE EDITORS

Prof. Zoran Rajic, Ph.D., Faculty of Agriculture, Belgrade, Serbia,

Prof. Zoran Njegovan, Ph.D., Faculty of Agriculture, Novi Sad, Serbia,

Prof. Jonel Subic, Ph.D., Institute of Agricultural Economics, Belgrade, Serbia,

Prof. Jean Vasile Andrei, Ph.D., National Institute for Economic Research, Romanian Academy, Romania,

Prof. Ferhat Cejvanovic, Ph.D., Government of Brcko District, Bosnia and Herzegovina,

EXECUTIVE EDITORS

Prof. Dragic Zivkovic, Ph.D., Faculty of Agriculture, Belgrade, Serbia,

Prof. Aleksandar Grubor, Ph.D., Faculty of Economy, Subotica, Serbia,

Prof. Dorel Dusmanescu, Ph.D., Petroleum Gas University, Faculty of Economy, Ploiesti, Romania,

Prof. Branislav Vlahovic, Ph.D., Faculty of Agriculture, Novi Sad, Serbia,

Prof. Adelaida Honțuș, Ph.D., University of Agronomic Sciences and Veterinary Medicine of Bucharest, Romania,

Prof. Cristiana Tindecu, Ph.D., University of Agronomic Sciences and Veterinary Medicine of Bucharest, Romania,

Prof. Alina Marcuta, Ph.D., University of Agronomic Sciences and Veterinary Medicine of Bucharest, Romania,

Prof. Liviu Marcuta, Ph.D., University of Agronomic Sciences and Veterinary Medicine of Bucharest, Romania.

INTERNATIONAL EDITORIAL BOARD

Prof. Radovan Pejvanovic, Ph.D., Faculty of Agriculture, Novi Sad, Serbia,

Prof. Zorica Vasiljevic, Ph.D., Faculty of Agriculture, Belgrade, Serbia,

Prof. Vladimir I. Trukhachev, Ph.D., Russian State Agrarian University - Moscow Timiryazev Agricultural Academy, Russian Federation,

Prof. Alan Randall, Ph.D., Faculty of Agriculture, Food and Natural Resources, University of Sydney, Sydney, Australia,

Prof. Vincent Dolle, Ph.D., Mediterranean Agronomic Institute Montpellier (IAMM-CIHEAM), Montpellier, France,

Prof. Andras Nabradi, Ph.D., University of Debrecen, Debrecen, Hungary,

Prof. Eirik Romstad, Ph.D., Norwegian University of Life Sciences, Aas, Norway,

Prof. Wim Heijman, Ph.D., Wageningen University, Wageningen, The Netherlands,

Prof. Nicolae Istudor, Ph.D., Academy of Economic Studies, Bucharest, Romania,

Prof. Andrzej Kowalski, Ph.D., Institute of Agricultural and Food Economics, Warsaw, Poland,

Prof. William H. Meyers, Ph.D., College of Agriculture, Food and Natural Resources, Columbia, Missouri, USA,

Prof. Thomas Glauben, Ph.D., Leibniz – IAMO Institute, Halle, Germany,
Tomas Doucha, Ph.D., Institute of Agricultural Economics and Information, Prague, Czech Republic,
Prof. Margaret Loseby, Ph.D., State University of Tuscia, Viterbo, Italy,
Prof. Aleksandar Ostojic, Ph.D., Faculty of Agriculture Banja Luka, Republika Srpska, Bosnia and Herzegovina,
Prof. Toma Dinu, Ph.D., University of Agricultural Sciences and Veterinary Medicine, Bucharest, Romania,
Prof. Natalia Nikolaevna Balashova, Ph.D., Faculty of Economy, Volgograd State Agricultural Academy, Volgograd, Russian Federation,
Prof. Masahiko Gemma, Ph.D., Waseda University, Tokyo, Japan,
Prof. Agatha Popescu, Ph.D., University of Agricultural Sciences and Veterinary Medicine of Bucharest, Bucharest, Romania,
Prof. Chivu Luminita, Ph.D., National Institute for Economic Research, Romanian Academy, Romania
Georgescu George, Ph.D., National Institute for Economic Research, Romanian Academy, Romania

INTERNATIONAL EDITORIAL REVIEW BOARD

Prof. Irina Gabriela Rădulescu Ph.D., Petroleum-Gas University, Faculty of Economic Sciences, Ploiesti, Romania,
Prof. Mirela Clementina Panait Ph.D., Petroleum-Gas University, Faculty of Economic Sciences, Ploiesti, Romania.
Doc. Lea-Marija Colarič-Jakše, Ph.D., Landscape Governance College GRM Novo Mesto, Slovenia
Prof. Koviljko Lovre, Ph.D., Faculty of Economy, Subotica, Serbia,
Prof. Petar Veselinović, Ph.D., Faculty of Economy, Kragujevac, Serbia,
Prof. Snezana Djekic, Ph.D., Faculty of Economy, Nis, Serbia,
Prof. Pero Petrovic, Ph.D., Institute of International Politics and Economics, Belgrade, Serbia,
Doc. Marija Turnšek Mikačič, Ph.D., Landscape Governance College GRM Novo Mesto, Slovenia
Prof. Lela Ristić, Ph.D., Faculty of Economy, Kragujevac, Serbia,
Prof. Vlade Zaric, Ph.D., Faculty of Agriculture, Belgrade, Serbia,
Prof. Nedeljko Tica, Ph.D., Faculty of Agriculture, Novi Sad, Serbia,
Prof. Vesna Rodic, Ph.D., Faculty of Agriculture, Novi Sad, Serbia,
Vesna Popovic, Ph.D., Institute of Agricultural Economics, Belgrade, Serbia,
Doc. Nemanja Berber, Ph.D., Faculty of Economy, Subotica, Serbia,
Prof. Milan R. Milanovic, Megatrend University, Belgrade, Serbia,
Prof. Ivan Milojevic, Ph.D., Military Academy, University of Defence, Belgrade, Serbia,
Prof. Nikolai I Kuznetsov, Ph.D., Saratov State Agrarian University – N.I. Vavilov, Saratov, Russian Federation,
Prof. Kenneth Thomson, Ph.D., University of Aberdeen, Aberdeen, Scotland, UK,
Dan Marius Voicilas, Ph.D., Romanian Academy of Science, Institute of Agricultural Economics, Bucharest, Romania,
Prof. Claudiu Cicea, Ph.D., Academy of Economic Studies, Bucharest, Romania,
Prof. Adrian Turek Rahoveanu, Ph.D., University of Agricultural Sciences and Veterinary Medicine of Bucharest, Romania,
Marek Wigier, Ph.D., Institute of Agricultural and Food Economics, Warsaw, Poland,

Prof. Mile Pesevski, Ph.D., University “Ss Cyril and Methodius”, Faculty of Agricultural Sciences and Food, Institute of Agroecconomics, Skopje, Republic of North Macedonia,

Prof. Marko Slavković, Ph.D., Faculty of Economy, Kragujevac, Serbia,

Prof. Blagica Sekovska, Ph.D., Faculty of Veterinary Medicine, Skopje, Republic of North Macedonia,

Doc. Nikola Miličević, Ph.D., Faculty of Economy, Subotica, Serbia,

Prof. Aleksandra Despotovic, Ph.D., Biotechnical Faculty, Podgorica, Montenegro,

Prof. Marko Ivankovic, Ph.D., Federal Agro-Mediterranean Institute, Mostar, Bosnia and Herzegovina,

Prof. Bahrija Umihanic, Ph.D., Faculty of Economy, Tuzla, Bosnia and Herzegovina,

Prof. Alexandru Stratan, Ph.D., Institute of Economy, Finance and Statistics, Chisinau, Moldova,

Prof. Mihael Toman, Ph.D., Biotechnical faculty, University of Ljubljana, Domzale, Slovenia,

Klaus Wagner, Ph.D., Federal Institute of Agricultural Economics, Vienna, Austria,

Prof. Andrea Segre, Ph.D., Faculty of Agriculture, Bologna, Italy,

Prof. Raluca Ion, Ph.D., Academy of Economic Studies, Bucharest, Romania,

Zbigniew Florianczyk, Ph.D., Institute of Agricultural and Food Economics, Warsaw, Poland,

Crina Turtoi, Ph.D., Romanian Academy of Science, Institute of Agricultural Economics, Bucharest, Romania,

Prof. Dragana Gnjatovic, Ph.D. University of Kragujevac, Faculty of Hotel Management and Tourism in Vrnjačka Banja, Serbia,

Asst. Prof. Dejan Sekulić Ph.D. – University of Kragujevac, Faculty of Hotel Management and Tourism in Vrnjačka Banja, Serbia

Prof. Vasily Erokhin, Ph.D., Stavropol State Agrarian University, Stavropol, Russian Federation,

Prof. Nenad Stanišić, Ph.D., Faculty of Economy, Kragujevac, Serbia,

Prof. Ivo Grgic, Ph.D., Faculty of Economy, Zagreb, Croatia,

Prof. Stane Kavcic, Ph.D., University of Ljubljana, Biotechnical Faculty, Ljubljana, Slovenia,

Prof. Anatoli Saiganov Semenovich, Ph.D., Institute of System Research in the Agro-industrial Complex of National Academy of Sciences of Belarus, Minsk, Republic of Belarus,

Prof. Natalia Sergeevna Morozyuk, Ph.D., Odessa State Agrarian University, Odessa, Ukraine,

Prof. Goran Maksimovic, Ph.D., Faculty of Agriculture Lesak, Serbia,

Bahrija Kacar, Ph.D., Government Office for the Sustainable Development of Underdeveloped Areas of the Republic of Serbia, Novi Pazar, Serbia,

Prof. Kadrija Hodzic, PhD, Faculty of Economics, University of Tuzla, Tuzla, Bosnia and Herzegovina,

Prof. Svetlana Vukotic, Ph.D., Faculty of Applied Management, Economics and Finance, Belgrade – Serbia

Prof. Carlos Saborio Viquez, Ph.D., University of Costa Rica, San Jose, Costa Rica,

Prof. Miguel Moreno Millan, Ph.D., University of Cordoba, Cordoba, Spain,

Prof. Ion Iarca, Ph.D., Petroleum and Gas University, Economic Sciences Faculty, Ploiesti, Romania,

Prof. Done Ioan, Ph.D., Petroleum and Gas University, Economic Sciences Faculty, Ploiesti, Romania,

Prof. Riza Avcioglu, Ph.D., Aegean University, Faculty of Agriculture, Izmir, Turkey,

Prof. Diran Akinleye, Ph.D., University of Lagos, Akoka, Nigeria,

Prof. Bojana Ostojić, Ph.D., Faculty of Project Management (PMC), Belgrade, Serbia

Prof. Zorica Sredojevic, Ph.D., Faculty of Agriculture, Belgrade, Serbia,

Prof. Natalija Bogdanov, Ph.D., Faculty of Agriculture, Belgrade, Serbia,

Prof. Elena Stoian, Ph.D., University of Agricultural Sciences and Veterinary Medicine, Bucharest, Romania,

Prof. Victor Manole, Ph.D., Academy of Economic Studies, Bucharest, Romania,
Prof. Gabriel Popescu, Ph.D., Academy of Economic Studies, Bucharest, Romania,
Prof. Dan Boboc, Ph.D., Academy of Economic Studies, Bucharest, Romania,
Prof. Aurelia Felicia Stancioiu, Ph.D., Academy of Economic Sciences, Bucharest, Romania,
Prof. Constantinos Alexiou, Ph.D., Polytechnic School, Aristotle University, Thessaloniki, Greece,
Prof. Nicholas Apergis, Ph.D., University of Piraeus, Piraeus, Greece,
Prof. Zaklina Stojanovic, Ph.D., Faculty of Economics, Belgrade, Serbia,
Prof. Snezana Stetic, Ph.D., The College of Tourism, Belgrade, Serbia,
Prof. Vladimir Senić, Ph.D. University of Kragujevac, Faculty of Hotel Management and Tourism in Vrnjačka Banja, Serbia
Prof. Sait Engindeniz, Ph.D., Ege University, Faculty of Agriculture, Department of Agricultural Economics, Izmir, Turkey,
Prof. Tetyana Mostenska, Ph.D., National University of Food Technologies, Kyiv, Ukraine,
Corina Ene, Ph.D., Petroleum and Gas University, Economic Sciences Faculty, Ploiesti, Romania,
Anna Ivolga, Ph.D., Stavropol State Agrarian University, Stavropol, Russian Federation,
Prof. Andreja Borec, Ph.D., University of Maribor, Faculty of Agriculture and Life Sciences, Hoce, Slovenia,
Prof. Mihai Mieila, Ph.D., Faculty of Economic Sciences, Valahia University, Targoviste, Romania,
Prof. Donatella Privitera, Ph.D., Department of Educational Sciences, University of Catania, Catania, Italy,
Prof. Marija Mandaric, Ph.D. University of Kragujevac, Faculty of Hotel Management and Tourism in Vrnjačka Banja, Serbia
Prof. Marija Lakićević, Ph.D. University of Kragujevac, Faculty of Hotel Management and Tourism in Vrnjačka Banja, Serbia
Prof. Marco Platania, Ph.D., Department of Formational Sciences, University of Catania, Catania, Italy,
Asst. Prof. Miljan Leković, Ph.D. – University of Kragujevac, Faculty of Hotel Management and Tourism in Vrnjačka Banja, Serbia
Asst. Prof. Milica Luković Ph.D. – University of Kragujevac, Faculty of Hotel Management and Tourism in Vrnjačka Banja, Serbia
Adrian Stancu, Ph.D., Petroleum and Gas University, Economic Sciences Faculty, Ploiesti, Romania,
Prof. Natalya Bannikova Vladimirovna, Ph.D., Stavropol State Agrarian University, Russian Federation,
Asst. Prof. Danijela Pantović, Ph.D. – University of Kragujevac, Faculty of Hotel Management and Tourism in Vrnjačka Banja, Serbia
Prof. Darko Dimitrovski, Ph.D. University of Kragujevac, Faculty of Hotel Management and Tourism in Vrnjačka Banja, Serbia
Prof. Darina Zaimova, Ph.D., Trakia University, Stara Zagora, Bulgaria,
Prof. Matteo Vittuari, Ph.D., Faculty of Agriculture, Bologna, Italy,
Prof. Zoran Grgic, Ph.D., Faculty of Agriculture, Zagreb, Croatia,
Vesna Milicic, Ph.D., University of Ljubljana, Biotechnical Faculty, Ljubljana, Slovenia,
Prof. Marija Kostić, Ph.D. University of Kragujevac, Faculty of Hotel Management and Tourism in Vrnjačka Banja, Serbia
Asst. Prof. Nemanja Pantić, Ph.D. – University of Kragujevac, Faculty of Hotel Management and Tourism in Vrnjačka Banja, Serbia

Alexandr Trukhachev, Ph.D., Stavropol State Agrarian University, Russian Federation,
Prof. Dimitre Nikolov, Ph.D., Institute of Agricultural Economics, Sofia, Bulgaria,
Prof. Christina Yancheva, Ph.D., Agricultural University, Plovdiv, Bulgaria,
Prof. Svetlana Ignjatijević, Ph.D., Faculty of Economics and Engineering Management,
Novi Sad, Serbia

Dario Simicevic, Ph.D., College of Tourism, Belgrade, Serbia,
Prof. Vladislav Zekic, Ph.D., Faculty of Agriculture, Novi Sad, Serbia,
Aleksandar Rodic, Ph.D., Institute Mihailo Pupin, Belgrade, Serbia,
Prof. Sanjin Ivanovic, Ph.D., Faculty of Agriculture, Belgrade, Serbia,
Prof. Milan Pocuca, Ph.D., Business Academy, Faculty of Law, Novi Sad, Serbia,
Prof. Snezana Milicevic, Ph.D. University of Kragujevac, Faculty of Hotel Management and
Tourism in Vrnjačka Banja, Serbia

István Kapronczai, Ph.D. Research Institute of Agricultural Economics, Budapest, Hungary,
Prof. Tanja Stanišić, Ph.D. University of Kragujevac, Faculty of Hotel Management and
Tourism in Vrnjačka Banja, Serbia

Branko Mihailovic, Ph.D., Institute of Agricultural Economics, Belgrade, Serbia,
Vesna Parausic, Ph.D., Institute of Agricultural Economics, Belgrade, Serbia,
Vlado Kovacevic, Ph.D., Institute of Agricultural Economics, Belgrade, Serbia.

Natasa Kljajic, Ph.D., Institute of Agricultural Economics, Belgrade, Serbia,

Prof. Vladimir Zakic, Ph.D., Faculty of Agriculture, Belgrade, Serbia,

Boris Kuzman, Ph.D., Institute of Agricultural Economics, Belgrade, Serbia,

Prof. Jovan Zubovic, Ph.D., Institute of Economic Sciences, Belgrade, Serbia,

Zoran Simonovic, Ph.D., Institute of Agricultural Economics, Belgrade, Serbia,

Prof. Zeljko Vojinovic, Ph.D., Faculty of Economy, Subotica, Serbia,,

Prof. Zoran Pavlovic, Ph.D., Business Academy, Faculty of Law, Novi Sad, Serbia,

Svetlana Roljevic, Ph.D., Institute of Agricultural Economics, Belgrade, Serbia.

Predrag Vuković, Ph.D., Institute of Agricultural Economics, Belgrade, Serbia.

Prof. Rajko Tepavac, Ph.D., Faculty of Economics and Engineering Management, Novi Sad, Serbia

Marko Jeločnik, Ph.D., Institute of Agricultural Economics, Belgrade, Serbia.

Prof. Nikola Ćurčić, Ph.D., Institute of Agricultural Economics, Belgrade, Serbia.

Lana Nastić, Ph.D., Institute of Agricultural Economics, Belgrade, Serbia.

Anton Puškarić, Ph.D., Institute of Agricultural Economics, Belgrade, Serbia.

Prof. Slavoljub Vujović, Ph.D., Institute of Economics, Belgrade, Serbia

Rita Lankauskienė (previously – Rita Vilkė), Ph.D., Lithuanian Centre for Social Sciences,
Institute of Economics and Rural Development, Lithuania

Živilė Gedminaitė-Raudonė, Ph.D., Lithuanian Centre for Social Sciences, Institute of
Economics and Rural Development, Lithuania

Prof. Jelena Kočović, Ph.D., Faculty of Economy, Belgrade, Serbia,

Prof. Ionel Bostan, Ph.D., Ștefan cel Mare University of Suceava, Romania,

Ivana Ostojić, Ph.D., Institute of Social Sciences, Belgrade, Serbia,

Tamara Gajić, Ph.D., Geographical Institute “Jovan Cvijić”, SASA, Belgrade, Serbia.

Layout Editor:

Vladimir Sokolović, Belgrade, Serbia

UDC 338.43:63

ISSN 0352-3462

**ECONOMICS OF
AGRICULTURE**

CONTENT

1. Slobodan Popović, Milica Lakić, Ivan Arnautović, Dejan Sredojević:
**APPLICATION OF CONTROLLING AND IT SYSTEMS
IN BUSINESS OF MEDIUM-SIZED AGRICULTURAL AND
OTHER ENTERPRISES ACCORDING TO ASSESSMENT
OF TOP MANAGEMENT 685**
2. Chioma Patricia Adekunle:
**IMPACT OF CROP DIVERSITY ON FOOD AND
NUTRITIONAL OUTCOMES OF FARM HOUSEHOLDS
IN OGUN STATE, NIGERI. 699**
3. Tamara Rađenović, Žarko Rađenović, Miško Rađenović, Bojan Krstić:
**ASSESSING EU AGRICULTURAL PERFORMANCE
TOWARD A CIRCULAR ECONOMY: EVIDENCE
FROM CLUSTER ANALYSIS 719**
4. Sinan Çavuşoğlu:
**CONSUMER BEHAVIOR TOWARD ECO-LABELED AGRI-FOOD
PRODUCTS: EVIDENCE FROM TÜRKİYE 735**
5. Stoja Jotanović, Đorđe Savić, Tamara Stojanović, Bernisa Klepo, Predrag Ilić:
**SOCIO-ECONOMIC DETERMINANTS AND BARRIERS
TO ORGANIC PRODUCT CONSUMPTION
IN BOSNIA AND HERZEGOVINA 749**
6. Ivana Miklošević, Andreja Katolik Kovačević, Anica Vukašinović:
**PROFITABILITY DETERMINANTS OF AGRICULTURAL
ENTERPRISES: EMPIRICAL EVIDENCE FROM
RURAL ECONOMIES 765**
7. Anđelka Pindović, Ljiljana Arsić, Sanja Dobričanin, Lela Ristić:
**THE ROLE OF HUMAN CAPITAL IN SHAPING ATTITUDES
AND ADOPTING ORGANIC AGRICULTURE
IN KOSOVO AND METOHIJA 783**

8. Milan Bubulj, Saša Kukolj, Sonja Zlatanov, Slobodan Adžić:
ADVANCED PLS-SEM APPLICATIONS IN MANAGEMENT RESEARCH: MODERATION, PREDICTION, AND MANAGERIAL INSIGHTS FROM THE RAKIJA CASE 805

9. Dejan Vukosavljević, Danijela Vukosavljević, Milovan Mirkov, Jovana Radulović:
ECONOMIC FEASIBILITY OF FARM MACHINERY INVESTMENTS: A FARM-LEVEL INVESTMENT ANALYSIS 821

10. Branko Mihailović, Vesna Popović, Gordana Radović:
DEVELOPMENT OF SERBIAN AGRICULTURE THROUGH BRICS INTEGRATION: OPPORTUNITIES AND LIMITATIONS 839

11. Tamara Rajić, Ivana Ostojić, Marko Jovanović, Predrag Jovanović:
UNRAVELING THE DRIVERS OF ORGANIC FOOD PURCHASE INTENTIONS: A THEORY OF PLANNED BEHAVIOR PERSPECTIVE FROM SERBIA 855

12. Marija Koprivica, Kristina Bradić, Mirjana Gligorijević, Milica Kočović De Santo:
MACHINE LEARNING-DRIVEN PREMIUM ESTIMATION IN CROP INSURANCE: LEVERAGING CLIMATE AND COMMODITY MARKET BIG DATA 871

13. Vladimir Ilić, Vladimir Džamić, Ana Ilić, Kristina Ristić, Sunčica Stanković:
PSYCHOLOGICAL AND SOCIAL DETERMINANTS OF RESIDENTS' SUPPORT FOR SUSTAINABLE RURAL TOURISM DEVELOPMENT: A SERIAL MEDIATION MODEL 883

14. Marijana Živković, Marija Ilievska Kostadinović, Ivana Savić:
FINANCIAL RISKS AND MANAGEMENT PRACTICES IN AGRICULTURE: EVIDENCE FROM RURAL TOURISM FARMERS IN SERBIA 897

15. Zorica Sredojević, Sandra Jagodić Rusić, Jasmina Poštin:
ADDING VALUE TO PLUM AS A POSSIBILITY OF ECONOMICS SUSTAINABILITY OF ITS PRODUCTION 915

16. Boris Radovanov, Aleksandra Marcikić Horvat, Otilija Sedlak:
TOWARDS SUSTAINABLE GROWTH: ASSESSING THE NEXUS BETWEEN AGRICULTURAL OUTPUT AND CIRCULAR ECONOMY INDICATORS 931

17. Anita Klikovac, Marijana Milunović, Ana Anufrijev:
**THE ROLE OF MODERN INNOVATIONS IN
THE TRANSFORMATION OF SERBIAN AGRICULTURE
TOWARDS SUSTAINABILITY 945**
18. Aleksandra Angeleska, Blagica Sekovska, Igor Esmerov,
Elizabeta Dimitrieska Stojkovic, Risto Uzunov:
**THE ROLE OF THE VITICULTURE AND WINE SECTOR
IN RURAL DEVELOPMENT AND THE AGRO-FOOD ECONOMY:
EVIDENCE FROM NORTH MACEDONIA 959**
19. Aleksandar Lukić, Milan Novović, Dragan Milačić:
**STRATEGIC ANALYSIS OF BILATERAL TRADE BETWEEN
NORTH MACEDONIA AND SERBIA: ECONOMIC
AND FINANCIAL TRENDS 973**
20. Julija Avakumović, Jelena Avakumović:
**ECONOMIC ANALYSIS OF JOB SATISFACTION
OF EMPLOYEES IN THE SERVICE OF AGRAR SECTOR
IN THE REPUBLIC OF SERBIA 985**

APPLICATION OF CONTROLLING AND IT SYSTEMS IN BUSINESS OF MEDIUM-SIZED AGRICULTURAL AND OTHER ENTERPRISES ACCORDING TO ASSESSMENT OF TOP MANAGEMENT

Slobodan Popović¹, Milica Lakić², Ivan Arnautović³, Dejan Sredojević⁴

**Corresponding author E-mail: slobodan.popovic49@gmail.com*

ARTICLE INFO

Original Article

Received: 31 January 2026

Accepted: 15 March 2026

doi:10.59267/ekoPolj2603685P

UDC 631.115:[005.5:004.9

Keywords:

Controlling, it systems, making business decisions, top management, middle company.

JEL: A29, L86, B20, D81

ABSTRACT

The aim of the paper was to present the functioning of controlling in the operations of agricultural enterprises. Methodologically, the authors presented in an objective and systematic manner the importance of applying controlling in making valid management decisions by top management in the operations of medium-sized agricultural and other medium-sized enterprises. The clarity of the application was made by comparing the two types of analyzed enterprises. The contribution of the authors of the study is reflected in the presentation of a strong connection between the management decisions of top managers in both types of medium-sized enterprises in relation to the analyzed factors: legality of operations, accuracy, data protection, efficiency of application and their overall result. The author's recommendation is that controlling in the operations of the analyzed enterprises be continuously used in order to increase the efficiency and legality of operations.

Introduction

The process of applying management accounting is related to the use of controlling in the full sense of the word, and the entire process can be viewed as controlling or the functioning of such business in the work of numerous legal entities. In addition, the

-
- 1 Slobodan Popović, PhD, Faculty of Economics and Engineering Management, Cvečarska 2, 21000 Novi Sad, Serbia, Phone: +381640483563, E-mail: slobodan.popovic49@gmail.com, ORCID ID (<https://orcid.org/0000-0002-6321-8141>)
 - 2 Milica Lakić, PhD, PIM Banja Luka University, Despota Stefana Lazarevića bb, 78000 Banja Luka, Republic of Srpska, Bosnia and Herzegovina, Phone: +38751378300, E-mail: mlakic@gmail.com, ORCID ID (<https://orcid.org/0000-0002-2879-7838>)
 - 3 Ivan Arnautović, PhD, Faculty of Organizational Studies EDUKA Belgrade, Majke Jevrosime 15, 11000 Belgrade, Serbia, E-mail: info@vos.edu.rs, ORCID ID (<https://orcid.org/0000-0002-1287-4317>)
 - 4 Dejan Sredojević, PhD, High School of Modern Business, Terazije, 27, 11000 Belgrade, Serbia, Phone: +38163569023, E-mail: dsredojevic.vps@gmail.com, ORCID ID (<https://orcid.org/0000-0002-3122-9778>)

process of applying controlling is related to the making of valid business decisions by the decision-maker, and that in the business of numerous heterogeneous companies that have applied innovative approaches in regular business (Bienkovska et al., 2020).

The application of controlling as an important management factor in management accounting is applied by numerous heterogeneous companies whose top management makes numerous management and control decisions on a daily basis in order to increase the overall efficiency of operations in the companies they manage (Bienkovska et al., 2020).

More broadly, in a large number of heterogeneous legal entities, the top management that leads them continuously strives to introduce innovative solutions that involve the application of various controls in the operations of the aforementioned legal entities. Thus, the process of introducing controlling logically occurs both in numerous heterogeneous companies and within all organizational parts of the company's operations (Bourne, 2011; Bowden & Liddle, 2018; Lartey, et al., 2020).

However, it should be emphasized that the process of introducing controlling should be viewed within the framework of making real management decisions in heterogeneous companies. Basically, controlling in its work relies on the work and operation of accounting, that is, it is related to the work of management accounting as well as to the work of the financial sector in the work of companies.

The establishment of the controlling process should be seen as a process of continuity (Kunesch, 1996). The work of controlling has its own time dimension, and its duration in the work of the company starts from the moment of the top management's decision to introduce it into the regular business of the company (Kvon & Han, 2020; Trung & McMillan, 2021; Shi et al., 2021).

The goals of management can be expressed financially, first of all, within the framework of accounting and finance, but also descriptively, but in relation to the movement in the market, then in relation to the movement of the workforce process, with the note that it is necessary to monitor all the assigned plans that are set before employees in heterogeneous companies (Lutovac, 2024).

Financial management in agricultural and other enterprises should be seen within the framework of generally accepted efforts undertaken by the top management of enterprises to improve overall management in enterprises in which they perform a management function and in which they make important management decisions on a daily basis (Cantino, 2009; Anwar & Sun, 2015; Baráth & Fertő, 2017).

Introducing the controlling process is one of the possible ways to improve financial management. With its application, top management is able to make important management decisions in the company's work with a greater degree of certainty (Đuranović & Popović, 2021). Prominent views come to practical expression and gain increasing importance, especially in connection with the organization of agricultural production (Nowak et al., 2016; Zelenović et al., 2018).

The functioning of important organizational decisions by decision-makers is largely related to the appreciation of financial and other reports delivered by management accounting to top management (Sun, 2022; Mielitz & MacDonald, 2022; Atatsi et al., 2023). By introducing internal control, it is possible to raise the quality of overall control functions in the work of numerous heterogeneous companies (Kabuye et al., 2019; Porras-Gómez, 2022; Jiao, 2023).

In addition to the introduction of internal control processes into the company's regular operations, top management should also take care of the introduction of numerous other forms of innovation. This can fundamentally increase the security of the overall business. One of the many ways to improve management decision-making is the application of management accounting, i.e. controlling in the business of heterogeneous companies (Oppong et al., 2023; Chen et al. al., 2023).

Materials and methods

The research framework for acquiring practical knowledge related to the business of medium-sized enterprises in the Republic of Serbia regarding the application of controlling included consideration of the criteria for the existence of a predominant activity. More precisely, controlling was analyzed in the operations of two types of companies: agricultural and so-called other companies.

The aforementioned determination to focus on the business of medium-sized enterprises was not done by accident, but the same was done intentionally to see the existence of differences in the work of agricultural enterprises in relation to the operations of other (other) enterprises in relation to the application of management accounting, i.e. controlling, especially from the point of view of the analysis of selected factors of possible influence on business results.

143 medium-sized enterprises were surveyed, i.e. 52 agricultural and 92 medium-sized enterprises, which were thus classified in relation to business operations in the domain of performing their core activity. More precisely, the methods used were based on analyzing four factors that can affect the implementation of controlling, namely: legality of operations, accuracy of financial statements in operations, implemented data protection in operations, effectiveness of implementation of business protection and, overall evaluation of the management structure that can affect the effectiveness of implementation in operations.

The survey was conducted in two types of medium-sized enterprises, with the survey being completed by accounting and finance managers in the aforementioned enterprises. The allowed evaluation interval offered ranged from 1 to 10. The weakest confidence could be evaluated with a score of 1 in relation to the offered factors, and with a score of 10 it was possible to express the highest confidence (trust) in the company's operations based on the analyzed factors by the management. The research period in which the research was conducted was from 01. 03. to 30. 03. 2024.

After the survey, the authors performed a classic statistical analysis of the initial data. In their work, they used the software IBM SPSS, version 25. The grouping of the obtained results was done in the form of the presented tables 1-2. Table 1 has been strengthened by showing the results of the T-test, where the evaluation of factors on the work of controlling in the analyzed two types of companies is systematized. The threshold, i.e. the limit value, was statistically significant at the level of 0.05.

Results

The results obtained are grouped into two large units.

The first part includes a presentation of the obtained research results, which include a substantive comparison of the evaluation of top management based on the application of controlling in relation to factors that included the impact on the actual operation of management accounting in two forms of organized companies. The obtained results are strengthened by the presentation of the t test values and the presentation of significance, which are actually shown in Table 1.

Furthermore, or within the presentation of the results that are visible in the so-called. second unit, the authors presented the results of each individual contribution in relation to the prediction of total income for the two types of medium-sized companies analyzed. The obtained results are supplemented by the amount of income tax on total income generated based on data from the final account, which were submitted by managers and which referred to the very end of business in 2023.

The above was done with the aim of observing all the above activities in order to discover the attitudes of top management in business, or financial management, which is applied in the two analyzed types of medium-sized enterprises according to the application of controlling.

The authors present the results obtained after the evaluation by top managers based on the practical application of management accounting in relation to the analyzed factors that may have an impact on the business of the two mentioned types of medium-sized enterprises in Table 1.

Table 1. Presentation of the evaluation of top managers in relation to the analyzed factors

Analyzed	The size company	Mean	Average deviation of all results from the arithmetic mean	t	p
Legality of business	Agricultural enterprises (N=52)	5.79	0.38	-30.200	<0.0005*
	Other companies (N=91)	7.81	0.36		
Accuracy of financial statements	Agricultural enterprises (N=52)	5.78	0.39	-24.854	<0.0005*
	Other companies (N=91)	7.57	0.48		

Analyzed	The size company	Mean	Average deviation of all results from the arithmetic mean	t	p
Data protection	Agricultural enterprises (N=52)	4.01	0.61	-33.751	<0.0005*
	Other companies (N=91)	6.81	0.35		
Application efficiency	Agricultural enterprises (N=52)	4.03	0.01	-40.255	<0.0005*
	Other companies (N=91)	7.60	0.46		
Total valuation	Agricultural enterprises (N=52)	4.70	0.16	-33.611	<0.0005*
	Other companies (N=91)	7.71	0.27		

*Statistical significance at level of 0.05

Source: Author's presentation of the obtained values after calculation (2024).

The results of the comparison of two types of companies operating in the economy of the Republic of Serbia in terms of the functional operation of management accounting in Table 1 clearly show the strong influence of the analyzed factors on the effectiveness of controlling in medium-sized companies that apply it. At the same time, the results presented by the authors show a great deal of overlap with the already stated views regarding the making of valid business decisions by top managers in the operations of the listed companies, which has already been shown in works such as (Bakmaz et al., 2023).

In the second part of the research, the authors presented the results of the research, which included the prediction of the movement of total revenue in the operations of the listed companies. The forecast was made in relation to five factors that influence management accounting, or controlling, and which was observed in relation to the making of important management decisions by top management, which essentially manages one of the two forms of organization of the company in real business conditions.

The results of the business operations of the authors of this study, where a presentation of the individual contributions of each of the listed analyzed factors that can influence the work of business accounting, or controlling, is given in Table 2. In it, the authors presented the individual contributions of individual factors as part of the influence whose application can affect the prediction of total revenue based on the application of controlling in two different forms of business operations of the company.

Table 2. Contribution of analyzed factors from the aspect of the forecast of total revenue in companies that have implemented controlling

A constant	Beta	t	p
	-	0.449	0.648
Legality of business	-0.324	-8.904	<0.0005*
Accuracy of financial statements	0.070	1.270	0.196
Application efficiency	0.261	6.449	<0.0005*
Data protection	-0.012	-0.129	0.890

*Statistical significance at level of 0.05

Source: Author's presentation of the obtained values after calculation (2024).

The results obtained in Table 2 showed that there is a significant influence of the factors: legality of business and efficiency of the application of control in the business of both forms of medium-sized enterprises operating in the Republic of Serbia ($p < 0.001$).

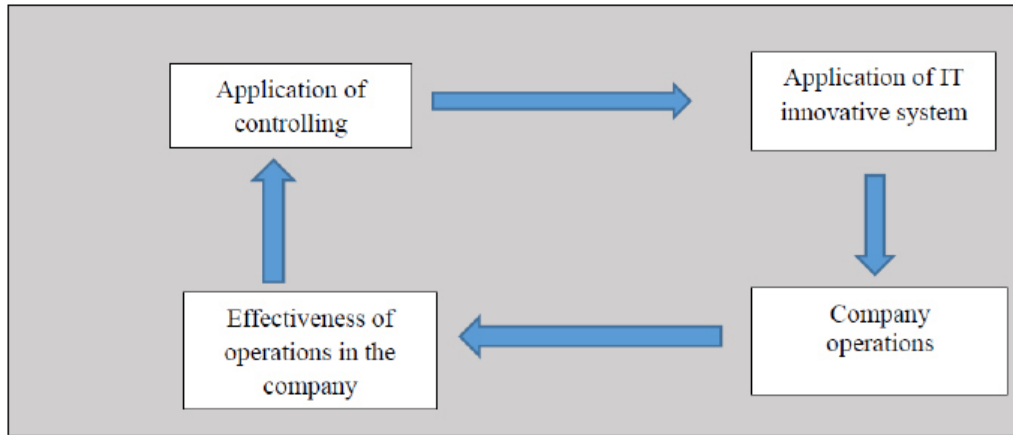
The results presented in Table 2 indicate that two factors have a statistically significant impact on the prediction of total revenues: legality of operations and enforcement efficiency. Both variables are significant at the 0.05 level, while the accuracy of financial statements and data protection do not show a statistically significant effect.

The coefficient for business legality is negative and statistically significant ($\beta = -0.324$; $p < 0.0005$), indicating an inverse relationship with the dependent variable in the estimated business model of medium-sized enterprises regarding the application of controlling in regular business operations.

Implementation efficiency has a positive and statistically significant coefficient ($\beta = 0.261$; $p < 0.0005$), which suggests that higher perceived efficiency of controlling in the work of medium-sized enterprises is associated with higher predicted total revenue in both forms of analyzed enterprises operating in the Republic of Serbia.

In the third part, the authors presented a possible schematic view that essentially shows a business model in which the connection of the functioning of controlling with the active participation of the IT System, which the top management of medium-sized companies can apply with the aim of increasing the efficiency of operations in the work of companies in which they make valid management decisions, is given.

The presentation of the model that takes into account the controlling and functioning of the IT system is shown in Figure 1 by the authors.

Figure 1. Modeling the connection of controlling and IT innovative system

Source: Author's (2024).

Discussion

The evaluation by the top management in two forms of different companies showed that there is a significant difference in the matter of practical understanding of the application of management accounting, i.e. controlling, noting that in all the analyzed factors of influence, the existence of significant deviations in the application of the two forms of the analyzed companies in regular business can be seen.

The results obtained largely coincide with the authors' previously stated views on the great importance of establishing a functional control system in the operations of numerous companies (Novaković et al., 2018; Bakmaz et al., 2024). The t-test results indicate statistically significant differences between agricultural and other medium-sized enterprises for all analyzed factors. In particular, the largest differences were observed for application efficiency ($t = -40.255$; $p < 0.0005$) and data protection ($t = -33.751$; $p < 0.0005$), which is visible in the presentation of the obtained results in Table 1.

The results of the t-test indicate that the overall observed values of all analyzed factors are statistically significant ($t = -33.611$; $p < 0.0005$), i.e., there are differences between the two aforementioned forms of organizing medium-sized enterprises in the Republic of Serbia in terms of management accounting applied in regular business operations.

The evaluation by top management in two forms of different companies showed that there is a significant difference in terms of practical perception of the application of management accounting, or controlling, with the note that for all analyzed influence factors, the existence of significant deviations in the application in the two forms of analyzed companies in regular business operations can be seen.

The results presented in the study are such that it can be seen that the application of controlling in the business of medium-sized enterprises is of great importance for correct, optimal, i.e. timely management decisions in the business of heterogeneous companies.

However, the application of one of the forms of introducing control is a complex and comprehensive issue, which can be seen in numerous works that were created before the preparation of this study, such as works (Oievo et al., 2021) and which fully coincides with the obtained results of this study where the focus was on the application of top management beliefs regarding the introduction of controlling into regular operations.

Therefore, based on the obtained results presented in this paper, it follows that the application of controlling is of great importance. At the same time, its introduction is justified in different companies according to the form of organization but also in relation to the application of other determining factors, which may be the subject of some future research, where the results of this study will serve as the basis for future upgrades in defining the discovery of some new ways of applying control in business.

The results of the study show that the application of controlling is of great importance in the operations of the two analyzed forms of business of medium-sized enterprises, i.e. in the operations of medium-sized agricultural enterprises, which essentially organize the largest part of the agricultural production of an economy, but also in the operations of those enterprises that do not carry out their main activity in agriculture, which was also the basis for comparative observation in this study, because other enterprises carry out their main activity in other areas of the economy (outside the organization of agricultural activity).

The above-mentioned basic positions are reinforced in the second part of the research. Namely, based on a comparison of the impact of the set factors and the forecast of total revenue, the authors of this study determined the existence of a strong connection with the process of establishing controlling in the operations of the listed companies (Table 2).

Based on the results presented in Table 2, it can be seen that there is a statistical significance at the 0.05 level for the factors: legality of business operations and efficiency of application in the functioning of controlling for the two mentioned forms of medium-sized enterprises in the Republic of Serbia.

The obtained results, especially those research results that are given in the third part of the obtained results, namely the formation of an innovative model of behavior between controlling and the introduction of an innovative IT system that will enable its business to increase the safety in the work of numerous companies and their effectiveness to a large extent relates to the improvement of overall business. In addition, modeling that takes into account controlling and the IT system that supports it affects the improvement of the accuracy of financial statements, largely coincide with the views of authors from several countries, the so-called Western Balkans, such as (Duhovnik, 2017; Blanchat, 2018; Amidu et al., 2021; Wimmeret al., A2022; et al., 2023, Meronzanotte et al., 2023).

The presentation of the influence of important factors that influence the prediction of the formation of the future amount of total income is of great importance for the future business of heterogeneous companies. In order for such an observation to be relevant, it is necessary to supplement it with the application of other factors, including the application of control factors (Jordan et al., 2023; Jakubovska et al., 2023).

Conclusions

The significance of this paper is that it clearly confirmed the importance of applying management accounting or controlling in the management processes of primarily agricultural enterprises. The paper points out the importance of the growing trust of top management in the application of controlling in the analysed enterprises. The study indicates the possible practical application of controlling in numerous heterogeneous enterprises.

After reading this study, the conclusions are visible.

First, there is a strong connection between the analysed factors, which influence the establishment of management accounting or controlling on the basis of making important business decisions by top management who wants to increase business efficiency.

The second conclusion would be that there is a distinct or strong individual contribution of the projection of two factors, namely: the legality of business and the efficiency factor of the application of the established form of control by the top management of the analysed companies.

Third, there is no strong connection in terms of the accuracy of financial reporting and data protection in relation to the future operations of companies that have opted for the implementation of controlling.

Based on the three conclusions obtained, it follows that there is a fundamental need to introduce controlling into the regular operations of medium-sized agricultural enterprises, but also in the operations of the so-called other medium-sized enterprises.

Conflict of interests

The authors declare no conflict of interest.

References

1. Aburishah, K. E., Dahiyat, A. A., Owais, W. O., Al Shanti, A. M., & AlQudah, L. A. (2022). The effect of ownership structure and board structure on accounting conservatism throughout financial reporting: Evidence from Jordanian industrial corporations. *Cogent Business & Management*, 9(1). <https://doi.org/10.1080/23311975.2022.2112819>
2. Amidu, R., Levy, D., & Bolomope, M. (2021). Conceptualising valuation quality in practice: a valuer perspective. *Journal of Property Research*, 38(3), 213–237. <https://doi.org/10.1080/09599916.2021.1930108>

3. Anwar, S. & Sun, S. (2015). Taxation of labour income and the skilled–unskilled wage inequality. *Economic Modelling*, 47, 18-22 <https://doi.org/10.1016/j.econmod.2014.12.037>
4. Atatsi, E., Azila-Gbette, E., Akuma-Zanu, H. & Mensah, C. (2023). Financial management practices and life satisfaction: Mediating effect of financial satisfaction, *Cogent Education*, 10(2) <https://doi.org/10.1080/2331186X.2023.2251746>
5. Bakmaz, O., Bjelica, B. & Jelena Vitomir, J. (2023). Application of internal audit in processes of reducing corruption in a transitional economy like the Republic of Serbia, *Temel-ij*, 7(1), 36-42. https://www.temel-ij.org/_files/ugd/29815f_8cc551e7088e4ad2b3206259dd40b319.pdf
6. Bakmaz, O., Bjelica, B. & Vukasović, D. (2023-a). The importance of monitoring the realization of income and costs in the management and business of agricultural enterprises in relation to the introduced forms of internal-control mechanisms, *Agricultural Engineering*, 2, 45–51, <https://scindeks.ceon.rs/article.aspx?artid=0554-55872302045B>
7. Bakmaz, O., Anđelić, S., Dragosavac, M., Grublješić, Ž., Nastić S., Popović, D., Tubić M. & Popović S. (2024). The importance of determining the efficiency of business of agricultural farms in relation to the use of credits in agriculture, the example of the Republic of Serbia, *Agricultural Engineering*, 1, 10-16, DOI: <http://jageng.agrif.bg.ac.rs/index.php?strana=naslovna&jezik=en>
8. Baráth, L. & Fertő, I. (2017). Productivity and Convergence in European Agriculture. *Journal of Agricultural Economics*, 68, 228-248. <https://doi.org/10.1111/1477-9552.12157>
9. Bieńkowska, A., Tworek, K. & Zabłocka-Kluczka, A. (2020). IT Reliability and Its Influence on the Results of Controlling: Comparative Analysis of Organizations Functioning in Poland and Switzerland, *Information Systems Management*, 37(1), 33-51. <https://doi.org/10.1080/10580530.2020.1696545>
10. Blanchat, M. (2018). Beyond COUNTER-Compliant: Ways to Assess E-Resources Reporting Tools. *The Serials Librarian*, 74(1–4), 87–93. <https://doi.org/10.1080/0361526X.2018.1428464>
11. Bourne, M. (2011). Controlling the Shadow Trade, *Contemporary Security Policy*, 32(1), 215-240. https://www.researchgate.net/publication/232883789_Controlling_the_Shadow_Trade
12. Bowden, A. & Liddle, J. (2018). Evolving public sector roles in the leadership of place-based partnerships: from controlling to influencing policy, *Regional Studies*, 52(1), 145-155. <https://doi.org/10.1080/00343404.2017.1346369>
13. Calderon, F., Manuela Jr, S., & Briones, T. (2023). The impact of sustainability reporting on organizational behavior from Western and Asian perspectives: a systematic review of literature. *Journal of Sustainable Finance & Investment*, 13(2), 990–1008. <https://doi.org/10.1080/20430795.2021.1879560>

14. Cantino, V. (2009). Corporate governance, performance measurement and regulatory compliance of the internal control system. DataStatus, Belgrade. [in Serbian: Cantino, V. (2009). Korporativno upravljanje, merenje performansi i normativna usaglašenost sistema internih kontrola. DataStatus, Beograd].
15. Chen, S., Lakkanawani, P., Suttipun, M. & Xue, He. (2023). Environmental regulation and corporate performance: The effects of green financial management and top management's environmental awareness, *Cogent Business & Management*, 10(1), <https://doi.org/10.1080/23311975.2023.2209973>
16. Duhovnik, M. (2007). The problems of accounting in a public institution: The case of Slovenia, *Financial Theory and Practice*, 31, 421–445. <https://hrcak.srce.hr/en/22170>
17. Đuranović, D. & Popović, S. (2021). Risk evaluation in the business of medium-sized companies on the example of the Republic of Serbia, *Temel-ij*, 5(2), 26-33. https://www.temel-ij.org/_files/ugd/29815f_300afdfb775d4daabe52ceec25264a3e.pdf
18. Jakubowska, D. & Sadílek, T. (2023). Sustainably produced butter: The effect of product knowledge, interest in sustainability, and consumer characteristics on purchase frequency, *Agricultural Economics – Czech*, 69(1), 25–34. <https://www.agriculturejournals.cz/pdfs/age/2023/01/02.pdf>
19. Jiao, J. (2023). Financial management early warning model of enterprise circular economy based on chaotic particle swarm optimization algorithm, *Journal of Industrial and Production Engineering*, <https://doi.org/10.1080/21681015.2023.2280184>
20. Jordan, C., Donoso, G. & Speelman, S. (2023). Irrigation subsidy policy in Chile: lessons from the allocation, uneven distribution and water resources implications, *International Journal of Water Resources Development*, 39(1), 133-154. <http://hdl.handle.net/10.1080/07900627.2021.1965964>
21. Kabuye, F., Kato, J., Akugizibwe, I. & Bugambiro, N. | Ntim, C. (Reviewing editor) (2019). Internal control systems, working capital management and financial performance of supermarkets, *Cogent Business & Management*, 6(1), <https://doi.org/10.1080/23311975.2019.1573524>
22. Kunesch., H. (1996). Planning and control systems in materials management-an empirical study, *Production Planning & Control*, 7(2), 205-211. <https://doi.org/10.1080/09537289608930343>
23. Kwon., Y. & Han., S. (2020). Controlling Shareholders' Preference in Business Groups: Evidence from Korea, *Emerging Markets Finance and Trade*, 56(4), 940-959. <http://hdl.handle.net/10.1080/1540496X.2018.1553157>
24. Lartey., P, Kong., Y, Bah., F, Santosh., R. & Gumah., I. (2020). Determinants of Internal Control Compliance in Public Organizations; Using Preventive, Detective, Corrective and Directive Controls, *International Journal of Public Administration*, 43(8), 711-723. https://www.researchgate.net/publication/335082288_Determinants_of_Internal_Control_Compliance_in_Public_Organizations_Using_Preventive_Detective_Corrective_and_Directive_Controls

25. Lenggenhager, L. (2021). Response to the reviews of Ruling Nature, Controlling People, *Journal of Southern African Studies*, 47(4), 732-734. <https://ideas.repec.org/a/taf/cjssxx/v47y2021i4p732-734.html>
26. Lutovac, J. (2024). Macroeconomic influences on financial stability in the context of banks association an example of the functioning of the national bank of Serbia, *Temel-ij*, 8(1), 1-8. https://www.temel-ij.org/_files/ugd/29815f_561d8acfaedf40d9a10520707c72ac56.pdf
27. Mezzanotte, E. (2023). Corporate sustainability reporting: double materiality, impacts, and legal risk. *Journal of Corporate Law Studies*, 23(2), 633–663. <https://doi.org/10.1080/14735970.2024.2319058>
28. Mielitz, K. & MacDonald, M. (2022). Social Desirability in Multivariate Context for Inmate Survey Research, *Corrections*, 7(4), 247-261 <https://doi.org/10.1080/23774657.2020.1789520>
29. Novaković, S., Vukasović, D., Laban, B., Ivić, M., Popović, V. & Popović, S. (2018). Managing agricultural company by using internal control and significance of risk presentation, *Economics of Agriculture*, 2, 801-812. <https://scindeks.ceon.rs/journalDetails.aspx?issn=0352-3462>
30. Nowak, A., Janulewicz, P., Krukowski, A. & Bujanowicz-Haraś, B. (2016). Diversification of the level of agricultural development in the member states of the European Union. *Cahiers Agricultures*, 25(5). <https://doi.org/10.1051/cagri/2016040>
31. Oppong, C., Atchulo, A., Akwaa-Sekyi, E., Grant, D. & Kpegba, S. (2023). Financial literacy, investment and personal financial management nexus: Empirical evidence on private sector employees, *Cogent Business & Management*, 10(2), <https://doi.org/10.1080/23311975.2023.2229106>
32. Oyewo, B., Vinh. V. X. & Akinsanmi, T. (2021). Strategy-related factors moderating the fit between management accounting practice sophistication and organizational effectiveness: The Global Management Accounting Principles (GMAP) perspective, *Spanish Journal of Finance and Accounting/Revista Española de Financiación y Contabilidad*, 50(2), 187-223. <https://doi.org/10.1080/02102412.2020.1774857>
33. Porras-Gómez, A. (2022). Multi-level governance of grant programs. The case of Cohesion and External Action in the European Union, *Public Money & Management* <https://doi.org/10.1080/09540962.2022.2071050>
34. Shi, X., Bu, D., Wen., C. & Lan, Z. (2021): Financial background of controlling shareholder and corporate financialization, *China Journal of Accounting Studies*, 9(3), 383-407.
35. Shonkoff, E., Cara, K., Pei, X., Chung, M., Kamath, S., Panetta, K., & Hennessy, E. (2023). AI-based digital image dietary assessment methods compared to humans and ground truth: a systematic review. *Annals of Medicine*, 55(2). <https://doi.org/10.1080/07853890.2023.2273497>

36. Stevanović, A., Bošković, J., Zečević, V., Pešić, V., Ćosić, M., Šarčević-Todosijević Lj., Burić, M., Popović, V. (2023). Variability and heritability of technological characteristics of *Amaranthus* leaves and seeds. *Notulae Botanicae Horti Agrobotanici Cluj-Napoca*, 51(2). https://www.researchgate.net/publication/371753276_Variability_and_heritability_of_technological_characteristics_of_Amaranthus_leaves_and_seeds_leaves
37. Sun, J. (2022). Essential skills for public budgeting and financial management, *Journal of Public Affairs Education*, 28:3, 290-301, <https://doi.org/10.1080/15236803.2022.2031473>
38. Trung., N. & McMillan., D. (Reviewing editor) (2021). The relationship between internal control and credit risk – The case of commercial banks in Vietnam, *Cogent Business & Management*, 8(1). https://www.econstor.eu/bitstream/10419/270263/1/10.1080_23311975.2021.1908760.pdf
39. Wimmer, C., Whalley, B., & Hollins, J. (2021). “I can’t skip it”: does free report improve accuracy in false memories? *Memory*, 29(3), 353–361. <https://doi.org/10.1080/09658211.2021.1895223>
40. Zelenović, V., Vojinović, Ž & Cvijanović, D. (2018). Serbian agriculture loans with the aim of improving the current situation, *Economics of Agriculture*, 323-336. https://www.academia.edu/56723416/Serbian_agriculture_loans_with_the_aim_of_improving_the_current_situation?email_work_card=titledoi:10.5937/ekoPolj1801323

IMPACT OF CROP DIVERSITY ON FOOD AND NUTRITIONAL OUTCOMES OF FARM HOUSEHOLDS IN OGUN STATE, NIGERIA

Chioma Patricia Adekunle¹

*Corresponding author E-mail: adekunlecp@funaab.edu.ng

ARTICLE INFO

Original Article

Received: 31 March 2025

Accepted: 30 May 2025

doi:10.59267/ekoPolj2603699P

UDC 631.584.4:612.39-058.42(669Ogun)

Keywords:

agriculture, diet, deprivation, hunger, portfolios

JEL: Q12, Q18, I12, D12

ABSTRACT

Using cross-sectional data from 386 arable crop farmers in Ogun State, Nigeria, this study examines the effect of crop diversity on farm households' food and nutrition outcomes. Three nutrition indicators were considered: per capita food consumption expenditure, per capita calorie consumption, and dietary diversity. Crop diversification was measured using the Herfindahl–Hirschman Index based on agricultural revenue generated from crops cultivated by households. Ordinary least squares regression was employed to estimate the effects of crop diversity on the selected nutrition outcomes. The results indicate an average per capita calorie consumption of 2,822.34 kcal, exceeding the recommended daily intake of 2,500 kcal. Households in the Abeokuta and Ijebu-Ode zones demonstrated better nutritional outcomes than those in Ikenne. Approximately 63.5% of households were moderately diversified, while 30.8% were highly diversified. Crop diversity significantly improved calorie intake, real food consumption expenditure, and dietary diversity, highlighting its importance for strengthening household food and nutrition security.

Introduction

Despite the international organizations' efforts to achieve “zero hunger” and “food and nutrition security” by 2030, there is still an unprecedentedly high level of global food and nutrition insecurity. To achieve the second Sustainable Development Goal (SDG) of zero hunger, it is necessary to find a sustainable way of increasing the income of rural dwellers in developing countries. Food supply reductions and nutrition insecurity continue to pose major challenges in developing countries. In Sub-Saharan Africa (SSA), food insecurity has intensified, as population growth outpaces both the quantity and quality of food required to meet the needs of the expanding population.

1 Chioma Patricia Adekunle, Senior Lecturer, Federal University of Agriculture, Abeokuta, Nigeria, Phone: +2348060174180, E-mail: adekunlecp@funaab.edu.ng, ORCID ID (<https://orcid.org/0000-0001-6841-2165>)

The unprecedented high food and nutrition insecurity in the SSA is partly due to existing policy somersaults, which seem to undermine the impact of flows of capital on food and nutrition security (Cassimon et al. 2021; Cassimon et al. 2022; Ogunniyi et al. 2020).

The high dependence on imported crops such as rice and wheat has placed the SSA countries at a high risk of food and nutrition insecurity resulting from the global supply chain disruption, recently aggravated by the COVID-19 pandemic and the war in Ukraine (Ben Hassen and El Bilali, 2022). Food and nutrition security is the fundamental challenge to human welfare and economic growth in Africa, especially with the rise of food prices, forcing the world to face a food insecurity crisis (Akerele, 2015).

Akombi (2017) reports that malnutrition in Nigeria remains a significant concern, with 32% of children under five affected by stunting, and the overall hunger situation classified as serious from an international perspective (Von Grebmer et al., 2015). Abbasi (2016) indicates that household food insecurity, based on calorie intake, ranges between 49% and 78% in the country. Additionally, Agada and Igbokwe (2015) observe that most households consume diets that are both limited in variety and low in quality.

Although smallholder farmers are key contributors to agricultural production in Sub-Saharan Africa, providing a significant share of the labour force in many developing countries, they also bear the primary responsibility for household food and nutrition security. As prosumers, their access to food largely depends on their own production, either consuming what they grow due to limited purchasing power or using income from their produce to buy additional food. Matshe (2003) posits that 70% of malnourished people in Africa and Asia are rural dwellers who are also smallholder farmers (Crush and Frayne, 2011). Smallholder farmers tend to improve their food and nutritional outcomes by diversifying farm production (Palmioli et al. 2020; Sibhatu and Qaim, 2018; Powell et al. 2015). The main intervention aimed at improving the households' dietary diversity and reducing food insecurity in rural areas is promoting on-farm production and improving local food supply (Snapp and Fisher, 2015). Hence, crop diversification can be an important means of achieving food security. It is therefore considered an important strategy in overcoming many of the emergencies faced by agricultural households in developing countries (Joshi, 2003).

Crop diversification can serve as an instrument for employment generation, poverty alleviation, and an important strategy to overcome food and nutrition insecurity in developing countries (Nnadi et al. 2013; Daud et al. 2018). Although the increased diversification of agricultural and food systems could help improve dietary quality and nutrition (Bowman and Zilberman, 2013; Pingali, 2015; Herforth and Ahmed, 2015; Verger et al., 2017), empirical studies on this are rather scarce. Therefore, this study examined the effects of crop diversity on the food and nutrition security outcomes of farm households in Ogun State, Nigeria. Specifically, the paper:

- i. describes the socioeconomic characteristics of farm households;
- ii. assesses the household food and nutrition security outcomes;
- iii. describes the crop diversity score of the farm households;
- iv. assesses the crop diversification pattern of the farm households;
- v. assesses the extent of crop diversification of the farm households; and
- vi. determines the effects of crop diversity on the food and nutrition security outcomes of farm households.

Methodology

This study was carried out in Ogun State, Nigeria. Primary data used comes from a cross-section of 386 arable crop farmers in Ogun State who received a structured questionnaire distributed between August and December 2022.

The study employed a multistage sampling strategy. In the first stage, one (1) block is randomly chosen from each zone to create four (4) blocks, out of which five (5) cells were randomly selected to create a total of 20 cells. The sampling frame was created using a list of cells from OGADEP that included numerous farming communities. At random, 20 farmers were chosen from each of the 20 cells in the second stage, with a goal of targeting 400 farmers overall. However, 386 farm households were used for the analyses after the data had been cleared of consistent responses and information that deviated from the standard.

The specific methods of data analysis are described below:

Objective One: Descriptive statistics were used to describe the pattern of food consumption among the respondents. To describe the pattern of households' food consumption, weekly expenditure on food items that make up each food group was first computed, before the total weekly food consumption expenditure on each food group over a period of seven (7) days, as follows:

$$TFE_i = \frac{1}{A} \sum_{\alpha=1}^{N=12} E_i \quad (1)$$

TFE_{it} = the adult equivalent weekly food expenditure of the household. E_{it} = weekly food group 'a' consumption expenditure by household 'i'. A = the adult equivalent value.

Objective Two: Three indicators of food and nutrition security outcomes of households were used in the empirical analysis of this study: these are per capita food consumption expenditure, per capita calorie food consumption, and dietary diversity.

Per capita daily calorie intake: The share of the population whose daily calorie intake is less than 2100 calories was used to construct the first metric, the calorie deficiency rate. Daily food amounts were converted into kilocalories using the food composition FAO tables for the purpose of calculating daily calorie intake, which was then multiplied by the average size of the family to determine the per capita daily caloric intake (in kilocalories). It is essential to remember that other foods, water, and seasonings do not add to the overall number of calories. No nutritional weight was assigned to condiments.

Diet Diversity: The Diet Diversity Score (DDS) measures the variation in nutrient intake from different food types consumed by households over a given period. A higher DDS indicates that a household consumes a more varied diet, providing adequate quality to meet essential micronutrient requirements (Ogundari, 2017). In this study, household dietary diversity was estimated using the Berry index, following the approach of Freire and Rudkin (2019):

$$DDI_i = 1 - \sum_{\alpha=1}^N S_{\alpha i}^2 \quad (2)$$

where DDI ranges between 0 and 1 (the closer to 1, the more dietary diversified a household is), and S_{git} is the consumption food group share 'i in the total value of food consumption.

Objective Three: Two indicators of crop diversity were employed in this study: (i) the crop diversity score, measured by the number of crops cultivated by each household, and (ii) the crop diversification index, which assesses the distribution of agricultural revenue across different crops using the Herfindahl–Hirschman Index:

$$HHI = 1 - \sum_1^N P_i^2 \quad (3)$$

HHI = level of crop diversification

P_i = Share of revenue from crop 'i in total household revenue from all crops, i.e.

$$P_i = \frac{Y_i}{Y}, \quad Y = \sum Y \quad (4)$$

Y_i = Total revenue from crop "i."

Y = Total revenue from all crops grown

The Herfindahl–Hirschman Index (HHI) was employed to measure the degree of crop diversification, reflecting how households' crop revenues are distributed across

different crops. Households with highly diversified crop revenues exhibit higher HHI values, while those with less diversification have lower HHI values. The minimum HHI value of 1 represents households relying entirely on a single crop for revenue. Thus, the greater the number of revenue sources and the more evenly the revenue is distributed among crops, the higher the HHI, indicating a higher level of crop diversification.

Objective Four: An Ordinary least squares regression model was used to determine the effects of crop diversity on the food and nutrition security outcomes of farm households. The model is specified below:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots \dots \dots + \beta_{14} X_{14} + \varepsilon_i \quad (5)$$

where Y = Food and nutrition outcomes of farm households

X_1 = Urban residence (1=Yes, 0= Otherwise)

X_2 = Age of household head (Years)

X_3 = Sex (1= Male, 0= Female)

X_4 = Marital status of household head (1= Married, 0= Otherwise)

X_5 = Education (years of schooling)

X_6 = Income (₹/month)

X_7 = Crop diversification (Index)

X_8 = Total Livestock Units (TLUs)

X_9 = Farm size (Hectares)

X_{10} = Number of crops cultivated

X_{11} = Access to extension service (1=Yes, 0= Otherwise)

X_{12} = Credit access (1=Yes, 0= Otherwise)

X_{13} = Non-farm participation (1=Yes, 0= Otherwise)

X_{14} = Farming experience (years)

Results and discussion

Socio-economic characteristics of the farm households

Both directly and indirectly, the socio-economic traits of the heads of farm households played a significant role in determining the degree of food and nutrition security of farm households in the study area. These include factors like age, gender, marital status, educational attainment, religion, and household size, among others. The results were compiled in Table 1.

The respondents' age distribution revealed that 48.71 percent are between the ages of 31 and 50. This demonstrated that the majority of farm households are in a period of economic growth and can thus actively participate in infrastructure development. Additionally, the fact that 69.43 percent of respondents were men implied that men

predominated in the study area's agricultural activities. This might be because farming activities are physically demanding. In Nigeria, particularly in the countryside, the male is typically the head of the household.

In addition, farm households had a marriage rate of 70.06 percent, indicating that most respondents were married and had families to support. According to the table below, 28.24 percent of household heads had no formal education, while 51.30 percent only had primary education, indicating that the literacy rate among farmers was relatively low. The typical (48.45 percent) farm household in the study area had between 5-6 persons per household.

To make ends meet, farm households engage in a variety of income activities, both on and off the farm. About 56.48 percent of the households have farming as the main income activity, which is in line with expectations, given that the study is focused on farm households. Farmers of arable crops produce barely enough food for themselves, and 61.14 percent of them cultivate between 0.6 and 1.0 hectares.

Table 1. Socio-economic characteristics of the respondents

Characteristics	Frequency	Percentage
Age (years)		
Under 30	34	8.81
31–50	188	48.71
Over 51	155	42.49
Education		
No formal education	109	28.24
Primary	198	51.30
Secondary	53	13.74
Tertiary	26	6.74
Gender		
Male	268	69.43
Female	118	30.57
Marital status		
Single	38	9.84
Married	282	70.06
Widowed	66	17.10
Household size		
3–4	103	26.68
5–6	187	48.45
7+	96	24.87
Primary occupation		
Farming	218	56.48
Artisan	54	13.99
Trading/Business	66	17.01
Salaried employment	28	7.25
Other	20	5.18
Farm size (hectares)		

Characteristics	Frequency	Percentage
0.1–0.5	78	20.21
0.6–1.0	236	61.14
More than 1.0	72	18.65
Religion		
Christian	198	51.13
Muslim	134	34.72
Other	54	13.99

Source: Field Survey, 2022.

Descriptive statistics of household food and nutrition outcomes

Table 2 presents descriptive statistics for key household food and nutrition security indicators across four Local Government Areas (LGAs) in Ogun State Abeokuta, Ilaro, Ikenne, and Ijebu-Ode as well as pooled values for the entire sample of 386 households. The indicators considered include per capita calorie consumption, dietary diversity, per capita value of food consumed, and per capita total expenditure.

i. Per-Capita Calorie Consumption

Per capita calorie consumption across the LGAs ranges from 2715.33 kcal (Ikenne) to 2994.86 kcal (Abeokuta), with the pooled mean at 2822.34 kcal. These values suggest that, on average, households are consuming sufficient calories relative to the FAO-recommended daily intake of 2100–2500 kcal per adult equivalent (FAO, 2022). However, the minimum values reported (as low as 482.08 kcal in Ilaro) indicate that some households experience severe caloric inadequacy, highlighting intra-community disparities. Similar patterns have been observed in smallholder farming communities in Nigeria, where average calorie intake may meet national norms, but vulnerable households remain food insecure (Abdulai & Aubert, 2004; Olaniyi et al., 2018).

ii. Dietary Diversity

Dietary diversity scores (DDS) are generally low, with means ranging from 0.74 in Ikenne to 0.89 in Abeokuta, and a pooled average of 0.78. These low scores reflect a diet dominated by staples with limited inclusion of other food groups such as fruits, vegetables, and protein-rich foods. Low dietary diversity is a common characteristic of rural Nigerian households and is associated with poor micronutrient intake and higher risks of malnutrition (Sibhatu, Krishna, & Qaim, 2015; Jones et al., 2014). The low minimum values (0.01 across LGAs) further suggest that some households have extremely monotonous diets.

iii. Per-capita Value of Food Consumed

The mean per capita value of food consumed varies between ₦1021.76 in Ikenne and ₦1830.13 in Ijebu-Ode, with a pooled mean of ₦1644.53. This variation reflects differences in household purchasing power, market access, and local food prices. Households in Ijebu-Ode appear to spend more on food, which could be indicative

of higher income levels or better market integration. Higher expenditure on food has been shown to correlate positively with dietary diversity and nutritional quality in smallholder settings (Ruel, 2003; Kennedy et al., 2003).

iv. Per-capita Total Expenditure

Per capita total expenditure follows a similar trend, ranging from ₦2062.93 in Ikenne to ₦24741.47 in Ijebu-Ode. The exceptionally high mean in Ijebu-Ode might be a typographical error or reflect inclusion of non-food expenses; however, it indicates substantial heterogeneity in household economic conditions. Total household expenditure is a key determinant of both food security and the ability to diversify diets, as households with higher disposable income are more capable of purchasing nutrient-rich foods (Smith and Subandoro, 2007).

The pooled statistics demonstrate that while average calorie intake is generally adequate, dietary diversity remains suboptimal, suggesting that food security in these LGAs is quantitatively sufficient but qualitatively inadequate. This aligns with broader findings in Sub-Saharan Africa, where calorie sufficiency does not necessarily guarantee nutritional adequacy (FAO, 2022; Sibhatu et al., 2015). The observed variations across LGAs highlight the importance of local context in designing interventions aimed at improving household food and nutrition outcomes, including policies to promote crop diversification, nutrition-sensitive agriculture, and targeted social protection for the most vulnerable households.

Table 2. Descriptive statistics of household food and nutrition security outcomes

Abeokuta	Mean	Minimum	Maximum
Per capita calorie consumed	2994.86	563.17	9984.48
Dietary diversity	0.89	0.01	0.92
Per capita value of food consumed	1597.43	643.99	15843.94
Per capita total expenditure	2382.84	955.34	21012.05
Total number of households = 96			
Ilaro			
Per capita calorie consumed	2846.02	482.08	7932.16
Dietary Diversity	0.78	0.01	0.76
Per capita value of Food consumed	1158.54	551.28	14912.34
Per capita total expenditure	2153.32	825.04	17332.82
Total number of households = 98			
Ikenne			
Per capita calorie consumed	2715.33	612.44	8696.01
Dietary diversity	0.74	0.01	0.85
Per capita value of food consumed	1021.76	640.26	16129.38
Per capita total expenditure	2062.93	847.69	19199.06
Total number of households = 92			

Ijebu-Ode			
Per capita calorie consumed	2989.36	694.48	9845.99
Dietary diversity	0.83	0.01	0.88
Per capita value of food consumed	1830.13	744.43	16672.65
Per capita total expenditure	24741.47	1149.22	23331.63
Total number of households = 100			
Pooled			
Per capita calorie consumed	2822.34	508.47	8855.68
Dietary diversity	0.78	0.01	0.84
Per capita value of food consumed	1644.53	623.13	14944.04
Per capita total expenditure	2353.36	852.28	18843.12
Total number of households = 386			

Source: Field Survey, 2022.

Crop diversity score

The crop diversity scores presented in Table 3 reveal important patterns in farming practices across the study area. The maximum number of crops grown by a household was eight, while the average household cultivated approximately 2.27 crops (± 1.003), indicating that mixed cropping is a common practice, with 88.88% of households growing more than one crop.

Examining the scores by agricultural development zones shows notable variations. Households in the Abeokuta zone had the highest average crop diversity score (3.127), suggesting a greater range of crops cultivated per household. This was followed by Ijebu-Ode (2.892), while Ilaro recorded the lowest score (2.018), indicating comparatively lower crop diversification. These differences may reflect variations in land size, market access, household labor availability, and agro-ecological conditions across the zones. The findings underscore the prevalence of mixed cropping as a strategy to enhance food security and income diversification, while also highlighting regional disparities that could inform targeted agricultural interventions.

Table 3. Crop diversity score

Diversity score	Mean	Standard deviation	Minimum	Maximum
Abeokuta	3.127	1.126	1	8
Ijebu-Ode	2.892	1.089	1	10
Ikene	2.164	1.007	1	7
Ilaro	2.018	0.867	1	7
Pooled	2.268	1.003	1	8

Source: Field Survey, 2022.

Pattern of crop diversification

Table 4 presents the pattern of crop diversification among farm households, showing both the frequency of cultivation and the contribution of each crop group to total annual farm revenue. The data indicate that households engage in a wide range of crops, reflecting mixed farming systems aimed at improving both income and household food security.

Among cereals, maize is the most commonly cultivated crop, with 86.53% of households growing it, contributing 15.12% of total farm revenue. Rice is grown by 35.75% of households, accounting for 12.68% of revenue. The high prevalence of maize and rice reflects their importance as staple foods for both home consumption and market sales, a pattern widely observed among smallholder farmers in Nigeria (Oladeebo and Oladeebo, 2008; Adegbite et al., 2021).

Pulses, seeds, and nuts are cultivated by 25.34% of households, contributing a smaller share of revenue (4.89%). Despite their lower economic contribution, pulses are nutritionally important as a source of protein and micronutrients, which can complement cereals and roots to improve household dietary diversity (Sibhatu et al., 2015).

Cassava and yams dominate root and tuber production, with 94.3% of households growing cassava and 77.46% growing yams. Cassava contributes the largest revenue share among all crops at 20.31%, while yam accounts for 13.97%. This highlights the economic and dietary significance of roots and tubers in Ogun State, which serve both as staple foods and as a source of cash income (Akinola et al., 2017).

Fruits and vegetables are grown by 22.8% and 80.05% of households, respectively, contributing 4.75% and 11.15% of total revenue. Vegetables appear to be a more common and economically important crop group, suggesting that farmers prioritize these crops for both household nutrition and market sales. This aligns with studies indicating that vegetable cultivation is increasingly promoted in smallholder systems due to its high nutritional value and income potential (FAO, 2019).

Other food crops, including condiments, account for smaller proportions of cultivation and revenue, reflecting their supplementary role in both diet and farm income. Their cultivation contributes to household food diversity and resilience, even if they do not dominate revenue streams.

The multiple cropping patterns observed particularly the integration of cereals, roots, legumes, and vegetables particularly demonstrate that households pursue crop diversification both for economic and nutritional purposes. High cultivation frequencies of staples like cassava, maize, and yams ensure energy security, while inclusion of legumes, vegetables, and fruits contributes to dietary diversity and micronutrient intake (Jones et al., 2014; Sibhatu et al., 2015). Additionally, the revenue data suggest that diversification also supports income smoothing, helping households cope with seasonal variability in production and market prices, consistent with findings in Sub-Saharan African smallholder systems (Randolph et al., 2007).

Overall, the table underscores that mixed crop production remains a central strategy for balancing economic returns and household nutrition, reinforcing the importance of designing agricultural interventions that promote both production diversity and market access.

Table 4. Pattern of crop diversification

Crop group	Frequency*	Percentage	Annual Revenue (mean)	Revenue share (%)
Corn				
Rice	138	35.75	178,374.28	12.68
Maize	334	86.53	212,784.55	15.12
Other	187	48.45	103,748.37	7.37
Pulses				
Pulses, seeds, and nuts	98	25.34	68,785.28	4.89
Roots and tubers				
Cassava	368	94.3	285,780.00	20.31
Yam	299	77.46	196,566.90	13.97
Other	176	45.6	102,354.36	7.27
Fruits and vegetables				
Fruits	88	22.8	66,880.64	4.75
Vegetables	309	80.05	156,875.08	11.15
Other foods (condiments)	54	13.99	34,875.45	2.5
Total		100	1,407, 024.91	100

Source: Field survey, 2022 * implies multiple responses

Level of crop diversification

Table 5 presents the level of crop diversification among farm households in the study area, measured using the Herfindahl-Hirschman Index (HHI). The HHI is commonly used in agricultural research to quantify production diversity, with higher values indicating greater diversification (Sibhatu et al., 2015).

The results show that only 5.7% of households are not diversified ($HHI = 1$), implying that a very small proportion of farm households cultivate a single crop exclusively. The majority of households, 63.5%, are moderately diversified with an HHI between 1.0 and 2.0, while 30.8% are highly diversified ($HHI \geq 2.0$). This indicates that a substantial

share of households engage in mixed cropping systems, cultivating multiple crop types on their farms.

These findings are consistent with studies in Sub-Saharan Africa that suggest smallholder farmers often diversify their crop production as a risk management strategy, improving resilience against climatic shocks, pest infestations, and market fluctuations (Jones et al., 2014; Sibhatu et al., 2015). Crop diversification also has important implications for household food and nutrition security, as diversified farms provide direct access to a wider range of food groups, which can improve dietary diversity and micronutrient intake (Randolph et al., 2007; Smith and Haddad, 2015).

The observed predominance of moderate diversification (63.5%) suggests that while most households engage in multi-cropping, there may be constraints limiting the adoption of highly diversified systems. These constraints could include limited land size, labor availability, access to inputs, and knowledge on optimal crop combinations, which aligns with evidence from other Nigerian studies showing that resource-poor households often face trade-offs between diversification and farm productivity (Adebayo and Olagunju, 2021).

Overall, the distribution of crop diversification levels implies that policies promoting diversified cropping systems through improved access to extension services, inputs, and credit could enhance both agricultural resilience and household dietary outcomes in the study area (Sibhatu et al., 2015; Jones et al., 2014).

Table 5. Level of crop diversification

Level	Frequency	Percentage
Not diversified (HHI=1)	22	5.70
Moderately diversified ($1.0 < \text{HHI} < 2.0$)	245	63.47
Highly diversified ($\text{HHI} \geq 2.0$)	119	30.83
Total	386	100

Source: Field Survey, 2022.

Effects of crop diversity on food and nutrition security outcomes of farm households

The relatively high R-squared values (0.34–0.82) and statistically significant F-statistics indicate good explanatory power and overall model robustness. The results collectively suggest that crop diversity is a critical pathway linking agriculture to food and nutrition security, alongside income, education, and access to productive and financial resources. Table 6 shows the ordinary least squares regression result of the effects of crop diversity on the food and nutrition security outcomes of farm households. It was found that:

Urban residence: Urban residence shows a negative and significant effect on per capita calorie intake and dietary diversity, but a positive and significant effect on the per capita value of food consumed. This suggests that while urban households spend more on food, possibly due to higher food prices and greater reliance on purchased foods,

their diets may not necessarily be calorie-dense or diverse. Similar findings have been reported in Nigeria and other developing countries, where urban diets are increasingly characterized by processed foods with lower nutritional quality despite higher food expenditure (FAO, 2022; Ruel, Garrett, and Hawkes, 2010).

Age: The age of the household head is negatively associated with calorie intake and dietary diversity but positively associated with food expenditure, indicating that older household heads may prioritize food quality or market purchases over calorie sufficiency. This could be partly attributed to the fact that older household heads are less likely to engage in diversified crop cultivation and therefore less likely to generate extra income that can be used to purchase more and diverse foods. Similar results were found by Amao (2023) and Babatunde et al. (2007).

Sex: Gender effects are also pronounced as male-headed households exhibit higher calorie intake but lower food expenditure and dietary diversity, consistent with evidence that female-headed households tend to allocate food budgets more efficiently toward diverse and nutritious diets (Quisumbing et al., 2015). The sex of the household head was found to significantly influence food consumption patterns in the study area. Specifically, it has a negative influence on dietary diversity and the monetary value of food consumed, while exerting a positive effect on calorie intake. This suggests a nuanced relationship: although male-headed households may spend less on diverse food items or show lower dietary diversity in terms of food categories, they tend to consume diets that are higher in calories. Conversely, female-headed households appear to allocate resources differently, potentially prioritizing dietary variety over caloric intake.

This pattern aligns with studies in nutrition and household economics, which indicate that gender roles and control over household resources influence both the diversity and quantity of food consumed (Doss, 2013; FAO, 2011). Therefore, policy interventions aimed at improving household nutrition should consider gender dynamics in resource allocation and decision-making, as the nutritional outcomes of households are partly shaped by the sex of the household head.

Marital status: The household head's marital status has a positive effect on the quantity of food consumption, but a negative effect on calorie intake. This result indicates that households whose heads are married consume a higher quantity of food. However, their daily calorie intake is somewhat lower when compared to their unmarried counterparts.

Education: The coefficients for education, measured by the years of schooling of household heads, had a positive effect on both dietary diversity and calorie intake. This indicates that households with more educated heads tend to consume a more diverse diet and higher caloric intake. This finding aligns with the studies of Pauzé et al. (2016) and Ogundari (2017), who reported that households headed by individuals with more years of schooling exhibit a higher demand for dietary diversity. Pauzé et al. (2016) highlighted that greater access to formal education is a key driver of varied food consumption, while Ogundari (2017) reported similar results. These findings

suggest that improving access to formal education could be an important strategy for enhancing household dietary diversity. Education has a positive and significant effect on calorie intake and dietary diversity, supporting the view that education improves nutrition knowledge, food choices, and the efficient use of available resources (Smith and Haddad, 2015)

Income: Household income had a positive effect on diet diversity, implying that the higher household income results in higher dietary diversity. Daniel (2016) stated that households that earn higher income consumed more varied diets (allocated their income to more diverse foods) than their low-income counterparts, who devoted a larger income share to staple foods. However, household income hurts per capita calorie intake, indicating that poor households are characterized by inadequate calorie intakes as they consume substantially lower quantities of food.

Livestock ownership: The total livestock numbers had a significant positive effect on dietary diversity. This implies that livestock ownership leads to a more varied dietary intake by the household. Mannaf and Uddin (2012) suggested that livestock ownership as an asset reduced the food insecurity status of households and increased the probability of a more diverse diet. This finding is similar to the one reached by Pellegrini and Tasciotti (2014).

Farm size: Farm size had a positive effect on the food consumption value and diet diversity. This implies that as the area of plots cultivated by farm households increases, the more diverse their diet is.

Access to credit: Access to credit was found to have a positive effect on the dietary diversity of farm households. This indicates that households with access to credit are better positioned to purchase a wider variety of food items, enhancing the diversity of their diets compared to households without credit access. The availability of credit likely provides households with the financial flexibility to invest in nutrient-rich foods and to smooth consumption, especially during periods of low farm income or seasonal scarcity.

This finding aligns with existing literature, which suggests that access to financial resources enables households to make more diverse and balanced food choices, thereby improving overall nutritional outcomes (FAO, 2011; Nandi and Demir, 2020). By reducing liquidity constraints, credit allows households to overcome short-term budget limitations, supporting the acquisition of different food groups rather than relying solely on staples.

Therefore, promoting credit access among rural farm households could be an effective strategy for improving dietary diversity and nutritional wellbeing, particularly in resource-constrained settings.

Number of crops cultivated: The number of crops cultivated had a positive effect on the food and nutritional indicators. This association established the fact that the number of cultivated crops drives the calorie and diet intake. Hence, households tend to have

more options to increase their calorie intake and dietary diversity as the number of food crops they cultivate increases.

Crop Diversification: The crop diversification index and the number of crops cultivated are positive and statistically significant across all three outcome measures, confirming the central hypothesis of the study. This implies that households cultivating a wider range of crops not only consume more calories and higher-value food but also enjoy more diversified diets.

The results indicate that crop diversity has a positive effect on both the value of food consumed and dietary diversity among farm households. This suggests that households engaged in diversified crop production not only consume a wider variety of foods but also allocate more resources toward their food consumption. Essentially, a diversified crop portfolio provides multiple revenue streams, enabling households to purchase additional food items that they do not produce themselves, thereby enhancing dietary variety and overall food expenditure.

These findings are consistent with empirical evidence from Sub-Saharan Africa showing that on-farm crop diversity improves household dietary diversity by increasing direct access to multiple food groups and stabilizing food availability across seasons (Sibhatu et al., 2015; Jones et al., 2014). This observation is consistent with findings from previous studies in Malawi (Jones et al., 2014), Ethiopia (Melku et al., 2018), and India (Rajendran et al., 2017), which show that smallholder farmers practicing mixed cropping produce food both for home consumption and for sale. Since farmers cannot cultivate all the foods they consume, the income generated from selling surplus crops allows them to access non-cultivated foods, improving household nutrition. These results highlight the dual role of crop diversification in supporting both income generation and dietary adequacy, emphasizing the importance of promoting mixed cropping systems as a strategy for enhancing household food security.

Table 6. Effects of crop diversity on food and nutrition security outcomes

Explanatory variables	Per calorie of food consumed		Per capita value of food consumed		Dietary diversity	
	Coeff.	t-value	Coeff.	t-value	Coeff.	t-value
Urban residence	-0.03**	-2.16	0.01***	3.04	-0.03***	-3.82
Age of household head	-0.18***	-3.14	0.02***	3.83	-0.03*	-1.88
Sex	0.24***	4.16	-0.18***	-5.62	-0.21***	-3.13
Marital status of household head	-0.02***	-3.22	0.08***	4.04	0.33	0.43
Education	0.03**	2.12	-0.02	-0.11	0.02*	1.76
Income	-1.46***	-2.56	0.61	1.12	0.01***	3.33
Crop diversification index	0.16**	2.32	0.21**	2.44	0.03***	4.74

Explanatory variables	Per calorie of food consumed		Per capita value of food consumed		Dietary diversity	
Total livestock units	0.03	1.11	0.01	0.98	0.03***	4.67
Farm size	0.14	0.68	0.02**	2.16	0.02***	2.54
Number of crops cultivated	0.03***	3.43	0.02***	3.33	0.01**	2.23
Access to extension	0.02	1.52	0.02	0.88	0.02	1.55
Access to credit	0.13	1.02	1.18***	2.16	0.04***	3.91
Non-farm participation	0.16	0.86	0.03	0.73	0.05***	2.52
Farming experience	0.04	1.35	0.16	1.11	0.06	0.89
Constant	0.63***	3.28	1.18***	41.22	1.14***	44.17
R-squared	0.34***		0.82***		0.71***	
F-value (6, 293)	28.45		32.18		41.26	
Prob > F	0.00		0.00		0.00	
Root MSE	1.237		0.84		1.11	

Note: ***, **, * implies $p < 0.01$, $p < 0.05$, and $p < 0.1$ significance level respectively.

Conclusion

This study demonstrates that crop diversification significantly improves household food and nutrition security in Ogun State, Nigeria. Households cultivating a wider variety of crops exhibit higher dietary diversity, increased per capita calorie intake, and greater food expenditure, highlighting the dual role of diversification in supporting both nutritional adequacy and economic resilience. Socioeconomic factors, including education, income, household size, and gender of the household head, further shape these outcomes, emphasizing the importance of context-specific interventions.

Despite generally adequate average calorie consumption, dietary diversity remains suboptimal, suggesting that households' diets are calorically sufficient but nutritionally limited. This underscores the need for nutrition-sensitive agricultural policies that promote diversified cropping systems alongside improved access to extension services, credit, and markets.

The findings indicate that enhancing crop diversity is a viable pathway for achieving sustainable food security and improving nutritional outcomes among smallholder farming communities. Future research should explore seasonal variations in production and consumption, as well as the impact of value chain interventions on household diet quality.

Conflict of interests

The authors declare no conflict of interest.

References

1. Abbasi, N., Ghoochani, O. M., Ghanian, M., and Kitterlin, M. 2016. Assessment of households' food insecurity through the use of a USDA questionnaire. *Advances in plants and agriculture research*, 4(5): 1-8.
2. Abdulai, A., and Aubert, D. (2004). Farmers' perceptions and adoption of new agricultural technologies: Evidence from Burkina Faso. *African Journal of Agricultural and Resource Economics*, 2(1), 57-67.
3. Adebayo, F., and Olagunju, F. (2021). Crop diversification and smallholder productivity in Nigeria. *Journal of Agricultural Extension*, 25(2), 45-57.
4. Adegbite, A. O., Olajide, O. S., and Fadiji, O. O. (2021). *Determinants of crop diversification among smallholder farmers in southwestern Nigeria. Agriculture and Food Security*, 10(1), 1-11.
5. Adjognon, G. S., Liverpool-Tasie, L. S. O., and Reardon, T. (2017). *Agricultural input credit in Sub-Saharan Africa. World Development*, 100, 299-311.
6. Akerele, D., Sanusi, R. A., Fadare, O. A., and Ashaolu, O. F. (2017). Factors influencing nutritional adequacy among rural households in Nigeria: How does dietary diversity stand among influencers? *Ecology of food and nutrition*, 56(2): 187-203.
7. Akinola, A. A., Oyelade, O. J., and Lawal, A. O. (2017). Root and tuber crop production in Nigeria: Implications for food security. *Nigerian Journal of Agriculture, Food and Environment*, 13(2), 23-33.
8. Akombi, B. J., Agho, K. E., Hall, J. J., Merom, D., Astell-Burt, T., and Renzaho, A. M. 2017. Stunting and severe stunting among children under-5 years in Nigeria: A multilevel analysis. *BMC Pediatrics*, 17(1): 15.
9. Amao, I.O.; Ogunniyi, A.I.; Mavrotas, G.; and Omotayo, A.O. (2023). Factors Affecting Food Security among Households in Nigeria: The Role of Crop Diversity. *Sustainability*, 15: 8534. <https://doi.org/10.3390/su15118534>
10. Babatunde, R.; Omotesho, O.; and Sholotan, O. (2007). Factors influencing the food security status of rural farming households in North Central Nigeria. *Agricultural Journal*, 2: 351-357.
11. Ben-Hassen, T. and El-Bilali, H., (2022). Impacts of the Russia-Ukraine war on global food security: Towards more sustainable and resilient food systems? *Foods*, 11(2301).
12. Bowman, M.S.; Zilberman, D. (2013) Economic factors affecting diversified farming systems. *Ecology and Society*, 18.

13. Cassimon, D. Fadare, O. and Mavrotas, G. 2022. The combined effect of institutional quality and capital flows on food and nutrition security and undernourishment in Sub-Saharan Africa. *PLoS ONE*, 17: e0275345.
14. Cassimon, D., Fadare, O. and Mavrotas, G. (2021). Development finance, governance quality, and their impact on food and nutrition security in Sub-Saharan Africa. *Review of Development Finance*, 11: 1–17.
15. Crush, J.S.; and Frayne, G.B. (2011) Urban food insecurity and the new international food security agenda. *Development Southern Africa*, 28: 527–544.
16. Daniel, C. (2016). Economic constraints on taste formation and the true cost of healthy eating. *Social Science and Medicine*, 148: 34-41.
17. Daud, A.S., Awotide, B.A., Omotayo, A.O., Omotoso, A.T., and Adeniyi, A.B. (2018). Effect of income diversification on households' income in rural Oyo State, Nigeria. *Acta Universitatis Danubius. Administratio*, 14, 155–167.
18. FAO. (2019). *The State of Food and Agriculture 2019: Moving Forward on Food Loss and Waste Reduction*. Rome: Food and Agriculture Organization.
19. FAO. (2019). *The State of Food and Agriculture*. Rome: FAO.
20. FAO. (2022). *The State of Food Security and Nutrition in the World 2022*. Rome: Food and Agriculture Organization.
21. Freire, T., and Rudkin, S. (2019). Healthy food diversity and supermarket interventions: Evidence from the Seacroft Intervention Study. *Food Policy*, 83: 125-138.
22. Haggblade, S., Hazell, P., and Reardon, T. (2010). The rural non-farm economy. *World Development*, 38(10), 1429–1441.
23. Herforth, A.; and Ahmed, S. (2015). The food environment, its effects on dietary consumption, and potential for measurement within agriculture-nutrition interventions. *Food Security*, 7: 505–520.
24. Jones, A.D.; Shrinivas, A.; and Bezner-Kerr, R. (2014) Farm production diversity is associated with greater household dietary diversity in Malawi: Findings from nationally representative data. *Food Policy*, 46: 1–12.
25. Joshi, P.K., Ashok, G., BIRTHAL, P.S., and Tewari, L. (2003) Agriculture diversification in South Asia: patterns, determinants, and policy implications (No. 57), Washington, D.C. 20006; 2003.
26. Kennedy, G., Ballard, T., and Dop, M. C. (2003). *Guidelines for measuring household and individual dietary diversity*. Rome: FAO.
27. Matshe, I. (2009). Boosting smallholder production for food security: Some approaches and evidence from studies in sub-Saharan Africa. *Agrekon*, 48: 483–511.

28. Melku, M.; Takele, W.W.; Anlay, D.Z.; Ekubagewargies, D.T.; Getaneh, Z.; Abebe, M.; and Abebe, Z. Male and undernourished children were at high risk of anemia in Ethiopia: A systematic review and meta-analysis. *Italian Journal of Pediatrics*, 44: 1–11.
29. Nnadi, F., Chikaire, J., Echeta, J., Ihenacho, R., Umunnakwe, P., and Utazi, C. (2013). Agricultural insurance: A strategic tool for climate change adaptation in the agricultural sector. *Net Journal of Agricultural Science*, 1: 1–9. 37.
30. Ogundari, K. (2017). Categorising households into different food security states in Nigeria: the socio-economic and demographic determinants. *Agricultural and Food Economics*, 5(1): 8.
31. Ogunniyi, A.I., Mavrotas, G., Olagunju, K.O., Fadare, O., and Adedoyin, R. 2020. Governance quality, remittances, and their implications for food and nutrition security in Sub-Saharan Africa. *World Development*, 127: 104752.
32. Oladeebo, J. O., and Oladeebo, O. (2008). Economic efficiency of small-scale crop production in Nigeria: A case study. *Journal of Social Sciences*, 17(1), 27–33.
33. Olaniyi, O., Adebayo, F., and Oladeebo, J. (2018). Determinants of household food security among smallholder farmers in Nigeria. *Journal of Development and Agricultural Economics*, 10(7), 210–218.
34. Palmioli, L., Grando, S., Di Iacovo, F., Fastelli, L., Galli, F., Prosperi, P., Rovai, M., and Brunori, G. (2020). Small farms' strategies between self-provision and socio-economic integration: Effects on food system capacity to provide food and nutrition security. *Local Environment*, 25: 43–56.
35. Pauzé, E., Batal, M., Philizaire, Y., Blanchet, R., and Sanou, D. (2016). Determinants of diet quality among rural households in an intervention zone of Grande Anse, Haiti. *Food security*, 8(6): 1123–1134.
36. Pellegrini, L.; and Tasciotti, L. (2014) Crop diversification, dietary diversity and agricultural income: Empirical evidence from eight developing countries. *Canadian Journal of Development Studies*, 35: 211–227.
37. Pingali, P. (2015). Agricultural policy and nutrition outcomes—getting beyond the preoccupation with staple grains. *Food Security*, 7: 583–591.
38. Powell, B., Thilsted, S.H., Ickowitz, A., Termote, C., Sunderland, T. and Herforth, A. (2015). Improving diets with wild and cultivated biodiversity from across the landscape. *Food Security*, 7, 535–554.
39. Rajendran, S.; Afari-Sefa, V.; Shee, A.; Bocher, T.; Bekunda, M.; and Lukumay, P.J. (2017). Does crop diversity contribute to dietary diversity? Evidence from the integration of vegetables into maize-based farming systems. *Agricultural Food Security*, 6: 1–13.
40. Randolph, T. F., Schelling, E., Grace, D., Nicholson, C. F., Leroy, J. L., Cole, D. C., and Ruel, M. (2007). Role of livestock in human nutrition and health for poverty reduction. *Journal of Animal Science*, 85(11), 2788–2800.

41. Ruel, M. T. (2003). Operationalizing dietary diversity: A review of measurement issues and research priorities. *Journal of Nutrition*, 133(11), 3911S–3926S.
42. Sibhatu, K. T., Krishna, V. V., and Qaim, M. (2015). Production diversity and dietary diversity. *Proceedings of the National Academy of Sciences*, 112(34), 10657–10662.
43. Sibhatu, K.T.; and Qaim, M. (2018). Meta-analysis of the association between production diversity, diets, and nutrition in smallholder farm households. *Food Policy*, 77: 1–18.
44. Smith, L. C., and Haddad, L. (2015). Reducing child undernutrition. *World Development*, 63, 28–45.
45. Smith, L. C., and Subandoro, A. (2007). *Measuring food security using household expenditure and consumption surveys*. Washington, DC: International Food Policy Research Institute (IFPRI).
46. Snapp, S.S.; Fisher, M. (2015) “Filling the maize basket” supports crop diversity and quality of household diet in Malawi. *Food Security*, 7: 83–96.
47. Verger, E.O., Dop, M.C., and Martin-Prével, Y. (2017). Not all dietary diversity scores can legitimately be interpreted as proxies of diet quality. *Public Health Nutrition*, 20: 2067–2068.
48. Von Grebmer, K., Bernstein, J., Prasai, N., Yin, S. and Yohannes, Y. (2015). Global Hunger Index: Armed conflict and the challenge of hunger. *International Food Policy Research Institute and Concern Worldwide*. Available at <http://www.ifpri.org/publication/2015-global-hungerindex-armed-conflict-andchallenge->.

ASSESSING EU AGRICULTURAL PERFORMANCE TOWARD A CIRCULAR ECONOMY: EVIDENCE FROM CLUSTER ANALYSIS

Tamara Rađenović¹, Žarko Rađenović², Miško Rađenović³, Bojan Krstić⁴

*Corresponding author E-mail: tamara.radjenovic@znr fak.ni.ac.rs

ARTICLE INFO

Original Article

Received: 19 September 2025

Accepted: 20 October 2025

doi:10.59267/ekoPolj2603719R

UDC 338.43.02:330.341.1]
:303.725.32(4-672EU)

Keywords:

*agriculture, performance,
circular economy, cluster
analysis, resilience*

JEL: Q10, Q19, Q57

ABSTRACT

The purpose of this paper is to evaluate the structural performance of European agriculture in the context of the circular economy transition. The methodology applies a two-step cluster analysis to three indicators: AgroBioDiversity Index, Livestock Density Index, and Farms by Economic Size, using Eurostat data. The results identify five agricultural models, ranging from extensive small-scale systems with high biodiversity and weak economic strength, to industrialized structures with large farms and strong economic capacity, but greater sustainability risks. Findings show one-size-fits-all policy is ineffective. The recommendations emphasize the need for differentiated policies that enhance the resilience of extensive systems, mitigate environmental pressures in industrial systems, and maintain balance in mixed models. The study provides additional empirical evidence for tailoring circular economy strategies to diverse agricultural structures across the European Union, supporting context-specific approaches to sustainable agriculture.

-
- 1 Tamara Rađenović, Ph.D., Associate Professor, University of Niš, Faculty of Occupational Safety, Čarnojevića 10a, 18000 Niš, Serbia, Phone: +38163424365, E-mail: tamara.radjenovic@znr fak.ni.ac.rs, ORCID ID (<https://orcid.org/0000-0003-1632-7772>).
 - 2 Žarko Rađenović, Ph.D., Research Associate, University of Niš, Innovation Centre, University Square 2, 18000 Niš, Serbia, Phone: +381638787359, E-mail: z_radjenovic89@outlook.com, ORCID ID (<https://orcid.org/0000-0002-3679-7870>).
 - 3 Miško Rađenović, Ph.D., Full professor, University of Donja Gorica, Faculty of Culture and Tourism, Podgorica, Montenegro, Phone: +38971335097, E-mail: radjenovim@t-com.me, ORCID ID (<https://orcid.org/0000-0002-7964-5869>).
 - 4 Bojan Krstić, Ph.D., Full Professor, University of Niš, Faculty of Economics, King Aleksander Square 11, 18000 Niš, Serbia, Phone: +381611878684, E-mail: bojan.krstic@eknfak.ni.ac.rs, ORCID ID (<http://orcid.org/0000-0003-4597-6819>).

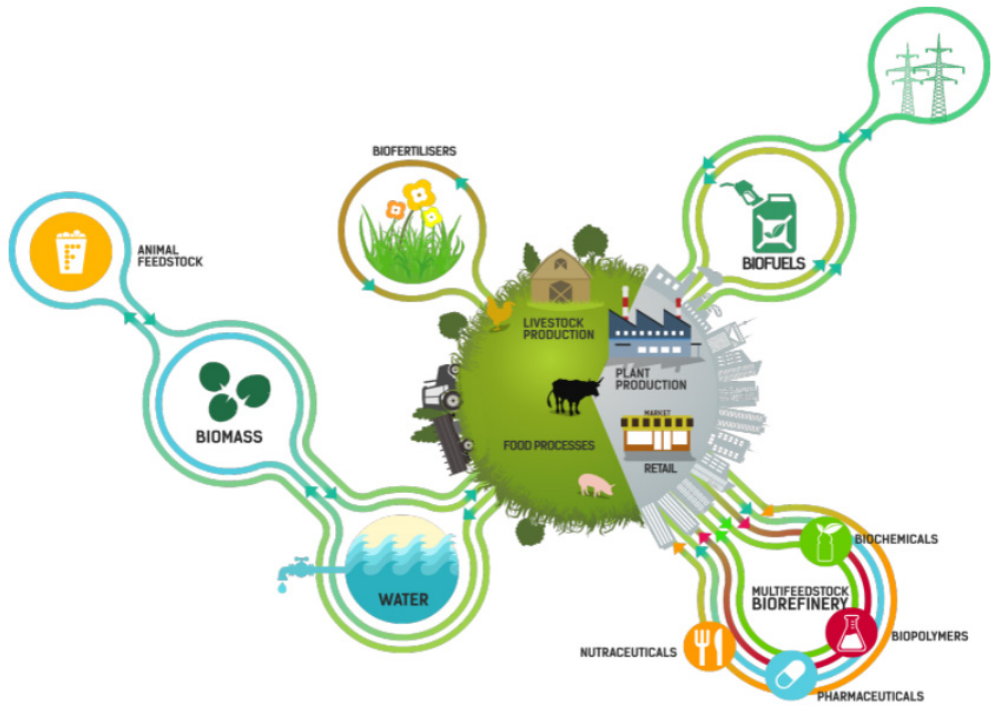
Introduction

The transformation of agricultural systems is central to achieving the objectives of the European Green Deal and the 2030 Agenda for Sustainable Development. Agriculture simultaneously drives economic growth, rural employment, and food security, but it also generates substantial environmental pressures, including land degradation, biodiversity loss, and greenhouse gas emissions (European Commission, 2019). In this context, the concept of the circular economy (CE) has emerged as a guiding framework for restructuring agri-food systems toward resource efficiency, closed nutrient loops, and enhanced ecological resilience (Geissdoerfer et al., 2017; Jurgilevich et al., 2016).

A growing body of literature emphasizes the role of indicators in monitoring sustainability and CE transitions in agriculture. Silvestri et al. (2024) stress that integrated sets of indicators are essential to capture the triple bottom line of environmental, social, and economic performance. Velasco-Muñoz et al. (2021) propose adapting CE strategies specifically to agricultural systems, highlighting the importance of narrowing, slowing, and closing resource loops through regenerative practices. Similarly, Castillo-Díaz et al. (2023) demonstrate that composite indicators can be used to benchmark the sustainability of agri-food systems at the EU level. Despite these advances, empirical studies that segment agricultural structures based on performance indicators remain limited, particularly in linking biodiversity, production intensity, and economic capacity to CE pathways.

This paper addresses that gap by assessing EU agricultural performance through three core indicators: the AgroBioDiversity Index (AGBDI), the Livestock Density Index (LDI), and Farms by Economic Size (FES). These dimensions are particularly relevant to CE transitions: agrobiodiversity supports ecological stability and resilience; livestock density reflects resource intensity and environmental pressures; and farm economic size indicates the economic viability and capacity for innovation (Figure 1). By applying a two-step cluster analysis, this study identifies structural models of agriculture across the EU and interprets their implications for sustainable development and CE-aligned policy design.

This study's originality lies in combining three structural indicators into an EU-wide segmentation using two-step cluster analysis. Whereas prior work benchmarks sustainability through composite indices (Castillo-Díaz et al., 2023) or maps spatial diversification (Matysik-Pejas et al., 2023), our typology uncovers distinct structural models and links each to tailored CE measures.

Figure 1. Connection between CE and agrobiodiversity

Source: Authors' adaptation according to AgroCycle

The central research question is: How do biodiversity, livestock intensity, and economic farm size combine to structure EU agriculture, and what does this imply for tailored circular economy strategies? The aim is to provide a data-driven classification of EU agricultural systems that supports differentiated policy strategies using agricultural predictive data processing. Rather than promoting uniform measures, the analysis offers evidence for tailoring CE-oriented interventions to the specific conditions of each cluster, balancing ecological and economic objectives across Europe.

European Agriculture and the CE Transition: Literature Review

The transition of European agriculture toward a CE is a rapidly evolving research area, reflecting the sector's central role in sustainability, resource efficiency, and climate goals. It is gaining increasing attention as a framework for achieving sustainable food systems, improving biodiversity, and minimizing environmental externalities. The literature highlights both the promise and complexity of this transformation.

Circular agriculture aims to minimize inputs and waste by closing resource loops, thereby reducing environmental impact. It promotes the reuse, recycling, and regeneration of resources within the agricultural and food system. Key principles include nutrient recycling, agrobiodiversity, reduced livestock intensity, and integrated production

systems (Chung et al., 2024; Kotyal, 2023). This model stands in contrast to the traditional linear systems, which are resource-intensive and environmentally damaging. It represents a shift from linear “take-make-dispose” models to systems that prioritize resource reuse, waste minimization, and environmental regeneration. European policy frameworks, such as the Circular Economy Action Plan and the European Green Deal, have established CE as a strategic priority; however, regulatory instruments specific to agriculture remain underdeveloped, and implementation is uneven across member states (Georgescu et al., 2025). Tailored, region-specific policies and investments in infrastructure are seen as essential for effective CE adoption (Zarbà et al., 2021).

European agriculture is highly heterogeneous, with significant spatial and structural differences that influence the implementation of CE. Studies highlight that circular models require differentiated implementation strategies based on these structural differences (Dovgal et al., 2024). For example, regions with small, biodiverse farms may be better aligned with CE principles but lack economic scalability, while industrialized systems present efficiency but risk environmental degradation. Countries with advanced agricultural sectors tend to be further along in adopting CE principles, while less developed regions face greater barriers due to limited infrastructure, investment, and institutional support (Matysik-Pejas et al., 2023; Georgescu et al., 2025). Cluster analyses and composite indicators reveal that balanced systems, those combining biodiversity, moderate livestock intensity, and medium farm size, are most closely aligned with sustainable CE outcomes (Matysik-Pejas et al., 2023; Castillo-Díaz et al., 2023).

The literature identifies several core strategies for advancing CE in agriculture. Waste recovery and bioenergy have been prominent, particularly anaerobic digestion and biogas production, though their success depends on feedstock quality, infrastructure, and innovative business models (Barros et al., 2020; Haque et al., 2023). Resource efficiency and recycling, including reducing raw material use, remain the most widely adopted CE strategies, especially in the food and beverage sector (De Pascale et al., 2023). Local productive systems, emphasizing territorial balance and regional supply chains, are highlighted as means to enhance resilience and sustainability (Castillo-Díaz et al., 2023).

Several challenges hinder CE adoption. Technological and economic barriers, including high costs, inadequate infrastructure, and limited life cycle assessment data, hinder implementation (Velasco-Muñoz et al., 2021; Haque et al., 2023). Stakeholder engagement is another critical factor, as CE requires collaboration among farmers, policymakers, and consumers, with government incentives playing a decisive role (Muscio & Sisto, 2020; Haque et al., 2023; Rađenović et al., 2025). Research and innovation gaps also persist; while publications on CE in agriculture have increased since 2015, economic and social dimensions remain underexplored compared to environmental impacts (Ali & Ali, 2024; Silvestri et al., 2024).

Adopting CE principles in European agriculture can reduce land use and greenhouse gas emissions, enhance food security, and support employment, including narrowing

gender gaps in agricultural work (van Zanten et al., 2023). However, trade-offs exist, as economic and social progress may sometimes come at the expense of environmental quality, underscoring the need for integrated policy approaches (Castillo-Díaz et al., 2023; van Zanten et al., 2023).

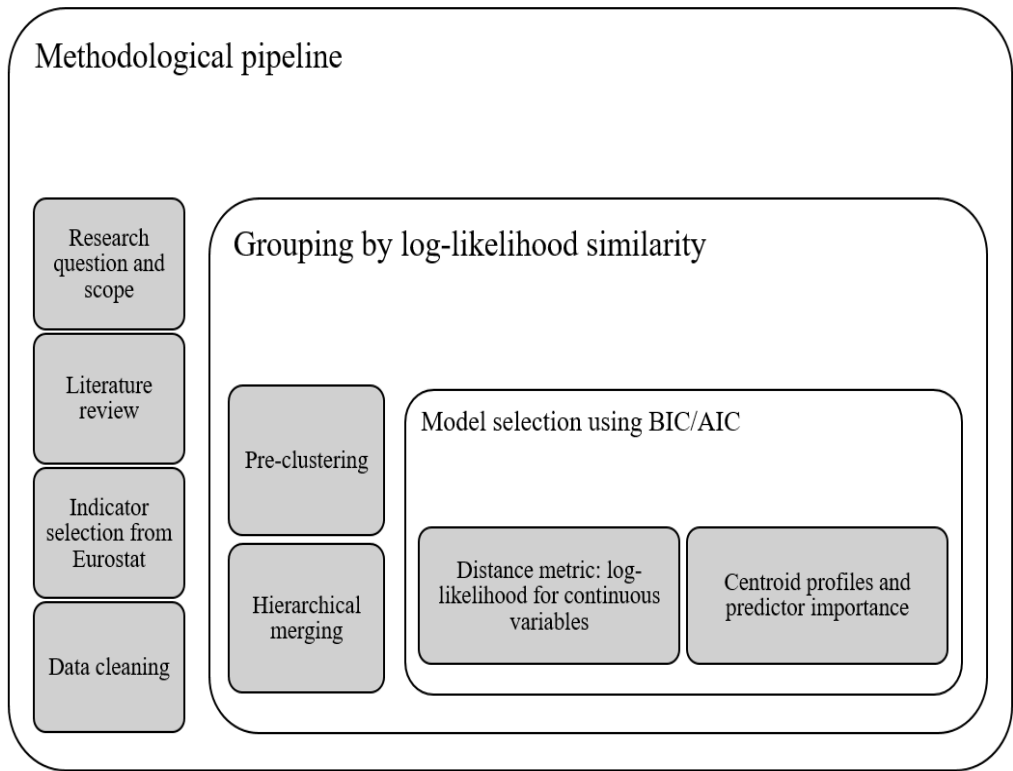
The literature underscores that while the transition to CE in European agriculture holds significant promise for sustainability, it is shaped by structural diversity, policy gaps, and the need for integrated, context-specific strategies. Further research and innovation, especially in economic and social dimensions, are critical for advancing this transition.

Materials and methods

The analysis is based on the application of the two-step cluster method to categorize EU countries according to their structural characteristics in agriculture. The two-step cluster analysis is a hybrid clustering technique designed to efficiently handle large datasets with mixed-type variables (both continuous and categorical) (Rađenović & Rajić, 2025). Unlike traditional clustering procedures, such as k-means (which requires only continuous variables) or hierarchical clustering (which can become computationally demanding with larger sample sizes), the two-step method combines the advantages of both approaches, offering a more robust and scalable solution (Ahmed et al., 2020). The procedure is carried out in two main phases, as illustrated in the methodological pipeline (Figure 2). In the first step (pre-clustering), cases are scanned sequentially and assigned into small “sub-clusters” using a distance measure. For continuous variables, the algorithm utilizes the log-likelihood distance, which assesses the similarity of observations based on their probability distributions rather than absolute distances. For categorical variables, a frequency-based approach is applied. In the second step, the sub-clusters are grouped into the final clusters using an agglomerative hierarchical method, which merges them iteratively until an optimal cluster solution is reached. A key strength of the two-step procedure is its ability to determine the optimal number of clusters automatically. This is achieved by employing model-fit criteria such as the Bayesian Information Criterion (BIC) or the Akaike Information Criterion (AIC), which balance model complexity with explanatory power (Rađenović & Rajić, 2025). The solution with the lowest BIC or AIC value is selected, thereby avoiding arbitrary pre-specification of the number of clusters. The clustering was performed using three indicators from the EUROSTAT database, according to the last available data for the analysed period of time, 2019-2023, for selected EU members:

- AGBDI (AgroBioDiversity Index) – measures the diversity of agricultural production and the level of agrobiodiversity conservation (Eurostat, 2019),
- LDI (Livestock Density Index) – reflects the intensity of livestock production through animal density per hectare of agricultural land (Eurostat, 2020),
- FES (Farms by Economic Size) – indicates the economic strength of farms measured by the standard output value (Eurostat, 2023).

Figure 2. Methodological pipeline of applied statistical techniques



Source: Authors' visualization

From a statistical standpoint, the two-step cluster method is particularly well suited for studies like this one, where indicators such as the AGBDI, LDI, and FES represent continuous variables with very different ranges and distributions. Before clustering, these variables were standardized to ensure comparability, preventing variables with larger scales (e.g., FES values) from dominating the analysis. The resulting clusters were evaluated using centroid values (means) for each variable, which serve as interpretable profiles of the agricultural systems. Despite these strengths, the two-step cluster analysis also presents certain limitations that must be acknowledged. First, the technique is sensitive to outliers, which can disproportionately influence centroid values and alter cluster boundaries. Second, the method relies on distributional assumptions embedded in the log-likelihood measure. Finally, two-step clustering is less flexible than model-based clustering approaches, which can incorporate prior theoretical knowledge into the classification process (Rađenović & Rajić, 2025).

Results and Discussion

The centroid values of the clusters reveal apparent structural differences across EU agricultural systems (Table 1).

Table 1. Cluster centroids and dispersion

Centroids							
		AGBDI		LDI		FES	
		Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Cluster	1	48.400	4.827	2.636	.746	166.238	206.337
	2	58.285	1.976	1.012	.409	12.818	10.492
	3	56.250	1.500	.302	.089	22.932	23.369
	4	61.150	4.255	.675	.239	49.6663	19.5535
	5	61.666	3.511	.506	.213	231.886	42.214

Source: Authors' calculations

The analysis covered 19 EU member states for which data on agrobiodiversity, livestock density, and farm economic size were jointly available and harmonized. Eight member states (Portugal, Spain, Poland, Romania, Slovakia, Slovenia, Sweden, and the Netherlands) were excluded due to missing or non-comparable values in one or more indicators. This ensures consistency of the dataset and comparability of cluster results across countries.

Cluster 1 (18.5%), which comprises Malta, Ireland, Belgium, and Austria, is defined by an average AGBDI of approximately 48, an LDI of 2.63, and an FES value of 166. This combination indicates low agrobiodiversity, very high livestock density, and relatively large farm sizes, a profile characteristic of intensive livestock-oriented agriculture with strong economic capacity where emphasis is placed on productivity rather than ecological diversity.

The second-largest group, Cluster 2 (25.9%) gathers Lithuania, Estonia, Czechia, and Cyprus, displays an AGBDI of around 58, an LDI of 1.01, and a remarkably low FES of 13. These figures suggest a structure dominated by small farms, low livestock intensity, and medium to high levels of biodiversity, indicating extensive small-scale farming systems which tends to be more economically vulnerable but plays a crucial role in maintaining local biodiversity.

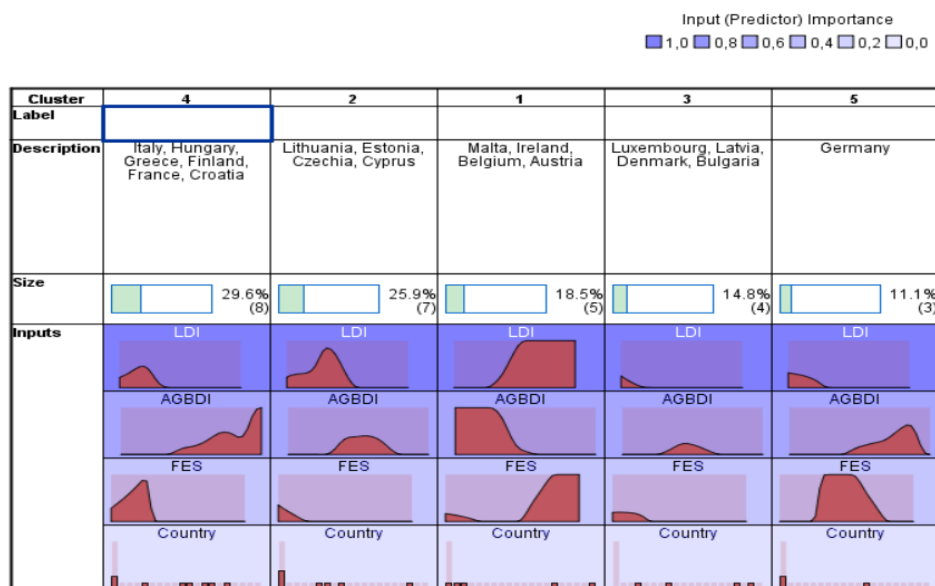
Cluster 3 (14.8%), comprising of Luxembourg, Latvia, Denmark, and Bulgaria, shows centroid values of AGBDI ≈ 56 , LDI ≈ 0.30 , and FES ≈ 23 . These results indicate moderate agrobiodiversity, very low livestock density, and small to medium farm sizes. The combination defines a model of highly extensive agriculture with limited livestock activity, reflecting production systems that are ecologically less intensive, but also economically constrained.

The largest group, Cluster 4 (29.6%), consisting of Italy, Hungary, Greece, Finland, France, and Croatia, records the highest agrobiodiversity (AGBDI ≈ 61), paired with low to medium livestock density (LDI ≈ 0.67) and medium-sized farms (FES ≈ 50). This

profile highlights a balanced agricultural structure, in which ecological and economic dimensions are relatively well harmonized, providing a potential model for sustainable agricultural development within the EU.

Finally, Cluster 5 (11.1%), represented solely by Germany, stands apart with centroid values of AGBDI ≈ 62 , LDI ≈ 0.51 , and FES ≈ 232 . The combination of high biodiversity, low livestock density, and considerable farm size places this cluster at the industrial end of the spectrum. It represents a capital-intensive agricultural model, where scale and economic strength dominate, but where potential risks for biodiversity and long-term sustainability are particularly pronounced.

Figure 3. Cluster characteristics and structure



Source: Authors' calculations

The application of the two-step cluster analysis highlights the structural differentiation of European agriculture (Figure 3). Clusters 2 and 3 represent extensive agricultural systems, characterized by small farm size, low livestock density, and relatively higher biodiversity. These systems face the challenge of increasing productivity while maintaining ecological resilience. Cluster 4 reflects a balanced model where biodiversity, livestock activity, and economic size are harmonized. This type of agriculture is most closely aligned with the concept of sustainability and can serve as a reference model for EU agricultural policies. Clusters 1 and 5 are characterized by high economic capacity, but also carry different risks. Cluster 1 exhibits a firm reliance on intensive livestock farming, whereas Cluster 5 represents industrial agriculture characterized by vast farms, which raises concerns about environmental impacts and biodiversity loss.

The two-step cluster analysis thus provides a nuanced framework for designing

agricultural policies. Instead of uniform policies for all EU countries, it allows for differentiated strategies tailored to the specific conditions of each cluster (Rađenović et al., 2022). The cluster relationship chart (Figure 3) provides a detailed profile of the five agricultural clusters identified through the two-step analysis, showing both the distribution of countries and the relative importance of the input indicators.

The comparison with previous studies supports and refines these findings. Similar patterns of structural heterogeneity across European agriculture are noted in composite sustainability assessments and spatial diversification analyses. For instance, the balanced model observed here mirrors the “territorially balanced” structures linked to stronger sustainability outcomes in Castillo-Díaz et al. (2023). However, unlike studies relying on aggregate sustainability scores, our cluster approach reveals structural typologies, providing more tangible entry points for CE policy design.

The extensive small-scale clusters (2 and 3) confirm results from Matysik-Pejas et al. (2023), who found that smaller, biodiverse farms achieve strong ecological performance but struggle economically. Our results reinforce that without targeted interventions, these systems risk “ecological poverty traps.” Circular strategies such as cooperative processing, shared machinery, and bio-based product valorisation could strengthen viability while maintaining biodiversity (Silvestri et al., 2024; Zarbà et al., 2021).

The intensive livestock-oriented Cluster 1 aligns with previous analyses of nutrient overload and environmental pressure in high-density livestock systems (Velasco-Muñoz et al., 2021). Technologies like manure treatment, biogas production, and precision feeding (Barros et al., 2020) are recognized as key CE levers, while our analysis helps identify the structural context where these interventions yield the highest environmental return.

Similarly, the industrial Cluster 5 confirms findings in van Zanten et al. (2023), who highlight the trade-off between efficiency and ecological stability at scale. While industrial models can contribute to circular goals through economies of scope and resource recovery, our results underscore that maintaining biodiversity and minimizing nutrient leakage require embedded circular design, like industrial symbiosis, renewable energy integration, and closed nutrient and water loops.

Methodologically, our approach diverges from prior index-based or regional typologies (Castillo-Díaz et al., 2023; Matysik-Pejas et al., 2023) by clustering structural indicators, biodiversity, livestock density, and economic size, via a two-step algorithm capable of capturing non-linear interdependencies. This aligns with Silvestri et al. (2024), who argue that multidimensional indicator packs better reflect agricultural performance than single composite indices. The resulting typology operationalizes the strategic view proposed by Velasco-Muñoz et al. (2021), that CE transitions in agriculture must be tailored to the structural realities of different farming systems rather than imposed uniformly.

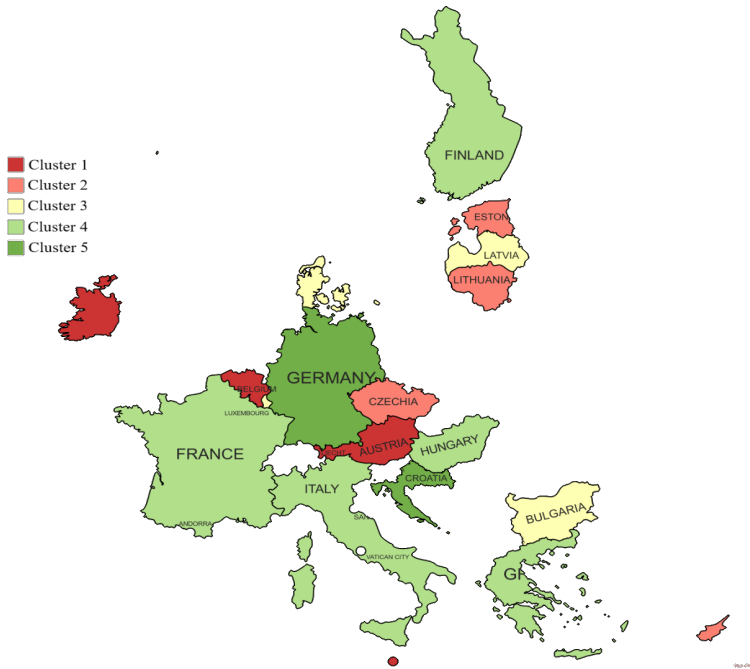
In policy terms, our results are consistent with the European Green Deal's call for resource efficiency and ecological resilience (European Commission, 2019), yet they emphasize the need for cluster-specific implementation. By distinguishing extensive, balanced, intensive, and industrial structures, this study offers an evidence-based framework for adapting Common Agricultural Policy (CAP) eco-schemes and rural development programs to each system's circular potential: supporting cooperative bioeconomy models in extensive clusters, nutrient and waste recycling technologies in intensive systems, and maintaining biodiversity-productivity synergies in balanced contexts.

The results indicate that EU countries can be grouped into distinct agricultural development models depending on the balance between farm economic size, livestock intensity, and agrobiodiversity.

- For capital-intensive systems (Cluster 1), CE interventions should focus on precision feeding, compost processing and biogas, and nutrient recycling as mitigation levers.
- For extensive systems (Clusters 2 and 3), the policy priority should be to strengthen the economic viability of farms while preserving biodiversity.
- For industrial systems (Cluster 5), focus should be placed on environmental protection measures and controlling the negative externalities of over-concentration.
- For balanced systems (Cluster 4), the task is to maintain their equilibrium and promote them as reference models of sustainable agriculture.

This analysis confirms that the development of sustainable agriculture in the EU is a multifaceted process, requiring policies that strike a balance between economic competitiveness and ecological resilience across differentiated agricultural clusters.

Moreover, structural differentiation allows the results to be interpreted through the lens of the CE transition depicted on the European clusters' map (Figure 4). Clusters 2 and 3, dominated by small and extensive systems, align with CE principles of biodiversity preservation and low ecological pressure but face challenges in economic viability. For these systems, circular strategies such as cooperative resource sharing, valorisation of agricultural residues, and integration into local bioeconomy initiatives could strengthen resilience without compromising ecological benefits (Velasco-Muñoz et al., 2021; Zarbà et al., 2021). In contrast, Cluster 4 illustrates a balanced structure where environmental and economic dimensions are already harmonized. This cluster can be considered a reference model for CE-oriented agriculture, demonstrating how moderate livestock intensity and medium-sized farms can support both competitiveness and biodiversity outcomes (Castillo-Díaz et al., 2023).

Figure 4. European clusters' map according to the given results

Source: Authors' visualisation

Clusters 1 and 5, by comparison, illustrate the risks of divergence from CE principles. Cluster 1's intensive livestock orientation raises concerns about nutrient overload, greenhouse gas emissions, and pressure on biodiversity. CE strategies in this context should emphasize nutrient recycling, precision livestock systems, and the integration of renewable energy to mitigate environmental impacts (Barros et al., 2020; Haque et al., 2023). Cluster 5, represented solely by Germany, demonstrates the economic strength of large-scale farming but also the need for industrial symbiosis and closed-loop nutrient and water systems to prevent long-term sustainability risks (van Zanten et al., 2023). Together, these results suggest that CE pathways in agriculture must be cluster-specific, reinforcing biodiversity in extensive systems, maintaining balance in mixed systems, and applying circular innovations to industrialized models.

Conclusions

This study applied a two-step cluster analysis to assess the structural performance of European agriculture using three indicators: agrobiodiversity, livestock density, and farm economic size. The results identified five distinct agricultural models, ranging from extensive small-scale systems with high biodiversity but weak economic strength, to capital-intensive industrial structures with large farms and high economic capacity but greater sustainability risks. Between these extremes, a balanced cluster emerged that combines biodiversity conservation, moderate livestock intensity, and medium-

sized farms, offering the closest alignment with sustainable and circular agriculture. Cross-country contrasts reinforce that similar cluster membership does not imply identical policy levers. For instance, Finland vs Greece (both Cluster 4) share a “balanced” profile statistically, yet differ in climate, soils, and farm structures. So, biodiversity actions (e.g., semi-natural habitat management, pesticide risk reduction) will look quite different in practice. Within Cluster 3, Denmark’s high LDI calls for precision nutrient management and manure processing, whereas Latvia/Bulgaria benefit more from boosting farm viability and habitat connectivity. In Cluster 1, Ireland and Belgium face similar nutrient and grassland pressures but start from different baseline governance and market contexts, implying different policy instruments (e.g., trading schemes vs. investment supports). The findings confirm that the transition of European agriculture toward a CE cannot be achieved through uniform policy measures. Instead, differentiated strategies are required. For extensive systems, the priority is to enhance economic resilience through cooperative models, residue valorisation, and integration into local bioeconomy networks. For industrialized systems, policies should focus on nutrient recycling, precision technologies, and industrial symbiosis to mitigate ecological pressures. Balanced systems should be promoted as reference models, demonstrating how environmental stability and economic competitiveness can be mutually reinforcing.

From a policy perspective, the results provide empirical evidence to guide the design of CE pathways tailored to diverse agricultural contexts within the EU. Incorporating CE strategies into the Common Agricultural Policy and national rural development programs will be essential to support transitions that are both ecologically resilient and economically viable. Future work should address several limitations of this study while deepening cross-country insights. First, our evidence relies on the latest available snapshots, which limit causal interpretation and mask regional heterogeneity, whereas a harmonized multi-year panel would allow for tests of cluster stability and transitions. Future research should expand the indicator set to include environmental footprints, resource circularity metrics, and social dimensions, thereby offering a more comprehensive assessment of how European agriculture can contribute to the broader sustainability and CE agenda.

Acknowledgements

This paper is part of the research supported by the Ministry of Science, Technological Development and Innovation of the Republic of Serbia pursuant to the agreement No. 451-03-137/2025-03/200148, and contributes to SDGs 12 and 13. In addition, this paper is also part of the research financed by the Ministry of Science, Technological Development, and Innovation of the Republic of Serbia, as agreed in decision No. 451-03-136/2025-03/200371.

Conflict of interest

The authors declare no conflict of interest.

References

1. Ahmed, M., Seraj, R. & Islam, S. (2020). The k-means Algorithm: A Comprehensive Survey and Performance Evaluation. *Electronics*. 9 (8): 1295. DOI: 10.3390/electronics9081295.
2. Ali, J., & Ali, T. (2024). Circular economy and agriculture: mapping scientific productivity, research patterns, and future research direction. *Environment, Development and Sustainability*, 26(12), 30063-30108. <https://doi.org/10.1007/s10668-023-03963-x>
3. Barros, M. V., Salvador, R., de Francisco, A. C., & Piekarski, C. M. (2020). Mapping of research lines on circular economy practices in agriculture: From waste to energy. *Renewable and Sustainable Energy Reviews*, 131, 109958. <https://doi.org/10.1016/j.rser.2020.109958>
4. Castillo-Díaz, F. J., Belmonte-Ureña, L. J., López-Serrano, M. J., & Camacho-Ferre, F. (2023). Assessment of the sustainability of the European agri-food sector in the context of the circular economy. *Sustainable Production and Consumption*, 40, 398-411. <https://doi.org/10.1016/j.spc.2023.07.010>
5. Chung, D., Duy, L., & Loan, L. (2024). Circular Agriculture: A General Review of Theories, Practices, and Policy Recommendations. *Vietnam Journal of Agricultural Sciences*, 7(2), 2173-2184. <https://doi.org/10.31817/vjas.2024.7.2.07>
6. De Pascale, A., Di Vita, G., Giannetto, C., Ioppolo, G., Lanfranchi, M., Limosani, M., & Szopik-Decpczyńska, K. (2023). The circular economy implementation at the European Union level. Past, present, and future. *Journal of Cleaner Production*, 423, 138658. <https://doi.org/10.1016/j.jclepro.2023.138658>
7. Dovgal, O., Potryvaieva, N., Bilichenko, O., Kuzoma, V., & Borko, T. (2024). Agricultural sector circular economy development: Agroecological approach. *Ekonomika APK*, 31(4), 10-22. <https://doi.org/10.32317/ekon.apk/4.2024.10>
8. European Commission (2019). Communication from the Commission: *The European Green Deal*; COM(2019) 640 final; European Commission: Brussels, Belgium, Available online: <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52019DC0640> (accessed on 8 September 2025)
9. Eurostat (2019). *Agrobiodiversity Index Report 2019: risk and resilience | Knowledge for policy*. Available online: https://knowledge4policy.ec.europa.eu/publication/agrobiodiversity-index-report-2019-risk-resilience_en (accessed on 12 September 2025)
10. Eurostat (2023). *Farms by Economic Size (tag00123)*. Available online: https://ec.europa.eu/eurostat/databrowser/view/tag00123/default/table?lang=en&category=t_agr.t_ef (accessed on 12 September 2025)
11. Eurostat (2020). *Livestock density index (tai09)*. Available online: <https://ec.europa.eu/eurostat/databrowser/view/tai09/default/table?lang=en> (accessed on 12 September 2025)

12. Geissdoerfer, M., Savaget, P., Bocken, N. M. P., & Hultink, E. J. (2017). The circular economy – A new sustainability paradigm? *Journal of Cleaner Production*, 143, 757-768. <https://doi.org/10.1016/j.jclepro.2016.12.048>
13. Georgescu, L. P., Barbuta Misu, N., Antohi, V. M., Fortea, C., & Zlati, M. L. (2025). Approaches and perspectives on the transition to the circular economy in the European Union. *Frontiers in Environmental Science*, 13, 1533776. <https://doi.org/10.3389/fenvs.2025.1533776>
14. Haque, F., Fan, C., & Lee, Y. Y. (2023). From waste to value: Addressing the relevance of waste recovery to agricultural sector in line with circular economy. *Journal of Cleaner Production*, 415, 137873. <https://doi.org/10.1016/j.jclepro.2023.137873>
15. Jurgilevich, A., Birge, T., Kentala-Lehtonen, J., Korhonen-Kurki, K., Pietikäinen, J., Saikku, L., & Schösler, H. (2016). Transition towards a circular economy in the food system. *Sustainability*, 8(1), 69. <https://doi.org/10.3390/su8010069>
16. Kotyal, K. (2023). Circular agriculture: Sustainable farming practices for zero waste. *Environmental Reports*, 5(1), 8-12, <https://doi.org/10.51470/ER.2023.5.1.08>.
17. Matysik-Pejas, R., Bogusz, M., Daniek, K., Szafrńska, M., Satoła, Ł., Krasnodębski, A., & Dziekański, P. (2023). An assessment of the spatial diversification of agriculture in the conditions of the circular economy in European Union countries. *Agriculture*, 13(12), 2235. <https://doi.org/10.3390/agriculture13122235>
18. Muscio, A., & Sisto, R. (2020). Are agri-food systems really switching to a circular economy model? Implications for European research and innovation policy. *Sustainability*, 12(14), 5554, <https://doi.org/10.3390/su12145554>
19. Rađenović, Ž., Janjić, I., Talić, M., Đokić, M., Rađenović, T., Boskov, T., & Krstić, B. (2025). Digital mapping of business performance indicators of agricultural holdings in Serbia. *Ekonomika Poljoprivrede*, 72(1), 225–240. <https://doi.org/10.59267/ekoPolj2501225R>
20. Rađenović, Ž., Krstić, B., & Marković, M. (2022). Economic Performance of Agriculture in the European Union Countries. *Zagadnienia Ekonomiki Rolnej/ Problems of Agricultural Economics*, 370(1), 5-21. DOI:10.30858/zer/145686
21. Rađenović, Ž. J., & Rajić, M. N. (2025). Two-step cluster analysis for energy performance indicators comparison. *Thermal Science*, (00), 56-56. DOI: <https://doi.org/10.2298/TSCI250205056R>
22. Silvestri, C., Silvestri, L., Piccarozzi, M., & Ruggieri, A. (2024). Toward a framework for selecting indicators of measuring sustainability and circular economy in the agri-food sector: A systematic literature review. *International Journal of Life Cycle Assessment*, 29, 1446-1484. <https://doi.org/10.1007/s11367-022-02032-1>

23. van Zanten, H. H. E., Simon, W., Van Selm, B., Wacker, J., Maindl, T. I., Frehner, A., ... & Herrero, M. (2023). Circularity in Europe strengthens the sustainability of the global food system. *Nature Food*, 4(4), 320-330. <https://doi.org/10.1038/s43016-023-00734-9>
24. Velasco-Muñoz, J. F., Mendoza, J. M. F., Aznar-Sánchez, J. A., & Gallego-Schmid, A. (2021). Circular economy implementation in the agricultural sector: Definition, strategies, and indicators. *Resources, Conservation and Recycling*, 170, 105618. <https://doi.org/10.1016/j.resconrec.2021.105618>
25. Zarbà, C., Chinnici, G., La Via, G., Bracco, S., Pecorino, B., D'Amico, M. (2021). Regulatory Elements on the Circular Economy: Driving into the Agri-Food System. *Sustainability*, 13, 8350. <https://doi.org/10.3390/su13158350>

CONSUMER BEHAVIOR TOWARD ECO-LABELED AGRI-FOOD PRODUCTS: EVIDENCE FROM TÜRKİYE

Sinan Çavuşoğlu¹

*Corresponding author E-mail: sinankys42@gmail.com

ARTICLE INFO

Original Article

Received: 09 December 2025

Accepted: 30 March 2026

doi:10.59267/ekoPolj2603735C

UDC 366.1:631.147(560)

Keywords:

eco-label, support for local producers, perceived price fairness, purchase intention, sustainable agri-food products, structural equation modeling (SEM)

JEL: Q13, Q18, M31, D12, C38

ABSTRACT

This study investigates consumer behavior toward eco-labeled agri-food products by integrating eco-label trust, perceived support for local producers, perceived price fairness, and purchase intention into a comprehensive structural model. Data were collected from 410 adult consumers in Türkiye through an online survey and analyzed using Structural Equation Modeling after confirming the validity and reliability of the measurement model. The findings indicate that both eco-label trust and perceived support for local producers significantly enhance consumers' perceptions of price fairness as well as their intention to purchase eco-labeled products. Moreover, perceived price fairness emerges as a meaningful direct predictor of purchase intention. Overall, the results suggest that consumer decisions regarding sustainable agri-food products are shaped not only by environmental considerations but also by the combined influence of trust mechanisms, social value orientations, and fairness evaluations.

Introduction

Sustainable agricultural production holds a critical position for the future of global food systems, gaining increasing importance as consumer awareness rises and policymakers respond to mounting environmental and economic concerns. Today, consumers evaluate food products not only on traditional criteria such as price and taste but also on factors related to environmental impact, production methods, and broader societal benefits. In this context, eco-labels have emerged as powerful communication tools that provide reliable and easily accessible information about a product's sustainability performance (Thøgersen, 2000; Delmas & Grant, 2014). However, the effectiveness of eco-labels depends heavily on consumer trust. When trust is lacking, the informational value of eco-labels is unlikely to influence purchasing behavior, thereby diminishing the intended marketing impact of these labels.

1 Sinan Çavuşoğlu, Ph.D., Associate Professor, Bingöl University, Social Sciences Vocational School, Finance Banking and Insurance Department, Bingöl 12000, Turkey, Phone: +905436881565, E-mail: sinankys42@gmail.com, ORCID ID: (<https://orcid.org/0000-0001-9365-8677>)

Beyond environmental considerations, agricultural food consumption also encompasses significant social and economic dimensions. Supporting local producers and strengthening rural economies play a strategic role in national food security and regional development policies. Skallerud and Wien (2019), demonstrates that consumer preferences for local foods are not driven solely by personal benefit but are also influenced by motivations such as contributing to community welfare, supporting local producers, and preserving regional economic structures. These findings highlight the importance of social value orientations in shaping consumer behavior and underscore the need to understand consumers' motivations to support local producers for sustainable agricultural policies to be successful.

Eco-labeled agricultural products often command higher prices in the marketplace, making price evaluation a critical component of consumer decision-making. Perceived price fairness-defined as consumers' assessments of whether a price is reasonable, justified, and equitable-lies at the core of willingness to pay for sustainable products (Bolton et al., 2003; Xia et al., 2004). When prices are perceived as unfair, consumers may refrain from purchasing eco-labeled products even if they trust the label. Therefore, understanding the interplay between trust, social contribution perceptions, and price fairness is essential for developing a holistic explanation of sustainable purchasing behavior.

Although prior studies have examined eco-label trust, social contribution perceptions, and price fairness, these constructs have largely been studied in isolation. Research investigating how these three dimensions jointly shape purchase intention remains limited. In particular, integrating perceptions of support for local producers into the decision-making framework for eco-labeled agricultural products introduces a novel and meaningful contribution to the literature. Addressing this gap, the present study integrates Eco-Label Trust, Support for Local Producers and the Local Economy, Perceived Price Fairness, and Purchase Intention into a single structural model. By doing so, it aims to provide a comprehensive understanding of the psychological and social determinants of consumer behavior toward sustainable agricultural products, contributing to both the sustainable food consumption literature and rural development-oriented agricultural economics research.

Literature review

Eco-labels function as signals that enable consumers to quickly assess product attributes and positively influence purchasing behavior, especially when they enhance perceptions of environmental benefit, sustainable production, and product credibility (Thøgersen, 2000). Prior studies have shown that trust in eco-labels increases perceived product quality and expectations of environmental benefits, thereby directly strengthening purchase intention (Delmas & Grant, 2014; Testa et al., 2015; Nguyen et al., 2025). Eco-label trust is not only associated with environmental concern but also with beliefs about the accuracy and transparency of product information, both of which play a decisive role in green consumption behavior (Van Amstel et al., 2008). Accordingly,

eco-label trust is recognized as a fundamental psychological mechanism influencing both price evaluations and purchase intention (Brécard et al., 2009).

Based on this theoretical foundation, the following hypotheses are proposed:

H₁: Higher trust in eco-labels increases consumers' perceptions of price fairness.

H₂: Higher trust in eco-labels increases consumers' purchase intention.

In the context of agri-food products, another important factor is consumers' motivation to support local producers and the local economy. Skallerud and Wien, demonstrated that preferences for local products are associated with helping behavior, meaning that consumers perceive supporting local producers as an ethical action (Skallerud & Wien, 2019). Similarly, Chiciudean et al. (2023) emphasized that the consumption of local products contributes to regional economic vitality and rural development. This literature indicates that perceptions of supporting local producers can significantly shape both price evaluations and purchasing behavior.

Based on this framework, the following hypotheses are proposed:

H₃: Greater perceived support for local producers and the local economy increases consumers' perceptions of price fairness.

H₄: Greater perceived support for local producers and the local economy increases consumers' purchase intention.

Perceived price fairness refers to consumers' judgments regarding whether a product's price is consistent with the value it provides (Xia et al., 2004). Marketing literature shows that when prices are perceived as unfair, purchase intention decreases significantly, whereas fair prices enhance brand preferences and positive behavioral outcomes (Bolton et al., 2003). Because sustainable and eco-labeled products typically carry higher prices, consumers' perceptions of price fairness become a critical determinant of purchase intention (Iyer et al., 2016; Konuk, 2018). This effect is especially pronounced in sustainable products, as consumers take perceived social and environmental benefits into account (Gleim et al., 2013).

Accordingly, the following hypothesis is proposed:

H₅: Higher perceived price fairness increases consumers' purchase intention.

Within this framework, the study model tests the relationships among four key constructs: (1) Eco-label trust, (2) Perceived support for local producers and the local economy, (3) Perceived price fairness, and (4) Purchase intention.

The model is grounded in robust theoretical foundations and offers an integrated perspective by examining how trust mechanisms and social value perceptions jointly influence consumer behavior in the context of sustainable agri-food products.

Materials and methods

This study adopts a quantitative and cross-sectional research design to examine consumer behavior toward eco-labeled agri-food products. Structural Equation Modeling (SEM) was employed, as it allows the simultaneous estimation of multiple latent constructs within a single model (Hair et al., 2019). The model includes four latent variables: Eco-Label Trust, Support for Local Producers and the Local Economy, Perceived Price Fairness, and Purchase Intention.

The target population consists of individuals aged 18 and above who regularly purchase packaged agri-food products (e.g., organic fruits and vegetables, dairy products, legumes, olive oil). Given that eco-labeled products are widely available across Türkiye and consumer characteristics vary by region, the accessible population was defined as consumers residing in Türkiye. A convenience sampling method commonly applied in consumer behavior studies on sustainable food consumption was utilized (Testa et al., 2015; Skallerud & Wien, 2019).

All measurement scales were adapted from established instruments in prior studies. The items measuring Support for Local Producers and the Local Economy were adapted from the helping behaviour/local food support constructs developed by Skallerud and Wien (2019), ensuring conceptual consistency while tailoring them to the eco-labeled agri-food context. Eco-Label Trust items were adapted from Thøgersen (2000) and Delmas and Grant (2014). Perceived Price Fairness was measured using items adapted from Xia et al. (2004) and Bolton et al. (2003). Purchase Intention items were adapted from Ajzen's (1991) Theory of Planned Behavior and Dodds et al. (1991). All items were assessed using a five-point Likert scale.

In accordance with recommended SEM sample size guidelines (at least ten respondents per estimated parameter) (Hair et al., 2019), a total of 410 valid responses were obtained. Data were collected through a self-administered online questionnaire distributed via Google Forms. Participants were informed about the purpose of the study, assured of anonymity, and reminded that participation was voluntary. To ensure the validity and reliability of the survey, a pilot study was conducted with a small sample of 30 people prior to the main data collection process. Based on feedback from the pilot study, minor linguistic adjustments were made to clarify the meaning of some items while maintaining the overall structure of the scales. Internal consistency (Cronbach's alpha) values were examined, and all variables were found to be within acceptable reliability thresholds. The survey used in the study was designed to explain the participants' demographic characteristics and the statements in the research model after the pilot study.

SmartPLS 4 statistical software package (SmartPLS GmbH, Oststeinbek, Germany) was used for data processing and statistical analysis. To estimate the relationships among the core constructs of the research model, the consistent Partial Least Squares Structural Equation Modeling (PLSc-SEM) approach was applied. The primary objective was to investigate the theoretical structural relationships within the proposed

model and assess the predictive capability of exogenous variables. For measurement model evaluation, Cronbach's alpha (α), composite reliability (CR), average variance extracted (AVE), outer loadings, the Fornell-Larcker criterion, and HTMT ratios were computed. For the structural model assessment, inner VIF values and effect sizes (f^2) were examined. Finally, hypotheses were tested using SEM.

Results

In this study, the demographic characteristics of the respondents who completed the survey were first identified. The results obtained in this context are presented in detail in Table 1.

Table 1. Demographics of the participants

Demographic Characteristics		n	%
Age	18-24	48	1.7
	25-34	66	16.1
	35-44	85	20.7
	45-54	68	16.6
	55-64	76	18.5
	65≤	67	16.4
Gender	Male	186	45.4
	Female	224	54.6
Education	Primary education	29	7.1
	High School	23	5.6
	Associate degree	103	25.1
	Bachelor's degree	169	41.2
	Master's degree/Ph.D.	86	21.0
Perception of income status	Very low	57	13.9
	Low	89	21.7
	Average	193	47.1
	High	46	11.2
	Very high	25	6.1

Source: Authors' calculation

An examination of the age distribution shows that the sample is relatively well balanced. The largest proportion of respondents (20.7%) falls within the 35-44 age group, followed by those aged 55-64 (18.5%) and individuals aged 65 and above (16.4%). This distribution indicates that attitudes toward eco-labeled agri-food products are not limited to younger consumers but are also widely shared among middle-aged and older adults. The age distribution of the participants was relatively balanced, with 48.5% of the respondents being under the age of 45 and 51.5% being aged 45 or older. With respect to gender, 54.6% of the participants are women. Prior research on sustainable consumption and healthy eating practices suggests that female consumers tend to exhibit higher levels of environmental sensitivity and ethical consumption behavior. Therefore, the gender composition of the sample is consistent with the general consumer profile documented in the literature.

Regarding education level, the majority of respondents have attained higher education. Specifically, 41.2% hold a bachelor's degree, and 21% have completed postgraduate studies. This finding aligns with previous studies indicating that awareness of eco-labels and sustainable food consumption is more prevalent among individuals with higher educational attainment. Additionally, the share of associate degree graduates (25.1%) demonstrates that individuals with tertiary education are strongly represented in the sample. In summary, the sample exhibits a suitable cognitive profile for evaluating environmental labels and sustainability-related product information.

In terms of perceived income status, the largest group of respondents (47.1%) rated their income status as "Average", followed by those who rated it as "Low" (21.7%). The relatively small proportions of respondents in the "Very low" and "Very high" perceived income status categories indicate that most participants placed themselves in the intermediate categories. The predominance of income average consumers also indicates that eco-labeled products are largely evaluated by individuals with moderate purchasing power. This distribution further supports the inclusion of price fairness as a critical variable in the model, as price sensitivity tends to be higher among income average consumers.

Overall, the demographic findings demonstrate that the sample provides an appropriate profile for analyzing attitudes toward sustainable agricultural products. Age and education levels are well represented, and the socio-demographic tendencies observed are consistent with those commonly reported in eco-label and sustainable consumption studies.

The measurement model was evaluated through construct validity procedures, including assessments of convergent and discriminant validity (Hair et al., 2014; Çavuşoğlu, 2021). As a first step, external loadings were examined to evaluate factor loadings, and all indicators were found to exceed the recommended threshold value of 0.50 (Kaiser, 1974).

Convergent validity was assessed using AVE and CR values (Kement et al., 2021). An AVE value of 0.50 or higher indicates adequate convergent validity (Fornell & Larcker, 1981), and all constructs should have a CR value above 0.60 to be considered reliable (Bagozzi & Yi, 1988). The reliability of the factor structures was further supported by Cronbach's alpha coefficients, which were used to assess internal consistency (Marmaya et al., 2019). In this study, all Cronbach's alpha values exceeded the 0.60 threshold, indicating satisfactory reliability (Kalaycı, 2005). Additionally, all CR values were greater than 0.60 and all AVE values met or surpassed the 0.50 criterion.

The results presented in Table 2 confirm that the model demonstrates a good fit. Overall, the measurement model was successfully validated based on both validity and reliability assessments.

Table 2. Reliability and validity

Items	Factor loading
<i>Eco-Label Trust (ELT)</i>	
$\alpha = 0.913$; $CR = 0.939$; $AVE = 0.794$	
I trust that eco-labeled agri-food products are produced using environmentally responsible methods.	0.914
Eco-labels indicate that an agricultural product is genuinely more sustainable.	0.919
I believe that eco-labeled products are more reliable than non-labeled alternatives.	0.908
I am confident that the production conditions of eco-labeled products are subject to stricter controls.	0.821
<i>Perceived Price Fairness (PF)</i>	
$\alpha = 0.853$; $CR = 0.901$; $AVE = 0.696$	
I find the higher prices of eco-labeled agri-food products justified.	0.824
I believe the price I pay for these products is fair.	0.895
Eco-labeled products are worth the price considering the benefits they offer.	0.836
Paying a slightly higher price for such products is acceptable to me.	0.778
<i>Support for Local Producers and Local Economy (SLPE)</i>	
$\alpha = 0.863$; $CR = 0.902$; $AVE = 0.648$	
I believe that purchasing eco-labeled agri-food products supports local producers.	0.850
I think choosing such products contributes positively to the local economy.	0.837
Buying eco-labeled local products provides an opportunity to support the livelihoods of rural producers.	0.856
I find purchasing eco-labeled products personally meaningful because it strengthens local producers.	0.744
Contributing to local farmers and rural communities is an important factor in my purchasing decisions.	0.730
<i>Purchase Intention (PI)</i>	
$\alpha = 0.815$; $CR = 0.879$; $AVE = 0.645$	
I intend to purchase eco-labeled agri-food products in the near future.	0.748
Whenever possible, I prefer to choose eco-labeled agricultural products.	0.865
My likelihood of purchasing these products regularly is high.	0.845
When choosing between similar products, I am more likely to select the eco-labeled option first.	0.749

Source: Authors' calculation

To assess the discriminant validity of the constructs, the Heterotrait-Monotrait Ratio (HTMT) and the Fornell-Larcker criterion values were analyzed. The HTMT results are presented in detail in Table 3. The analysis showed that all HTMT values were below the recommended threshold of 0.85 (Kline, 2011), confirming adequate discriminant validity among the constructs.

Table 3. HTMT

Variables	ELT	PF	SLPE
PF	0.812		
SLPE	0.630	0.753	
PI	0.737	0.761	0.775

Source: Authors' calculation

Second, to further establish discriminant validity, the Fornell-Larcker criterion was calculated. For this purpose, the square root of each construct's AVE value was computed and compared with the corresponding inter-construct correlations. The results obtained from this analysis are presented in detail in Table 4.

Table 4. Fornell Larcker Criterion

Variables	1	2	3	4
ELT	0.891			
PF	0.720	0.834		
SLPE	0.564	0.649	0.805	
PI	0.639	0.635	0.653	0.803

Source: Authors' calculation

The analysis revealed that the square root of each construct's AVE value was higher than its inter-construct correlations (Fornell & Larcker, 1981). Based on these findings, it was concluded that all constructs demonstrated adequate discriminant validity.

To structurally evaluate the research model, the Inner VIF values and effect size (f^2) results were examined. The Inner VIF values of the constructs used in the study were found to be below the threshold of 3 (Diamantopoulos & Siguaw, 2006). Accordingly, it was concluded that there is no multicollinearity issue among the constructs. The detailed results are presented in Table 5. Second, the effect size values were assessed within the structural model. Effect size coefficients between 0.02-0.15 are considered small, 0.15-0.35 moderate, and values above 0.35 large (Cohen, 1988). The results showed that eco-label trust had a large effect on perceived price fairness ($f^2 = 0.467$). Support for local producers had moderate effects on perceived price fairness ($f^2 = 0.218$) and purchase intention ($f^2 = 0.165$). By contrast, eco-label trust had a small effect on purchase intention ($f^2 = 0.095$), while perceived price fairness also had a small effect on purchase intention ($f^2 = 0.028$). The effect size estimates are provided in Table 5.

Following the completion of the measurement and structural model evaluations, the hypotheses were tested using structural equation modeling. The findings obtained from this analysis are presented in detail in Table 5.

Table 5. Structural properties (hypothesis testing)

Hypotheses		β	T Statistics	P Values	InnerVIF	f ²	Results
H ₁	ELT → PF	0.520	10.767	0.000	1.467	0.467	<i>Supported</i>
H ₂	ELT → PI	0.304	4.794	0.000	2.152	0.095	<i>Supported</i>
H ₃	SLPE → PF	0.355	7.249	0.000	1.467	0.218	<i>Supported</i>
H ₄	SLPE → PI	0.367	6.719	0.000	1.787	0.165	<i>Supported</i>
H ₅	PF → PI	0.178	2.455	0.014	2.532	0.028	<i>Supported</i>

Source: Authors' calculation

The structural model analysis conducted using SmartPLS showed that all proposed hypotheses were supported. Eco-label trust was found to have a positive effect on consumers' perceived price fairness as well as their purchase intention. The results indicate that as trust in eco-labels increases, consumers' perceptions of price fairness improve, and their purchase intentions strengthen. Accordingly, Hypotheses H₁ and H₂ were supported. Furthermore, perceptions of supporting local producers and the local economy were also found to positively influence both price fairness perceptions and purchase intention. The analysis revealed that higher levels of perceived support for local producers correspond with higher perceived price fairness and stronger purchase intention. Thus, Hypotheses H₃ and H₄ were also supported. Finally, perceived price fairness exerted a positive effect on purchase intention. This result demonstrates that as consumers perceive prices to be more fair, their intention to purchase eco-labeled agri-food products increases. Thus, Hypotheses H₅ were also supported.

Discussions

This study examined the psychological and perceptual factors shaping consumers' purchase intentions toward eco-labeled agri-food products and demonstrated that the majority of the theoretically proposed relationships were empirically supported. The structural model results indicate that almost all hypotheses align with findings from previous research in the literature.

First, Eco-Label Trust (ELT) was found to significantly enhance both Perceived Price Fairness (PF) and Purchase Intention (PI). This outcome is consistent with earlier studies showing that trust in eco-labels positively influences green consumption behavior (Thøgersen, 2000; Delmas & Grant, 2014; Testa et al., 2015). As highlighted in the literature, when consumers trust the accuracy and credibility of eco-labels and their certification processes, they perceive the environmental benefits of the product as more authentic, which in turn strengthens their intention to purchase.

The finding that Support for Local Producers and the Local Economy significantly affects both price fairness perceptions and purchase intention parallels studies emphasizing that local product consumption is driven by community-benefit and helping-behavior motivations (Skallerud & Wien, 2019; Chiciudean et al., 2023). Accordingly, the study reinforces the idea that social value orientations constitute an important determinant of sustainable product choices.

The third major relationship in the model is the positive effect of Perceived Price Fairness (PF) on Purchase Intention (PI). This result corresponds with marketing literature demonstrating the critical role of price fairness in shaping consumer behavior (Bolton et al., 2003; Xia et al., 2004). Prior research showing that the higher prices of sustainable and ethical products are accepted only when consumers perceive commensurate value and social benefit (Gleim et al., 2013; Iyer et al., 2016) further supports the findings of this study.

Overall, the study reveals that consumer behavior toward eco-labeled agri-food products is shaped by a multidimensional process involving trust, perceptions of supporting local producers/local economies, and price evaluations. The alignment of the hypotheses with prior empirical evidence reinforces the theoretical validity of the model. The results underscore the need to consider both individual and societal benefit perceptions in the marketing of sustainable agricultural products.

Conclusions

This study explained consumer behavior toward eco-labeled agri-food products through an integrated model that captures the interplay between trust, perceptions of social benefit, and price evaluations. The analyses revealed that both eco-label trust and perceived support for local producers shape consumers' perceptions of price fairness as well as their purchase intentions. Although perceived price fairness had a positive and statistically significant effect on purchase intention, its direct influence was weaker than those of eco-label trust and support for local producers. Thus, perceived price fairness should be regarded as a complementary rather than the dominant predictor of consumers' purchase intention toward eco-labeled agri-food products.

These findings demonstrate that consumer adoption of sustainable agri-food products is not driven solely by environmental concern; rather, it is shaped by the interaction of trust mechanisms, perceptions of societal contribution, and judgments of price fairness. The study highlights the need for a multidimensional approach that considers both individual and collective values in the marketing of eco-labeled agricultural products, offering meaningful theoretical and practical contributions to the sustainable consumption literature.

This study offers three significant contributions to the theoretical literature explaining consumer behavior toward eco-labeled agri-food products. First, it highlights the multidimensional role of eco-label trust in shaping consumer evaluations. The findings show that trust in eco-labels functions not only as a cognitive cue signaling product quality but also as a fundamental psychological mechanism that shapes consumers' price assessments and purchase decisions. This expands trust-based decision-making processes within the eco-label context and adds a meaningful contribution to the existing literature (Thøgersen, 2000; Delmas & Grant, 2014).

Second, incorporating perceived support for local producers and the local economy into the model introduces a socially oriented perspective to consumer behavior research.

The results demonstrate that sustainable product consumption is driven not only by environmental motivations but also by a desire to contribute to societal well-being. This finding extends studies that explain support for local producers (Skallerud & Wien, 2019) and deepens the social value dimension that has been relatively underexplored in the literature.

Third, the study reaffirms the mediating and explanatory role of perceived price fairness in consumer decision-making. Since sustainable agri-food products often carry higher prices, perceiving these prices as fair is essential for maintaining purchase intention. By showing that price fairness is not merely an economic evaluation but a holistic process intertwined with trust, social benefit perceptions, and sustainability considerations, this study enriches the marketing literature in a substantial way (Bolton et al., 2003; Xia et al., 2004).

The findings of this study offer actionable implications for all stakeholders within the agricultural food value chain, from producers to policymakers. For producers and retailers, the results demonstrate that enhancing the credibility of eco-labels directly strengthens purchase behavior. Therefore, ensuring transparency in certification processes, making production practices more visible, and clearly communicating trust-related messages on product packaging are of critical importance. Additionally, the strong consumer motivation to support local producers indicates that claims such as “supports local farmers” or “contributes to the regional economy” should be emphasized more prominently on labels. This approach reinforces perceptions of price fairness and increases purchase intention.

For local producer organizations and cooperatives, the findings highlight the positive influence of community-supported agriculture (CSA), short supply chains, and local markets on consumer behavior. Effectively communicating that products contribute not only to environmental sustainability but also to rural development can enhance the competitiveness of local producers.

From a policy perspective, the study underscores the importance of integrating sustainable agricultural product policies with rural development strategies. Supporting eco-label programs through incentives for local producers and increasing the visibility of these initiatives through consumer awareness campaigns will strengthen the cycle of sustainable agricultural production and consumption. Moreover, designing agricultural support mechanisms that align with consumer behavior can foster both the growth of local economies and the expansion of the sustainable products market.

While this study provides important insights into consumer behavior toward eco-labeled agri-food products, several limitations should be acknowledged. First, data were collected through an online survey using a convenience sampling method. This may limit the extent to which the sample represents the broader population of Türkiye. Future studies are encouraged to employ stratified sampling across different regions or design comparative analyses between rural and urban consumers. Second, all data were obtained through self-reported measures. Given that consumers may exhibit a tendency

to provide socially desirable responses regarding sustainable products, future research would benefit from incorporating behavioral data-such as actual purchase history, eye-tracking measures, or willingness-to-pay experiments-to triangulate and validate the findings. Third, the study utilizes a cross-sectional design, which does not allow the assessment of causal relationships over time. Longitudinal research designs could provide stronger evidence regarding the temporal and causal dynamics between the constructs. Lastly, the research model focuses on four primary variables. Incorporating additional variables-such as environmental concern, ethical consumption values, green knowledge, sensory quality perceptions, or price sensitivity-may strengthen the theoretical comprehensiveness of the model. Moreover, comparative international studies examining how support for local producers varies across cultural contexts would offer valuable contributions to the literature.

Conflict of interests

The author declare no conflict of interest.

References

1. Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, 50(2), 179-211. [https://doi.org/10.1016/0749-5978\(91\)90020-T](https://doi.org/10.1016/0749-5978(91)90020-T)
2. Bagozzi, R. P. & Yi, Y. (1988). On the evaluation of structural equation models. *Journal of the Academy of Marketing Science*, 16(1), 74-94. <https://doi.org/10.1007/BF02723327>
3. Bolton, L. E., Warlop, L., & Alba, J. W. (2003). Consumer perceptions of price (un) fairness. *Journal of Consumer Research*, 29(4), 474-491. <https://doi.org/10.1086/346244>
4. Brécard, D., Hlaimi, B., Lucas, S., Perraudeau, Y., & Salladarré, F. (2009). Determinants of demand for green products: An application to eco-label demand for fish in Europe. *Ecological Economics*, 69(1), 115-125. <https://doi.org/10.1016/j.ecolecon.2009.07.017>
5. Çavuşoğlu, S. (2021). Yeşil Reklam ve Yeşil Marka Farkındalığının Yeşil Müşteri Tatmini Üzerindeki Etkisi: Yeşil Satın Alma Davranışının Aracılık Rolü [The Effect of Green Advertising and Green Brand Awareness on Green Customer Satisfaction: The Mediating Role of Green Purchasing Behavior]. *Gaziantep University Journal of Social Sciences*, 20(3), 1355-1374. <https://doi.org/10.21547/jss.893209>
6. Chiciudean, D. I., Harun, R., Chița, A., David, L., & Pleșa, A. M. (2023). Consumer perception on the local gastronomical points and their importance for rural development. *Scientific Papers Series Management, Economic Engineering in Agriculture & Rural Development*, 23(4), 185-194.
7. Cohen, J. (1988). *Statistical Power Analysis for the Behavioral Sciences*. 2nd ed., Lawrence Erlbaum Associates.

8. Delmas, M. A., & Grant, L. E. (2014). Eco-labeling strategies and price-premium: the wine industry puzzle. *Business & Society*, 53(1), 6-44. <https://doi.org/10.1177/0007650310362254>
9. Diamantopoulos, A., & Siguaw, J. A. (2006). Formative versus reflective indicators in organizational measure development: A comparison and empirical illustration. *British Journal of Management*, 17(4), 263-282. <https://doi.org/10.1111/j.1467-8551.2006.00500.x>
10. Dodds, W. B., Monroe, K. B., & Grewal, D. (1991). Effects of price, brand, and store information on buyers' product evaluations. *Journal of Marketing Research*, 28(3), 307-319. <https://doi.org/10.1177/002224379102800305>
11. Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research*, 18(1), 39-50. <https://doi.org/10.1177/002224378101800104>
12. Gleim, M. R., Smith, J. S., Andrews, D., & Cronin Jr, J. J. (2013). Against the green: A multi-method examination of the barriers to green consumption. *Journal of Retailing*, 89(1), 44-61. <https://doi.org/10.1016/j.jretai.2012.10.001>
13. Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2019). *Multivariate Data Analysis* (8th ed.). Cengage Learning.
14. Hair, J. F., Hult, G. T. M., Ringle, C. M., & Sarstedt, M. (2014). *A primer on partial least squares structural equation modeling (PLS-SEM)*. Thousand Oaks, CA: Sage.
15. Iyer, P., Davari, A., & Paswan, A. (2016). Green products: altruism, economics, price fairness and purchase intention. *Social Business*, 6(1), 39-64. <https://doi.org/10.1362/204440816X14636485174912>
16. Kaiser, H. F. (1974). An index of factorial simplicity. *Psychometrika*, 39(1), 31-36. <https://doi.org/10.1007/BF02291575>
17. Kalaycı, Ş. (2005). *SPSS uygulamalı çok değişkenli istatistik teknikleri [SPSS applied multivariate statistical techniques]*. İstanbul: Asil Yayın Dağıtım.
18. Kement, Ü., Karaküçük, S., & Çavuşoğlu, S. (2021). Ekorekreatif tutum ölçeği geliştirilmesi: Geçerlik ve güvenilirlik çalışması [Ecorecreative attitude scale development: Validity and reliability study]. *Tourism and Recreation*, 3(1), 34-54.
19. Kline, R. B. (2011). *Principles and practice of structural equation modeling*. New York, NY: Guilford.
20. Konuk, F. A. (2018). Price fairness, satisfaction, and trust as antecedents of purchase intentions towards organic food. *Journal of Consumer Behaviour*, 17(2), 141-148. <https://doi.org/10.1002/cb.1697>
21. Marmaya, N. H., Zakaria, Z., & Mohd Desa, M. N. (2019). Gen Y consumers' intention to purchase halal food in Malaysia: A PLS-SEM approach. *Journal of Islamic Marketing*, 10(3), 1003-1014. <https://doi.org/10.1108/JIMA-08-2018-0136>

22. Nguyen, D. K., Kim, O. D. T., Thanh, N. L. T., Tan, Q. T., HD, M. N., & Quang, D. T. (2025). Exploring The Impact of Consumers' trust In Food Authenticity on Their Purchase Intentions: A Case of 'Sen Hue'-A Local Lotus-Grain Product in Central Vietnam. *Economic of Agriculture*, 72(3), 813-829. <https://doi.org/10.59267/ekoPolj2503813D>
23. Skallerud, K., & Wien, A. H. (2019). Preference for local food as a matter of helping behaviour: Insights from Norway. *Journal of Rural Studies*, 67, 79-88. <https://doi.org/10.1016/j.jrurstud.2019.02.020>
24. Testa, F., Iraldo, F., Vaccari, A., & Ferrari, E. (2015). Why eco-labels can be effective marketing tools: Evidence from a study on Italian consumers. *Business Strategy and the Environment*, 24(4), 252-265. <https://doi.org/10.1002/bse.1821>
25. Thøgersen, J. (2000). Psychological determinants of paying attention to eco-labels in purchase decisions: Model development and multinational validation. *Journal of Consumer Policy*, 23(3), 285-313. <https://doi.org/10.1023/A:1007122319675>
26. VanAmstel, M., Driessen, P., & Glasbergen, P. (2008). Eco-labeling and information asymmetry: a comparison of five eco-labels in the Netherlands. *Journal of Cleaner Production*, 16(3), 263-276. <https://doi.org/10.1016/j.jclepro.2006.07.039>
27. Xia, L., Monroe, K. B., & Cox, J. L. (2004). The price is unfair! A conceptual framework of price fairness perceptions. *Journal of Marketing*, 68(4), 1-15. <https://doi.org/10.1509/jmkg.68.4.1.42733>

SOCIO-ECONOMIC DETERMINANTS AND BARRIERS TO ORGANIC PRODUCT CONSUMPTION IN BOSNIA AND HERZEGOVINA

Stoja Jotanović¹, Đorđe Savić², Tamara Stojanović³, Bernisa Klepo⁴, Predrag Ilić⁵

*Corresponding author E-mail: tamara.stojanovic@agro.unibl.org

ARTICLE INFO

Original Article

Received: 05 March 2026

Accepted: 15 July 2026

doi:10.59267/ekoPolj2603749J

UDC 330.567.22:[339.13.025.4
:631.147(497.6)]

Key words:

*Organic food, consumer
behavior, trust paradox, market
barriers, information asymmetry*

JEL: Q13, D12, D82

ABSTRACT

The aim of the paper was to examine the impact of socio-economic characteristics on organic product consumer behavior in Bosnia and Herzegovina. The research was conducted via a structured online survey on a sample of 336 respondents. Results indicated a specific trust paradox, where high consumption was not accompanied by knowledge of the certification system but relied on the subjective perception of domestic origin. Women were identified as primary decision-makers, while income level directly determined purchase frequency. Dominant market barriers were high price and unavailability, confirming the high price elasticity of demand. It is concluded that the observed market is in an early development stage and burdened by information asymmetry, where organic food retains the character of a premium good. For further sector development, strengthening the recognition of the national organic label through consumer education and developing short supply chains to reduce transaction costs is recommended.

-
- 1 Stoja Jotanović, Ph.D., Full Professor, University in Banja Luka, Faculty of Agriculture, Bulevar vojvode Petra Bojovića 1A, Banja Luka, Republic of Srpska, Bosnia and Herzegovina, Phone: +387 51 330 952, E-mail: stoja.jotanovic@agro.unibl.org, ORCID ID (<https://orcid.org/0000-0003-3821-7259>)
 - 2 Đorđe Savić, Ph.D., Full Professor, University in Banja Luka, Faculty of Agriculture, Bulevar vojvode Petra Bojovića 1A, Banja Luka, Republic of Srpska, Bosnia and Herzegovina, Phone: +387 51 330 949, E-mail: djordje.savic@agro.unibl.org, ORCID ID (<https://orcid.org/0000-0002-0590-4151>)
 - 3 Tamara Stojanović, Ph.D., Associate Professor, University in Banja Luka, Faculty of Agriculture, Bulevar vojvode Petra Bojovića 1A, Banja Luka, Republic of Srpska, Bosnia and Herzegovina, Phone: +387 51 330 944, E-mail: tamara.stojanovic@agro.unibl.org, ORCID ID (<https://orcid.org/0009-0001-1479-9496>)
 - 4 Bernisa Klepo, MSc., Organska kontrola "OK", Kranjčevićeva 4, Sarajevo, Bosnia and Herzegovina, Phone: +387 33 656 501, E-mail: bernisa@organskakontrola.ba, ORCID ID (<https://orcid.org/0009-0001-1439-0906>)
 - 5 Predrag Ilić, MSc., Association for Horse-assisted Therapy "Let's Ride Together", Ustanička 2 part 32B, Belgrade, Serbia, Phone: +381 63 662 176, E-mail: 1961predragilic@gmail.com, ORCID ID (<https://orcid.org/0009-0006-8903-3811>)

Introduction

Driven by growing consumer awareness regarding health and sustainability, the global organic food market has transformed from a niche into a significant industry segment. Consumers increasingly seek ‘more natural’ alternatives to regain control over their dietary choices (Dragolea et al., 2023). While health concerns (‘egoistic motives’) remain the primary driver, particularly for older demographics (Vietoris et al., 2016), younger generations increasingly base their purchasing decisions on environmental and ethical considerations (Dragolea et al., 2023).

In the Western Balkans, the development of the organic sector faces specific challenges. Although consumers generally perceive organic food positively, actual consumption is constrained by undeveloped market institutions and weak purchasing power (Cerjak et al., 2010; Đokić & Milićević, 2022). Research indicates that high prices and limited availability remain the dominant barriers across the region (Vehapi & Dolićanin, 2016; Čagalj et al., 2020). Specifically, in Bosnia and Herzegovina (B&H), despite significant natural potential and a long tradition of extensive agriculture (Pržulj & Tunguz, 2016; Tomić et al., 2016), the sector remains marginal. According to recent data, cultivated organic land occupies only 0.1% of total agricultural area (2,495 hectares), while the sector is heavily reliant on the export of wild-collected berries and herbs (Willer et al., 2026).

This market environment fosters a specific ‘trust paradox.’ Organic food is a ‘credence good’ that requires institutional verification, yet consumers in transitional economies often lack familiarity with official labels and rely on alternative signals like ‘domestic’ origin or direct contact with producers (Nagy et al., 2022; Miftari et al., 2022). In B&H, this terminology conflation leads consumers to perceive uncertified, traditionally produced food as equivalent to certified organic products (Petrescu et al., 2017).

Despite its potential, the lack of empirical data on consumer profiles in B&H hinders the creation of effective agricultural policies. Therefore, the aim of this paper is to examine the impact of socio-economic characteristics on the perception, attitudes, and behavior of organic food consumers in B&H. The study seeks to identify key purchasing motives and analyze the economic and institutional barriers that limit the expansion of this market segment.

Materials and methods

The research presented in this paper was based on primary data collected during 2025 in the territory of Bosnia and Herzegovina. Considering the nature of the research problem, which requires an analysis of consumers’ attitudes, perceptions, and latent motives, a quantitative approach was applied using a structured survey questionnaire method. The research instrument (questionnaire) was created based on a review of relevant literature and previous related research in the region (Vehapi & Dolićanin, 2016; Kranjac et al., 2017) to ensure the comparability of the results.

The questionnaire was conceptualized into three logical units. The first part included a set of closed-ended questions intended to determine the socio-demographic profile of the respondents, including the following variables: gender, age, level of education, employment status, level of monthly household income, household size, and settlement type (village, suburban settlement, city). The second part of the questionnaire focused on consumer habits, including purchase frequency, preferred distribution channels, and the types of products the respondents most frequently buy. The third, most complex part of the questionnaire, was designed to measure attitudes, perception of barriers, and the level of information. A five-point Likert scale (from 1 – completely disagree/dissatisfied, to 5 – completely agree/very satisfied) was used to measure the strength of attitudes about the importance of nutrition, trust in organic products, and satisfaction with quality.

The distribution of the questionnaire was carried out digitally (online survey), using social media platforms and specialized groups dedicated to healthy nutrition and agriculture. This approach was chosen due to the possibility of rapid data collection and access to a specific target group of consumers who are digitally literate and informed. Although the convenience sample (N=336) carries certain limitations regarding the representativeness of the general population (the sample is slightly biased towards the urban and more educated population), it is adequate for researching the organic food market, given that previous empirical research (Vapa-Tankosić, 2018; Đokić & Milićević, 2016; Vehapi & Dolićanin, 2016) confirmed that precisely this demographic group represents the basis of real demand for premium food products.

After logical control and cleaning, the collected data were entered into a database and processed using the statistical package SPSS (version 22). In addition to standard descriptive statistics (frequencies, arithmetic means, standard deviations), methods of inferential statistics were used to test the set hypotheses. To analyze the impact of socio-demographic factors (as independent variables) on consumer attitudes and behavior (dependent variables), a one-way analysis of variance (ANOVA) was applied. To accurately determine between which groups statistically significant differences exist, the Tukey HSD (Honestly Significant Difference) post-hoc test was subsequently used. Given the unequal number of respondents in the groups (e.g., a significantly higher number of respondents with high incomes compared to those without income), the harmonic mean of the sample size (N=40.102) was used in the post-hoc analysis to ensure the robustness of the results and the validity of the statistical conclusions. The dependence between categorical variables, specifically between the habit of consumption and the level of information about certification, was tested using Pearson's Chi-square (χ^2) test of independence, along with the calculation of Cramer's V coefficient to assess the strength of the association.

Results and discussions

Socio-economic profile of the sample as a determinant of demand

The analysis of the socio-demographic structure of the sample (Table 1) provided insight into the profile of a typical organic food consumer in Bosnia and Herzegovina and indicated specific market segments. Women dominated the sample (65.2%), which was fully consistent with the findings of Kranjac et al. (2017), who identified women as the primary “gatekeepers” regarding food choices and family health care. The age structure showed that the most represented population categories were between 35 and 54 years of age (cumulatively 58.6%), which represented the economically most active part of the population. These respondents were in the life stage of family formation and childcare, which, according to recent empirical evidence (Woś et al., 2022), represents one of the strongest motivational factors for switching to an organic diet. Parents increasingly seek organic options to minimize their children’s exposure to synthetic contaminants and provide higher nutritional value during critical developmental stages.

Table 1. Socio-economic characteristics of the respondents (N = 336)

Variable	Category	Number (n)	Share (%)
Gender	Male	117	34.8
	Female	219	65.2
Age	up to 24 years	31	9.2
	25 – 34	63	18.8
	35 – 44	111	33
	45 – 54	86	25.6
	55 and over	45	13.4
Education	Primary	8	2.4
	Secondary	85	25.3
	Higher (College)	36	10.7
	University degree	146	43.5
	Academic (Master’s/Doctorate)	61	18.2
Place of residence	Village	61	18.2
	Suburban settlement	63	18.8
	City	212	63.1

Variable	Category	Number (n)	Share (%)
Monthly income (BAM)	No income	32	9.5
	up to 500	19	5.7
	500 – 1000	41	12.2
	1000 – 1500	126	37.5
	over 1500	118	35.1
Number of household members	1 – 2 members	70	20.8
	3 – 4 members	199	59.2
	5 and more members	67	19.9

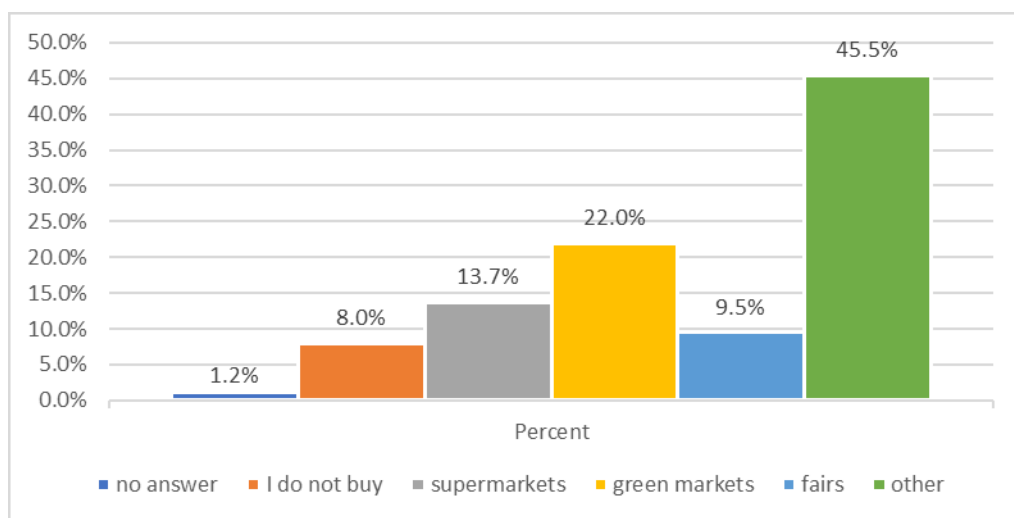
Source: Authors' calculation based on the conducted research.

It was particularly important to highlight the educational structure of the sample, where respondents with a university and academic education accounted for a majority of 61.7%. This data corresponded with the research by Galić (2022) for the territory of the Republic of Srpska, confirming that a higher level of education correlated with greater interest in food quality and the ecological aspects of production. The spatial distribution of the respondents showed a pronounced concentration in urban areas (63.1%), while the economic analysis revealed that the majority of respondents (72.6%) belonged to households with monthly incomes above 1000 BAM.

Although this structure deviated from the average of the general population in B&H, it faithfully represented the target market for organic products, which, due to higher production costs, also carried a higher market price. Previous empirical research in the region (Vapa-Tankosić, 2018; Vehapi & Dolićanin, 2016; Đokić & Milićević, 2016) emphasized that precisely this demographic group—an urban, educated population with stable incomes—represented the real demand base for organic products. Therefore, the results of this research should be interpreted primarily through the prism of the behavior of the financially capable part of the population, whose preferences were crucial for the formation of market strategies.

Consumer habits and the phenomenon of the “informal market”

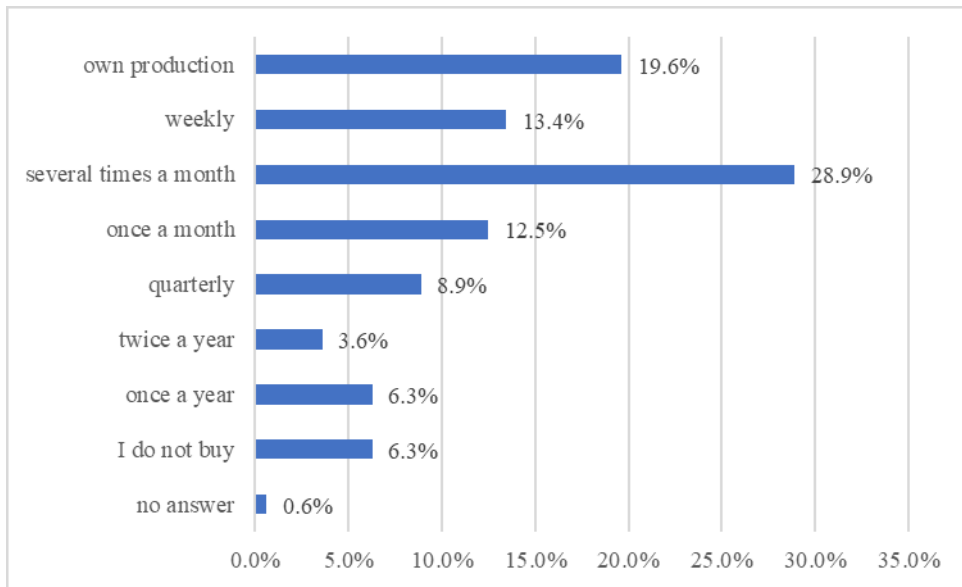
The analysis of consumer habits revealed a high presence of organic products in the respondents' diet. The results showed that 89.6% of the research participants declared themselves as consumers of organic food. However, a deeper analysis of distribution channels (Graph 1) indicated a specificity of the domestic market that differentiated it from developed Western economies. While specialized stores and supermarkets dominated in EU countries, in Bosnia and Herzegovina, these channels accounted for only 14% of the total procurement. In contrast, the dominant channel was the “other” category with 46%, followed by green markets with 22%.

Figure 1. Place of purchase of organic products (in %)

Source: Authors' calculation based on the conducted research.

The analysis of distribution channels (Figure 1) further illustrates the functioning of the trust paradox in practice. As Wu et al. (2021) point out in their critical review, consumer trust in food systems can be built directly (through interpersonal relationships and direct contact with producers) or indirectly (through institutional labels, certification bodies, and retail packaging). The overwhelming dominance of informal channels in this study, with 46% of respondents using 'other' channels (primarily direct farm purchases) and 22% using green markets, indicates that consumers in B&H predominantly rely on direct, face-to-face trust, which was in contrast to the findings of Vehapi and Dolićanin (2016), who observed the growing importance of supermarkets as the primary distribution channel in the Serbian market. The formal retail system (supermarkets), which requires indirect trust in the institutional label, accounts for only 14% of purchases, confirming that the local organic market is still heavily reliant on traditional, uncertified supply chains.

The purchase frequency (Figure 2) confirmed that these products were not just an occasional luxury, but a regular part of the consumer basket for a significant part of the sample, given that 42% of respondents procured them on a weekly or monthly basis. These findings indicated the existence of a strong informal market and short supply chains based on personal trust, rather than on commercial mechanisms. Consumers, although urban and highly educated, still preferred authenticity and direct contact with the producer over impersonal purchasing in a supermarket, which represented significant potential for the development of direct sales and agrotourism models.

Figure 2. Purchase frequency of organic products (in %)

Source: Authors' calculation based on the conducted research.

Consumption patterns and the “trust paradox”

One of the most significant findings of this research related to the discrepancy between declarative consumption and actual knowledge about the control system, which we defined as the “trust paradox”. Although almost 90% of respondents stated that they consumed organic products, data on information levels were devastating: only 23.2% of respondents knew to name certification bodies in B&H, while 36.9% admitted that they were not informed at all. The exceptionally high rate of declared consumption (89.6%) must be interpreted with caution. Firstly, it reflects the methodological bias of the online sample, which naturally attracts a more informed, digitally literate, and socio-economically stable segment of the population that is already interested in healthy lifestyles. Secondly, this high percentage is a direct manifestation of the terminology conflation typical for transition economies. Consumers in the region frequently conflate the concepts of ‘organic’, ‘domestic’, and ‘home-produced’ food, perceiving uncertified food bought directly from farmers as equally or more authentic than officially certified products in supermarkets (Miftari et al., 2022). Therefore, the reported consumption rate reflects the consumers’ subjective perception of eating ‘healthy and domestic’ rather than the actual purchase of institutionally certified organic products.

Table 2. Information about certification bodies in relation to product consumption

Consumption	Not informed (%)	Know they exist (without name) (%)	Know cert. bodies in B&H (%)	Total (%)
Yes	35.9	39.9	23.9	100
No	45.7	37.1	17.1	100
Total (sample)	36.9	39.6	23.2	100

Source: Authors' calculation based on the conducted research.

To statistically test the relationship between these two variables, the Pearson Chi-square (χ^2) test was applied. The test results ($\chi^2=1.617$; $p=0.656$) showed that there was no statistically significant relationship between consumption and knowledge of certification bodies. The value of Cramer's V coefficient ($V=0.069$) additionally confirmed an extremely weak, practically non-existent connection. As could be seen from Table 2, even among regular consumers of organic food (group 'Yes'), more than one-third (35.9%) admitted that they were not informed at all about the institutions that guarantee certification, which served as a basis for further statistical testing.

This statistical finding had a strong qualitative implication: the decision to purchase organic food in B&H was not rationally based on the recognition of an official mark or certificate. Instead, consumers equated the terms "organic" and "domestic". Trust was placed in the producer, not the institution. This was in line with findings from other developing markets, where informal quality guarantees often replaced institutional ones. Thus, Petrescu et al. (2017) pointed out that consumers, due to mistrust in the control system, preferred to choose uncertified food directly from farmers, while Nagy, Lakner, and Temesi (2022) emphasized that in the absence of institutional trust, consumers often rely on local origin and direct contact, equating organic with 'domestic', whereby the producer themselves becomes the main guarantor of the product's credibility.

Also, high satisfaction with quality ($M=3.99$) suggested that consumers perceived organic food as safer for health, which was in line with the research by Jotanović (2022) on the quality of food of animal origin, as well as the study by Madureira et al. (2022) which emphasized the perception of food safety as a key purchasing motive.

The impact of socio-economic factors on consumer behavior (ANOVA results)

In addition to the analysis of behavioral patterns, the research examined the impact of socio-economic variables on attitudes and actual consumption (Table 3). By applying a one-way analysis of variance (ANOVA), it was determined that the economic power of the respondents, measured by the level of monthly income, did not have a statistically significant impact on the satisfaction with the quality of organic products itself ($F = 0.948$; $p = 0.436$). Average satisfaction scores were consistently high across all income groups. Similarly, the analysis showed that the level of education also did not make a statistically significant difference in the perception of quality ($p = 0.456$). This meant that consumers of all economic categories, regardless of the intellectual or economic

status of the respondents, when they came into possession of an organic product, equally valued its quality and universally perceived it as superior.

Table 3. Summary of ANOVA test results: The impact of socio-economic factors on consumer attitudes and behavior

Independent variable	Dependent variable (Attitudes / Behavior)	F-value	p-value (Sig.)	Significance
Monthly income	Perception of differences (organic vs. conventional)	3.725	.006	Yes*
	Purchase frequency	2.831	.025	Yes*
	Importance of organic diet	.436	.783	No
	Personal opinion on organic products	1.138	.338	No
	Satisfaction with quality	.948	.436	No
Education level	Satisfaction with quality	.915	.456	No
	Purchase frequency	.636	.637	No

* Statistically significant at the $p < 0.05$ level

Source: Authors' calculation based on the conducted research.

However, when it came to purchase frequency, economic power became a crucial factor. The ANOVA test showed a statistically significant difference ($F=2.831$; $p=0.025$). The subsequent Tukey HSD test specified that the key difference occurred between the group with no income and the group with the highest incomes (over 1500 BAM), with a mean difference of -1.197 ($p=0.029$). This unequivocally confirmed that organic food in B&H was a price-elastic good – the desire to purchase was universal, but the realization of the purchase was strictly limited by the budget.

These findings were fully complementary to the results obtained by Vehapi and Dolićanin (2016), who also determined the existence of a statistically significant relationship ($p=0.034$) between the level of monthly net household income and the frequency of purchasing organic food in the Serbian market. Tomić et al. (2021) also confirmed this pattern, pointing out that population income had a strong impact on purchasing, and that households with high income decided on this type of consumption significantly more often.

Another important finding of the ANOVA test related to the perception of differences between conventional and organic products ($F=3.725$; $p=0.006$). The Tukey test showed that respondents with incomes over 1500 BAM statistically significantly better noticed these differences compared to the middle class (1000-1500 BAM) ($p=0.003$). This suggested that a higher economic status did not only bring greater purchasing power, but often went hand in hand with better information and a more sophisticated taste, enabling those consumers to more clearly differentiate the attributes of an organic product.

This thesis was also strengthened by the findings from the doctoral dissertation of Vapa-Tankosić (2018), which determined that the household monthly income variable made a significant unique contribution to predicting consumers' willingness to pay a higher price (premium) for organic products. Consumers who were more informed and who highly evaluated the nutritional properties of food were more willing to allocate additional funds. Also, Vehapi and Dolićanin (2016) concluded that precisely consumers with higher incomes and higher education represented the key segment showing recognition of benefits and willingness for more regular purchasing.

Gender dimension of diet perception

The analysis of differences in attitudes according to gender (T-test approximation through descriptive analysis) further illuminated the consumer profile. Although both genders highly rated the importance of diet for health, women expressed a statistically higher average score ($M=4.14$) compared to men ($M=3.87$). The difference of 0.27 points, with a stable standard deviation in both groups ($SD \approx 1.0$), indicated that women were generally more aware of the connection between diet and health.

The obtained results were fully complementary to the findings of Petrescu et al. (2017), who determined a statistically significant difference between genders in the Romanian market, confirming that women were significantly more dedicated to a healthier lifestyle and showed a higher degree of trust in the attributes of organic products compared to men. Similarly, the empirical research by Vapa-Tankosić (2018) pointed out that female respondents evaluated the nutritional properties of organic food with significantly higher scores and showed a greater willingness to allocate additional funds for it. Tomić et al. (2021) also recognized that predominantly women (especially those aged between 30 and 45, who had children) gave a distinct preference to organic food, viewing its purchase as a necessity.

The economic implication of these results was clear: although there was a universal desire for a healthier diet, actual demand remained price-elastic and strongly limited by income constraints, which continued to position the organic product on the domestic market as a premium good. This confirmed the thesis that marketing campaigns for organic products should primarily target the female population, using arguments related to health and family well-being. This recommendation was directly reinforced by Petrescu et al. (2017), who concluded that in promotional campaigns, the female segment required significantly less persuasion effort, given their greater initial belief in the health benefits of organic products.

Economic and institutional barriers to market development

The analysis of barriers using the multiple-response method ($N=310$) revealed a clear hierarchy of obstacles that limited the expansion of the organic food market; in the first place was the high price, followed by a lack of availability and weak supply.

Table 4. Key barriers to greater consumption of organic products

Barrier	Frequency (N)	Percentage of respondents (%)
High price	194	62.6
Lack of availability	188	60.6
Lack of information	173	55.8
Weak supply	162	52.3
Lack of trust	137	44.2
Other	18	5.8

Source: Authors' calculation based on the conducted research (N=310). Note: The sum of percentages is greater than 100% because respondents had the option of multiple choices.

The dominant barrier was the high price, which was cited as a key limiting factor by 62.6% of respondents. This data unequivocally showed that, despite the expressed demand, consumption in the domestic market remained highly price-elastic for the majority of the population. These findings fully corresponded with the research conducted by Ak and Teker (2019), emphasizing that economic factors remained the primary constraint in other developing markets as well. Thus, Đokić and Milićević (2016) identified precisely the “price premium” as the primary obstacle to converting preferred into actual consumption, which was confirmed by Tomić et al. (2021) who pointed out that the high price (51% of respondents) and weak purchasing power of the population (22%) were the main reasons for not purchasing organic products in the Serbian market.

In addition to the price factor, the results indicated critical physical market limitations: a lack of availability was highlighted by 60.6% of respondents, while a weak supply was cited by 52.3% of respondents. These data suggested that the high transaction costs of finding organic products additionally demotivated the average urban consumer, which is why these products remained marginalized compared to the conventional supply. Vehapi and Dolićanin (2016) pointed out similar problems of insufficient physical availability in developing markets, stating that inconsistent supply, lack of product assortment breadth, and poorly developed distribution channels represented significant obstacles to the growth of this sector.

The second key group of barriers related to institutional shortcomings. It was particularly indicative that 44.2% of respondents highlighted a lack of trust in the labeling system as a key obstacle, while 55.8% cited a lack of information. This finding directly corresponded to the previously identified problem of not knowing certification bodies and confirmed that the obstacle to market development was not exclusively in low purchasing power, but in a systemic lack of credibility. This thesis was also confirmed by Vapa-Tankosić (2018), whose empirical research emphasized that insufficient consumer information and lack of trust in product authenticity, due to doubts in control and certification systems, represented key barriers to demand expansion in transition markets.

These data sent a strong message to the supply chain. In conditions of pronounced information asymmetry, educational and marketing campaigns could do more for market growth than merely mechanically lowering prices. Consumers, especially those in urban centers who do not have direct contact with the village, simply could not easily find organic products in their regular places of purchase, and even when they found them, they were not sure of their origin due to not recognizing official certificates.

Comparative analysis of regional market trends

The comparison of the obtained results with related research in the Western Balkans region indicated clear specificities of consumer behavior in Bosnia and Herzegovina. Observing the market of neighboring Croatia, on the example of the Split region, Čagalj et al. (2020) identified that the high price was the main obstacle to greater organic food consumption, which fully corresponded with the findings of this research where the price barrier was also dominant. However, a notable difference was observed in the primary motivation; while Čagalj et al. (2020) found that consumers in Split highlighted environmental protection as the most significant purchasing motive, our results showed that consumers in B&H were primarily driven by personal health aspects and the nutritional value of food.

Significant deviations were observed when comparing with the Serbian market, especially in the segment of distribution channels. Analyzing consumer behavior in the Republic of Serbia, Vehapi and Dolićanin (2016) pointed out a clear trend of growing importance of conventional retailers, whereby supermarkets became the main place where consumers bought organic food. In contrast, our research confirmed the absolute dominance of informal and direct procurement channels in B&H (green markets and direct purchase from producers). Nevertheless, a common characteristic of both markets was information asymmetry, given that Vehapi and Dolićanin (2016) confirmed that a significant number of consumers did not recognize the national label for an organic product and did not know the certification process.

Similar challenges of transition economies were analyzed by Miftari et al. (2022) on the example of Kosovo, where they proved that the level of awareness about organic products was growing, but that the lack of an adequate institutional framework slowed down the development of the sector. Their research indicated that health care and recognition of the certification system significantly shaped consumer attitudes and intentions. In direct contrast to these findings, the results of our research proved that in the B&H market, institutional certification still did not have a decisive impact on consumption itself.

This phenomenon was further explained by findings from the Romanian market, where Petrescu et al. (2017) highlighted the phenomenon of the “trust paradox” – consumers, due to doubt in the official control system, preferred to choose uncertified food directly from farmers, considering it “more organic” than the one in supermarkets. While in more mature markets trust was gradually transferred to institutions, consumers in B&H, similarly to Romania, continued to build trust on traditional relationships, acquaintance with the producer, and the perceived “domestic” origin of the products.

Research limitations and recommendations for future research

Like any empirical research, this study carried certain limitations that should be taken into account when interpreting the results, but which simultaneously opened up space for further scientific research. The main limitation arose from the applied data collection methodology. Given that the research was conducted via an online survey questionnaire, the obtained convenience sample showed a certain degree of methodological bias (sample bias) towards a younger, urban, digitally more literate, and highly educated population. Although this demographic group undoubtedly represented the primary target market for organic food products, the obtained results could not be generalized with absolute certainty to the total population of Bosnia and Herzegovina. This particularly applied to older age groups and the rural population with limited access to digital technologies, whose behavioral patterns might deviate significantly.

Regarding recommendations for further work, there was an imposed need for a qualitative and field research approach that would encompass a broader and more nationally representative sample. In addition, future studies should be directed from a general analysis of organic food to specific production sectors. In-depth market research of organic products of animal origin would have a special scientific and practical contribution, given the pronounced comparative advantages for the development of sustainable organic livestock farming in the Republic of Srpska and Bosnia and Herzegovina. The integration of such specific, narrowly profiled topics into the framework of academic research – for example, through the preparation of student master's theses and broader projects in the field of agroecomics and rural development – would provide a valuable primary data base. Such an academic approach would enable more precise mapping of short supply chains and a more detailed evaluation of the economic sustainability and ESG aspects of local agricultural holdings' operations, which is a necessary prerequisite for creating efficient sector policies and adequate preparation of professional presentations at scientific symposiums in the field of agriculture.

Conclusions

The empirical investigation into the perception and behavior of organic food consumers in Bosnia and Herzegovina reveals that the domestic market remains in an early, transitional stage of development. The most critical finding of this study is the identification of the 'trust paradox,' characterized by a pronounced discrepancy between high declarative consumption and a pervasive lack of institutional trust. Consumers predominantly rely on informal supply channels and subjective perceptions, frequently equating the term 'domestic' with 'organic'. Consequently, the official certification system currently fails to fulfill its fundamental market function of mitigating information asymmetry. This creates an environment where consumers cannot clearly differentiate certified organic products from conventional or hobby agriculture, leaving ample room for unfair competition and market inefficiencies.

Furthermore, the socio-economic profiling confirms that organic food in this region functions primarily as a premium good intended for a specific market niche. The research identifies highly educated women from urban areas with above-average incomes as the primary purchasing decision-makers. Income level emerges as the key determinant of both consumption frequency and the ability to recognize superior quality. Given that respondents identified high price, limited physical availability, and a lack of clear information as primary barriers, it is evident that demand remains highly price-elastic for the majority of the population. Conversely, the less price-sensitive, high-income segment represents the primary target group for immediate marketing strategies.

Reflecting on the broader implications of these findings, it is evident that the sustainable expansion of the organic sector requires a strategic shift beyond merely subsidizing primary production. For organic agriculture to transition from an elite market niche to a mainstream driver of public health and rural development, a systemic transformation of consumer trust is imperative. Trust must be redirected from exclusively interpersonal relationships, such as personal acquaintance with the producer, towards robust institutional guarantees. This necessitates intensive, state-backed educational campaigns focused on the visual identity and credibility of the official national organic label. Additionally, addressing the critical barriers of physical availability and high transaction costs will require institutional support for short supply chains, such as 'farm-to-fork' initiatives and digital direct-sales platforms. Ultimately, overcoming the 'trust paradox' through targeted education and market formalization is the essential prerequisite for unlocking the full economic and ecological potential of organic agriculture in the region.

Conflict of interests

The authors declare no conflict of interest.

References

1. Ak A.E.Y., & Teker, D. (2019). Turkish consumers' perception on organic food. *PressAcademia Procedia (PAP)*, 9, 1-5. <https://doi.org/10.17261/Pressacademia.2019.1054>
2. Čagalj, M., Grgić, I., & Gugić, J. (2020). Study on consumer preferences towards organic food in the market of Split, Croatia. *Economics of Agriculture*, 67(1), 285–292. <https://doi.org/10.5937/ekoPolj2001285C>
3. Cerjak, M., Mešić, Ž., Kopic, M., Kovačić, D., & Markovina, J. (2010). What Motivates Consumers to Buy Organic Food: Comparison of Croatia, Bosnia Herzegovina, and Slovenia. *Journal of Food Products Marketing*, 16(3):278-292. <https://doi.org/10.1080/10454446.2010.484745>
4. Đokić, N., & Milićević, N. (2016). Profil potrošača i prepreke za povećanje potrošnje organske hrane u Srbiji. *Anali Ekonomskog fakulteta u Subotici*, 52(36), 65–77. [in English: Đokić, N., & Milićević, N. (2016). Organic Consumer Profile

- and Obstacles for Increasing Consumption of Organic Food in Serbia. *The Annals of Faculty of Economics in Subotica*, 52(36), 65–77.] Retrieved from <https://scindeks-clanci.ceon.rs/data/pdf/0350-2120/2016/0350-21201636065D.pdf>
5. Dragolea, L.-L., Butnaru, G. I., Kot, S., Zamfir, C. G., Nuță, A.-C., Nuță, F.-M., Cristea, D. S., & Ștefănică, M. (2023). Determining factors in shaping the sustainable behavior of the generation Z consumer. *Frontiers in Environmental Science*, 11, 1096183. <https://doi.org/10.3389/fenvs.2023.1096183>
 6. Galić, J. (2022). Socio-demografski profil potrošača organske hrane u Republici Srpskoj. *Anali Ekonomskog fakulteta u Subotici*, 48, 3–14. [in English: Galić, J. (2022). Socio-demographic Profile of Organic Food Consumers in the Republic of Srpska. *The Annals of the Faculty of Economics Subotica*, 23(1), 45-58.] <https://doi.org/10.5937/AnEkSub2248003G>
 7. Jotanović, S. (2022). Kvalitet hrane životinjskog porijekla u kontekstu održivih metoda uzgoja i dobrobiti životinja. *XXVII Savjetovanje inženjera poljoprivrede Republike Srpske, Organska poljoprivreda – sadašnje stanje i tendencije razvoja – Knjiga sažetaka*, Univerzitet u Banjoj Luci, Poljoprivredni fakultet, Banja Luka, 19, [in English: Jotanović, S. (2022). Quality of food of animal origin in the context of sustainable breeding methods and animal welfare. *XXVII Conference of Agricultural Engineers of Republic of Srpska, Organic Agriculture – Current State and Development Trends – Book of Abstracts*, University of Banja Luka Faculty of Agriculture, Banja Luka, 19.] Retrieved from <https://agrores.agro.unibl.org/wp-content/uploads/2024/12/Book-of-Abstracts-AgroReS-2022-3.pdf>
 8. Kranjac, M., Vapa-Tankosić, J., & Knežević, M. (2017). Profile of organic food consumers. *Economics of Agriculture*, 64(2), 497–514. <https://doi.org/10.5937/ekoPolj1702497K>
 9. Madureira, T., Nunes, F., Veiga, J., Mata, F., Alexandraki, M., Dimitriou, L., Meleti, E., Manouras, A., & Malissiova, E. (2025). Trends in Organic Food Choices and Consumption: Assessing the Purchasing Behaviour of Consumers in Greece. *Foods*, 14(3), 362. <https://doi.org/10.3390/foods14030362>
 10. Miftari, I., Haas, R., Meixner, O., Imami, D., & Gjokaj, E. (2022). Factors Influencing Consumer Attitudes towards Organic Food Products in a Transition Economy—Insights from Kosovo. *Sustainability*, 14(10), 5873. <https://doi.org/10.3390/su14105873>
 11. Nagy, L. B., Lakner, Z., & Temesi, Á. (2022). Is it really organic? Credibility factors of organic food—A systematic review and bibliometric analysis. *PLoS ONE*, 17(4), e0266855. <https://doi.org/10.1371/journal.pone.0266855>
 12. Petrescu, D. C., Petrescu-Mag, R. M., Burny, P., & Azadi, H. (2017). A new wave in Romania: organic food. Consumers' motivations, perceptions, and habits. *Agroecology and Sustainable Food Systems*, 41(1), 46–75. <https://doi.org/10.1080/21683565.2016.1243602>

13. Pržulj, N., & Tunguz, V. (2023). Organska poljoprivreda u funkciji održivog razvoja ruralnih područja Republike Srpske. U: Mataruga, M., Janjić, V., & Pržulj, N. (urednici) *Природни ресурси у функцији развоја друштва XXI вијека. Академија наука и умјетности Републике Српске*, Бања Лука, Монографија LIII:371–454 [in English: Pržulj, N., Tunguz, V. (2023). Organic agriculture in the function of sustainable development of rural areas of the Republic of Srpska. In: Mataruga M, Janjić V, Pržulj N (eds) *Natural resources for the development of society in the 21st century*. Academy of Sciences and Arts of the Republic of Srpska, Banja Luka, Monograph LIII:371–454]
14. Radojević, V. (2018). *Istraživanje tržišta organskih poljoprivredno-prehrambenih proizvoda u Republici Srbiji* [Doktorska disertacija, Univerzitet u Novom Sadu, Poljoprivredni fakultet]. [in English: Radojević, V. (2018). Market research of organic agri-food products in the Republic of Serbia [Doctoral dissertation, University of Novi Sad, Faculty of Agriculture].]
15. Tomić, G., Radanov, P., Stanojević, Lj., Karabašević, D., & Petrović, G. (2021). Istraživanje potrošača i njihovih navika na tržištu organskih proizvoda. *Ekonomija Teorija i Praksa*, 14(2), 101–118. [in English: Tomić, G., Radanov, P., Stanojević, Lj., Karabašević, D., & Petrović, G. (2021). Consumer research and their habits in the organic products market. *Economics Theory and Practice*, 14(2), 101–118.] <https://doi.org/10.5937/etp2102101P>
16. Vapa-Tankosić, J. M. (2018). *Determinante ponašanja potrošača na tržištu organskih proizvoda* [Doktorska disertacija, Univerzitet Union - Beogradska bankarska akademija]. [in English: Vapa-Tankosić, J. M. (2018). Determinants of consumer behavior in the organic products market [Doctoral dissertation, Union University - Belgrade Banking Academy].]
17. Vehapi, S., & Dolićanin, E. (2016). Consumers' behavior on organic food: Evidence from the Republic of Serbia. *Economics of Agriculture*, 63(3), 871–889. <https://doi.org/10.5937/ekoPolj1603871V>
18. Victoris, V., Kozelova, D., Mellen, M., Chrenekova, M., Potclan, J. E., Fikselova, M., Kopkas, P. & Horská, E. (2016). Analysis of Consumer's Preferences at Organic Food Purchase in Romania. *Polish Journal of Food and Nutrition Sciences*, 66(2), 139–146. <https://doi.org/10.1515/pjfn-2015-0028>
19. Willer, H., Schlatter, B., & Trávníček, J. (Eds.). (2026). *The World of Organic Agriculture: Statistics and Emerging Trends 2026*. Research Institute of Organic Agriculture FiBL and IFOAM - Organics International.
20. Woś, K., Dobrowolski, H., Gajewska, D., & Rembiałkowska, E. (2022). Organic Food Consumption and Perception among Polish Mothers of Children under 6 Years Old. *International Journal of Environmental Research and Public Health*, 19(22), 15196. <https://doi.org/10.3390/ijerph192215196>
21. Wu, W., Zhang, A., van Klinken, R. D., Schrobback, P., & Muller, J. M. (2021). Consumer Trust in Food and the Food System: A Critical Review. *Foods*, 10(10), 2490. <https://doi.org/10.3390/foods10102490>

PROFITABILITY DETERMINANTS OF AGRICULTURAL ENTERPRISES: EMPIRICAL EVIDENCE FROM RURAL ECONOMIES

Ivana Miklošević¹, Andreja Katolik Kovačević², Anica Vukašinović³

*Corresponding author E-mail: imiklosevic@unisb.hr

ARTICLE INFO

Original Article

Received: 31 March 2026

Accepted: 25 June 2026

doi:10.59267/ekoPolj2603765M

UDC 658.155:631.16

Keywords:

profitability, agriculture, correlation, panel data analysis, rural economies

JEL: Q12, Q14, C23, O13

ABSTRACT

This study investigates the profitability determinants of agricultural firms in rural economies and has focused on five Eastern European countries for time period spanning from 2005–2023. The aim of research is to evaluate the key structural, economic and technological factors that influence and effect the performance of agricultural enterprises. The methodology focuses on panel data analysis by employing fixed effects regression, stationarity analysis, examining correlation analysis and performing diagnostic tests for validity. The findings suggest that farm size, agricultural investment, exports and use of fertiliser influence profitability positively and significantly whereas labour employed in agriculture enterprises showcase a negative linkage indicating efficiency concerns. The results suggest that structural development, integration of markets and advancement in technology are crucial for enhancing agricultural performance. The study concludes that policy makers should promote land consolidation, investment support, export facilitation to enhance profitability in rural agricultural economies.

Introduction

Background of the Study

Agriculture has remained a vital component in the economic growth of various economies, especially within rural areas. In these area agriculture acts as a main determinant of livelihood, employment and food security. The food and agriculture organisation

-
- 1 Ivana Miklošević, Ph.D., Assistant Professor, University of Slavonski Brod, 108th Brigade ZNG Street No. 36, 35000 Slavonski Brod, Croatia, Phone: +385923501777, E-mail: imiklosevic@unisb.hr, ORCID ID (<https://orcid.org/0000-0002-5882-6409>)
 - 2 Andreja Katolik Kovačević, Ph.D., Assistant Professor, University of Slavonski Brod, 108th Brigade ZNG Street No. 36, 35000 Slavonski Brod, Croatia, Phone: +385915673396, E-mail: akkovacevic@unisb.hr, ORCID ID (<https://orcid.org/0000-0002-8985-0903>)
 - 3 Anica Vukašinović, Ph.D., Head of the Department for Education, Sport and Culture, Brod-Posavina County, Petra Krešimira IV Street No. 1, 35000 Slavonski Brod, Croatia, Phone: +385993227596 E-mail: anica.vukasinovic@gmail.com, ORCID ID (<https://orcid.org/0009-0006-4263-3545>)

reported that agriculture constitutes a major portion of rural livelihoods worldwide, with more than 2.5 billion individuals dependent upon this sector. In emerging economies, agriculture sector continues to be a leading force for economic stability and regional progress. Over past few decades, agricultural systems have experienced significant structural changes due to globalisation and bilateral-trade, technological advancement and policy reforms. Economies in Eastern Europe, for instance Croatia, Serbia, Romania, Bulgaria and Hungary, have witnessed significant changes in their agricultural sectors following economic transitions and integration into global markets. These shifts have had an impact over farm structures, investment trends and accessibility to markets, hence influencing agricultural profitability. Despite its significance, profitability in agriculture sector varies between economies over time. Determinants such as size of farm, capital availability, labor availability, technological advancement and integration into global markets significantly affect the economic outcomes of agricultural businesses. Evaluating these components are important for policy makers to frame policies targeted at boosting productivity and livelihood in rural regions.

Importance of Agricultural Profitability

Agricultural profitability acts as indicator of the sustainability and competitiveness of agricultural sectors. It denotes the capacity of agricultural businesses to maximise profits, reinvest in their business and adjust to changing and evolving economic circumstances. The World Bank emphasised that improving agricultural productivity and profitability is crucial for reducing rural poverty and fostering inclusive economic growth. Farmers on achieving higher profitability can now invest in modern technologies, increase production through efficiency and introduce better quality products. This, in return also supports upliftment and development of rural sector by providing more job opportunities and boosting local economies. On the contrary if agriculture sector faces low profitability it may result in low investment, dwindling productivity and more vulnerability for rural households. In economies undergoing transition, profits are shaped not only by the internal characteristics of farms but also influenced by external elements for instance market access, policy support and institutional development. Consequently, a thorough examination of the factors influencing profitability is essential to grasp the economic dynamics of agricultural enterprises.

Challenges in Rural Agricultural Economies

Rural agricultural economies encounter numerous structural and economic hurdles that can hinder profitability. A primary issue is the division of agricultural land into smaller plots, which diminishes production efficiency and hampers the use of modern technologies. In several Eastern European nations, the agricultural sector is predominantly composed of small, fragmented farms, making it challenging to achieve economies of scale. Another major obstacle is the limited access to financial resources. Agricultural investments are often hampered by insufficient credit facilities and high borrowing costs, which limit farmers' capacity to adopt advanced technologies and

enhance productivity. Reports from the European Commission highlight that access to finance remains a crucial concern for small and medium-sized agricultural enterprises in the area. Labor dynamics also significantly influence agricultural performance. Although agriculture has traditionally relied on labor-intensive methods, excessive reliance on labor can reduce efficiency, especially when mechanisation is lacking. Furthermore, fluctuations in agricultural exports and market prices create uncertainty, impacting farm income and profitability.

Research Gap and Contribution

Although a vast body of literature exists on productivity in agricultural sector few studies have focused on the joint effects of structural, economical and technological determinants on profitability of agriculture sector in rural economies. Also most past empirical studies have focused on developed economies, while limited attention has been given to economies undergoing transition in Eastern Europe.

Present study contributes by doing a detailed analysis of the determinants of agricultural profitability. Our study has employed panel data for selected Eastern European countries. Present study has incorporated variables such as size of the farm, agricultural labor, investment in advanced technology, exports of agricultural commodities and use of fertiliser. In this way present study captures multiple dimensions of agricultural performance. Further, the use of panel data allowed us to conduct analysis for both cross-country and time-series variations. This led to providing more robust and valid results.

Statement of the Problem

Agriculture sector plays crucial role in rural economic development but agricultural enterprises in many emerging economies continue to face challenges in achieving stable and sustainable profits. As evident there is lot of difference in profitability across economies suggesting that multiple factors influence agricultural performance, yet the relative importance of these factors remains unclear.

Present study highlights there is a dire need to evaluate how structural factors such as size of the farm, economic factors in form of investment and exports, technological advanced inputs like use of fertiliser, jointly affect agricultural profitability. Also it has been observed that the role of labor in advanced and modern agricultural systems remains ambiguous, especially in the context of increasing mechanisation and technological advancement.

Therefore present study will try to address the following questions: Which variables will serve as key determinants of agricultural profitability in rural economies ?

- To examine whether structural, economic and technological factors have any influence on performance of agricultural enterprises?

The history of agricultural profitability for countries in Eastern Europe has been essentially a narrative of reform and convergence. After the end of socialist systems, economies like Croatia, Serbia, Romania, Bulgaria and Hungary started facing the daunting task of modernising fragmented sectors so that they could compete within the international markets and European Union (Csáki & Jámbo, 2019). A central theme in this evolution was the impact of size of firm. For instance in Romania and Bulgaria, the implementation of land reforms led to a “polarisation” of the sector, where a large number of small and marginal, fragmented holdings existed alongside some large and highly efficient enterprises (Burja & Burja, 2016). While some other studies in Hungary suggested that the average size of farm remained below the European average, which hindered efficiency, results also indicated that increasing the average area per holding had a direct and positive linkage with total agricultural output (Florea et al., 2021; Ivanović et al., 2020). Interestingly, this association between size and profitability is not always direct or linear; larger farms get benefited due to economies of scale but some previous studies from Serbia and Romania suggested that very large agricultural companies also sometimes face negative profitability impacts due to managerial inefficiencies (Mijić & Jakšić, 2017; Milošev, 2023).

This profitability is heavily dependent upon agricultural labor productivity. If we assess emerging Eastern European economies, labor productivity has always been relatively lower than in Western Europe (Onegina et al., 2020). However, reforms and changes in economic system shows that productivity of labour is growing at an increasing rate averaging approximately 12% annually in some CEE regions but its also evident that some countries have started moving towards capital-intensive techniques (Bilenko, 2022). Further, the type of labor also plays a crucial role, for instance, some farms with large size in the CEE region that rely on skilled hired labor often showcase higher profitability for their own labor input compared to smaller firms that lack mechanisation (Średzińska, 2019; Ženka et al., 2015). This transformation is closely linked with investment in agriculture. Capital accumulation is key determinant for growth, yet academicians have reported over-investment in some regions, without any corresponding rise in productivity of labor (Pawłowski et al., 2021). In Serbia and Croatia, experts have emphasised that reaching a decisive level of technical equipment is important so as to use and implement modern advanced technological solutions that actually enhance financial performance (Kusz et al., 2020; Mihailović et al., 2023). Whether these days investments were successful or not is often indicated through input usage, particularly consumption of fertiliser and manures. As evident from previous studies, the reduction in use of fertiliser led to decline in output and yield in Central and Eastern Europe (Macours & Swinnen, 2000).

In today’s era, fertiliser is used as essential input for maximising output, but due to global shocks and international instability has led to increase in cost of inputs including fertilisers. This has started to become a threat to farm margins (Glauber, J. W., & Laborde Debucquet, D., 2023; Vos et al., 2024).

If compared in Romania and Bulgaria the usage of fertiliser levels is quite low than the average of EU. This relative comparison partially explains the existing yield gap and lower competitiveness (Burja & Burja, 2016; Ion et al., 2019). Further, the nature of agricultural specialisation also influences these costs for instance there are certain production lines which are more vulnerable to volatility in price of fertiliser than others hence directly having an impact on their net profitability (Kubala, 2024).

Finally, the narrative concludes with the role of agricultural exports. For countries like Serbia and Croatia, raising the portion of agricultural products in there export of is a proven way to diversify rural activities and reduce dependency on domestic primary sectors (Dimitrijević et al., 2023; Birovljev et al., 2017). A positive current account balance in the food sector not only increases the added value of agriculture but also allows these nations to become more resilient (Haller et al., 2025).

Petrović et al. also demonstrated that identifying errors and potential fraud in financial statements can serve as key component for these companies so as to maintain the market credibility needed for expanding agricultural exports (Petrović et al., 2025). Mihajlović et al. argued that Serbian dairy enterprises must optimise their production cycles through rigorous economic analysis to build resilience against global market volatility (Đurić & Njegovan, 2016).

By establishing a balance between these determinants like expanding farm size where required, investing in promoting the efficiency of labour and managing cost of fertiliser in these five countries can lead to improvement in their economic resilience and reduce the performance gap with their Western European counterparts (Bieniek-Majka & Guth, 2021; Mijić & Jakšić, 2017; Vukoje et al., 2022).

Materials and methods

Selection of Countries and Variables

Our empirical analysis will focus on five Eastern European countries namely Croatia, Serbia, Romania, Bulgaria and Hungary. The reason behind selecting these countries is there agricultural sector play a crucial role in rural economies. As this sector contributes significantly towards employment, food production and development of peripheral areas. Further, these countries possess similar agricultural structures and transitional economic characteristics, that will allow us for significant comparative analysis. Furthermore, present study will consider variables that presents main economic conditions that often effect agricultural enterprises in rural economies. Present study has included farm size as it represents the productive capacity and scalability of agricultural enterprises. Agricultural labor is also considered an important factor of production, specifically in rural areas where farming is still dependent on human intensive techniques. We have also considered agricultural exports as an indicator of market integration. Lastly, we have chosen fertiliser consumption as a proxy variable for technological input and production intensity.

Data Sources and Time Period

The empirical investigation relies on secondary data obtained from various recognised databases. The data was collected from the World Bank Open Data and the FAOSTAT database which provided uniform and comparable agricultural and economic indicators across economies. These databases are widely employed in agricultural economics because of their reliability and in depth coverage of macroeconomic and agricultural variables.

Present study employs the period spanning from 2005–2023, allowing for the analysis of long-term trends in determinants of profitability and agricultural performance. This time period was selected to ensure that we have sufficient observations for panel data analysis while also capturing structural changes that took place in agricultural production and economic rural development.

Tools and Techniques

Descriptive Statistical Analysis

Descriptive statistics is used to capture the main characteristics of the dataset. It is used to observe the general trends and behaviour of the selected variables across countries and selected time period. This technique provides information about the central tendency and variance or dispersion of the variables employed in the study (mean values, standard deviation, minimum and maximum values).

This technique will be employed to achieve Objective 1 which targets to identify the main economic factors influencing profitability of agricultural enterprises in rural economies.

Common statistical indicators used in the study include mean, median and standard deviation).

Unit Root Test (Panel Stationarity Test)

In order to avoid spurious regression results, present study tests the stationarity of the panel data series by employing a panel unit root test. Stationarity will ensure that the variance and mean of the variables remain constant and stable over selected time period.

This test will contribute to Objective 1, as it will verify the stability of agricultural economic indicators employed at time of investigation.

The unit root test model can be written as:

$$\Delta Y_{it} = \alpha + \beta Y_{i,t-1} + \sum \gamma_k \Delta Y_{i,t-k} + \varepsilon_{it}$$

where:

ΔY_{it} = represent first difference of the variable

$Y_{i,t-1}$ = denotes lagged level of the variable

ε_{it} = represents the error term

The results will be based on rule of thumb i.e. If $\beta < 0$ and statistically significant, the variable is considered to be stationary with constant mean and variance.

Panel Data Regression Model

To investigate the relationship between agricultural profitability and its determinants present study employed panel data regression analysis. Panel data set combines both cross-sectional and time-series observations that allows the empirical investigation of variations across countries and over the period of time simultaneously. This approach increases the number of observations and strengthen the efficiency of econometric estimation.

Panel data regression will be used to address Objective 2 of our study which aims at analysing the impact of structural and economic factors such as farm size, labor, agricultural investment and exports on agricultural profitability.

Panel regression model can be expressed as follows:

$$\text{Profitability}_{it} = \beta_0 + \beta_1 \text{FarmSize}_{it} + \beta_2 \text{Labor}_{it} + \beta_3 \text{Investment}_{it} + \beta_4 \text{Exports}_{it} + \beta_5 \text{Fertilizer}_{it} + \varepsilon_{it}$$

where:

$\text{Profitability}_{it}$ = denotes profitability of agricultural enterprises in country i at time t

FarmSize_{it} = represents average land size of agriculture

Labor_{it} = represents employment share provided by agriculture sector

Investment_{it} = denotes agricultural investment level

Exports_{it} = represents agricultural exports share

Fertiliser_{it} = means fertiliser consumption

ε_{it} = error term

Fixed Effects and Random Effects Models

In order to obtain robust results, the study examines both Fixed Effects (FE) and Random Effects (RE) models. The Fixed Effects model is employed to control for country-specific characteristics which are unobserved and they remain constant over time, while the Random Effects model pre-assumes that these individual effects are random in nature and not linked with the independent variables.

The Fixed Effects model can be showcased as: $\text{Profitability}_{it} = \alpha_i + \beta_1 X1_{it} + \beta_2 X2_{it} + \dots + \beta_k Xk_{it} + \varepsilon_{it}$

The Random Effects model is presented as follows:

$$\text{Profitability}_{it} = \beta_0 + \beta_1 X1_{it} + \beta_2 X2_{it} + \dots + \beta_k Xk_{it} + u_i + \varepsilon_{it}$$

where:

α_i = represents country-specific fixed effect

u_i = denotes random individual effect

ε_{it} = showcased the error term

Diagnostic Tests

Multicollinearity Test (Variance Inflation Factor – VIF)

Present study tests for the presence of multicollinearity among selected independent variables as a check of robustness before applying regression. Multicollinearity means when independent variables are highly or perfectly associated with each other, leading to distortion of results and questioning the reliability of regression coefficients.

The diagnostic test helps support Objective 2 of our study as it confirms that the selected determinants of agricultural profitability captures true individual explanatory power of independent variables. The presence or absence of multi-collinearity is given by Variance Inflating Factor which is further calculated as: $VIF_i = 1 / (1 - R_i^2)$

where:

VIF_i = denotes variance inflation factor of variable i

R_i^2 = represents coefficient of determination obtained when variable i is regressed on other independent variables

Presence or absence of MC is given by value of VIF, if greater than 10 indicates serious multicollinearity and value less than 10 presents no multi-collinearity.

Hausman Specification Test

This study employed Hausman test to examine whether the Fixed Effects (FE) is more suitable or Random Effects (RE) model is more appropriate for estimating panel data. The test assess whether the individual effects are correlated with independent variables or not.

This test will be used to examine Objective 2 of our study as it helps in selecting the most appropriate econometric model for examining the determinants of agricultural profitability.

The Hausman test statistic can be defined as follows:

$$H = (\beta_{FE} - \beta_{RE})' [\text{Var}(\beta_{FE}) - \text{Var}(\beta_{RE})]^{-1} (\beta_{FE} - \beta_{RE})$$

where:

β_{FE} = is the coefficient vector from Fixed Effects model

β_{RE} = represents the coefficient vector from Random Effects model

The results are given on basis of p-value, If the p-value is less than 0.05, we will employ the Fixed Effects model as it will give significant results and vice versa.

Heteroskedasticity Test

The term Heteroskedasticity denotes variance of the error terms being not constant across data set. The presence of heteroskedasticity leads to estimators being inefficient and biased standard errors.

Hence, failing to satisfy BLUE properties. Therefore, the study employs the Breusch–Pagan test to ensure the validity of our regression results.

The test statistic can be expressed as follows: $BP = n \times R^2$

where:

n = represents the number of observations

R^2 = denotes goodness of fit and coefficient of determination

If p-values comes out to be significant meaning less than 0.05 it indicates the presence of heteroskedasticity.

Results and Discussion

This section deals with presenting the empirical results obtained from the empirical investigation of the selected variables. The results and findings are further discussed in order to understand the key factors influencing agricultural profitability in the selected rural economies within the given time period.

Table 1 below highlights the description of variables considered in the study for analysis. The selected variables are used to capture key structural, economic and technological aspects of agricultural production, that serves as key factors for evaluating the profitability in rural economies.

Table 1. Description of Variables Used in the Study

Variable	Type	Description
Country	Categorical	Selected country
Year	Time variable	2005–2023
Profitability	Dependent	Agricultural value added / profitability index
Farm_Size	Independent	Agricultural land area
Labor	Independent	Agricultural employment (%)
Agri_Investment	Independent	Agricultural investment index
Agri_Exports	Independent	Agricultural exports (%)
Fertilizer	Independent	Fertilizer consumption

Source: World Bank and FAOSTAT

Table 2 below will help capture the descriptive statistics of the selected variables for time period spanning from 2005–2023. The table provides a summary of the central tendencies and variance in agricultural profitability and its key determinants.

Table 2. Descriptive Statistics of Selected Variables (2005–2023)

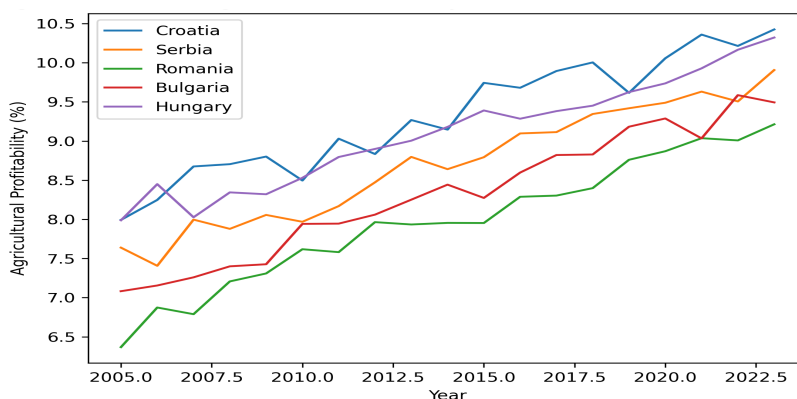
Variable	Mean	Median	Maximum	Minimum	Std. Dev.
Profitability (%)	9.42	9.30	14.10	6.10	1.85
Farm Size (ha)	7.86	7.70	11.90	5.20	1.63
Agricultural Labor (%)	14.52	13.90	22.30	5.80	4.91
Agricultural Investment (Index)	108.74	107.20	139.60	82.10	15.87
Agricultural Exports (%)	7.64	7.50	11.90	4.10	1.94
Fertilizer Use (kg/ha)	123.58	121.40	158.70	92.30	18.62

Source: Author's calculation

Results and findings under Table 2 showcase that the average profitability of agricultural enterprises across the selected countries during the given time period was 9.42%, with minimum value standing at 6.10% and maximum ranging upto 14.10%. The average farm size came out to be 7.86 hectares, indicating that the level of agricultural land available in the selected rural economies is moderate.

The values of dispersion concluded that Agricultural labor exhibited the highest variability among all the considered variables, indicating structural differences in labor dependency across countries. On the other hand, agricultural investment and use of fertiliser showed relatively more stable values, suggesting increase in technological advancement and increased financial support for agriculture enterprises during the study time period.

After showcasing the results of the descriptive statistics present study examines the stationarity properties of the panel data series. This is crucial as Non-stationary variables can lead to misleading regression results and estimations that are not reliable. Therefore, we have applied panel unit root tests to check for stationarity of the variables. Figure 1 below presents the changing trends and patterns in productivity of agriculture across different countries in given time period (2005-2023).

Figure 1. Trends in Agricultural Profitability across Selected Countries (2005–2023)

Source: Author's calculations based on World Bank and FAOSTAT data.

Figure 1 illustrated the changing trends in agricultural profitability by showcasing a gradual rise in profitability in most countries. This reflects improvements in investment in agriculture sector, rise in agricultural productivity and market integration in the rural economies. Next we have applied unit root test in table 3 to check for stationarity of selected series.

Table 3. Panel Unit Root Test Results: Levin–Lin–Chu (LLC) aur Im–Pesaran–Shin (IPS)

Variable	LLC (Level)	p-value	IPS (Level)	p-value	LLC (1st Diff.)	p-value	IPS (1st Diff.)	p-value
Profitability	-1.42	0.078	-1.31	0.095	-4.12***	0.000	-3.87***	0.000
Farm Size	-1.18	0.112	-1.05	0.146	-3.76***	0.000	-3.54***	0.000
Agricultural Labor	-2.21**	0.027	-2.05**	0.040	-3.88***	0.000	-3.61***	0.000
Agricultural Investment	-0.94	0.173	-0.88	0.189	-4.45***	0.000	-4.10***	0.000
Agricultural Exports	-1.36	0.086	-1.22	0.101	-3.89***	0.000	-3.61***	0.000
Fertilizer Use	-1.09	0.128	-0.97	0.162	-3.74***	0.000	-3.48***	0.000

Source: Author's calculation

The results and findings of the panel unit root showcased under Table 3 tests suggest that most variables are non-stationary at level but when differenced become stationary. Hence all variables turned out to be stationary at level that is they are integrated of order I(1).

However, one selected variable agricultural labor appeared to be stationary at level only, indicating it is integrated of order I(0).

After analysing the stationarity properties of the variables, next we analysed the association between the selected variables. Hence, a correlation analysis was conducted under table 4 to examine the strength and linkage of the relationships among the variables. This step will also help us assess potential multicollinearity issues.

Table 4. Correlation Matrix

Variable	PROF	FS	LAB	INV	EXP	FERT
Profitability (PROF)	1.000					
Farm Size (FS)	0.46	1.000				
Agricultural Labor (LAB)	-0.31	-0.28	1.000			
Agricultural Investment (INV)	0.58	0.44	-0.21	1.000		
Agricultural Exports (EXP)	0.52	0.39	-0.19	0.47	1.000	
Fertilizer Use (FERT)	0.49	0.41	-0.16	0.45	0.43	1.000

Source: Author's Calculation

The correlation matrix under Table 4 showcases moderate positive relationships among profitability and selected variables as size of farm, investment in agriculture, exports and use of fertiliser. This suggested that large farms, higher levels of investment,

stronger market linkages and the use of advanced technological inputs can contribute towards improved performance in agricultural sector.

Results for Agricultural labor highlighted a negative correlation with profitability, suggesting that greater reliance on labor-intensive production may lower the efficiency in agricultural sector. This type of linkage reflects structural limitations in rural economies where lower levels of mechanisation leads to an increase in production costs and lowering productivity. Further, the results showcased that none of the correlation coefficients exceeded the accepted threshold value of 0.70, suggesting no multicollinearity among the independent variables and confirmed the regression analysis without estimation problems.

After analysing the correlation among selected variables, our study investigated the presence of multicollinearity within the regression framework. Correlation analysis has indicated preliminary insight into the relationships between variables, however it does not capture the problem of multicollinearity completely. Therefore, we have further employed the Variance Inflation Factor (VIF) in Table 5 to examine if independent variables exhibit significant multicollinearity or not.

Table 5. Variance Inflation Factor (VIF) Test

Variable	VIF	Tolerance (1/VIF)
Farm Size	2.31	0.432
Agricultural Labor	2.84	0.352
Agricultural Investment	3.12	0.320
Agricultural Exports	2.57	0.389
Fertilizer Use	2.76	0.362
Mean VIF	2.72	-

Source: Author's calculation

The results of VIF can be observed under Table 6. Values of VIF showcase that all independent variables have VIF values less than 10, indicating the absence of serious multicollinearity in the model. This explains that the selected independent variables do not showcase strong linear relationships with each other. In other words it can be concluded that variables have independent explanatory power in the regression analysis.

After checking for multicollinearity and confirming the absence of MC among the explanatory variables, we determined panel regression model. For this we employed Hausman specification test in Table 7 to decide which model is more suitable for analysis Fixed Effects or Random Effects model.

Table 6. Hausman Test Results

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	14.27	5	0.014

Source: Author's calculation

The results of Hausman test under Table 6 concluded that the probability values is less than 0.05 indicating that the null hypothesis is rejected for the Random Effects model. Therefore, our study has considered the Fixed Effects model to be more appropriate for examining the relationship between agricultural profitability and its determinants.

Based on the findings concluded by Hausman specification test, the Fixed Effects model was considered to be the appropriate estimation technique for the panel data analysis. Therefore, present study has employed regression model using the Fixed Effects approach. The findings of the panel regression analysis can be seen in Table 7.

Table 7. Fixed Effects Panel Regression Results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Farm Size	0.284***	0.091	3.12	0.002
Agricultural Labor	-0.118**	0.054	-2.19	0.031
Agricultural Investment	0.347***	0.102	3.40	0.001
Agricultural Exports	0.263***	0.087	3.02	0.003
Fertilizer Use	0.149**	0.064	2.33	0.022
Constant	2.417**	0.985	2.45	0.016

Source: Author's Calculation, Notes: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$

Table 7 (A). Model stats

Statistic	Value
R-squared	0.61
Adjusted R-squared	0.58
F-statistic	19.47
Prob(F-statistic)	0.000
Observations	95
Cross-sections	5
Time period	2005–2023

Source: Author's calculation

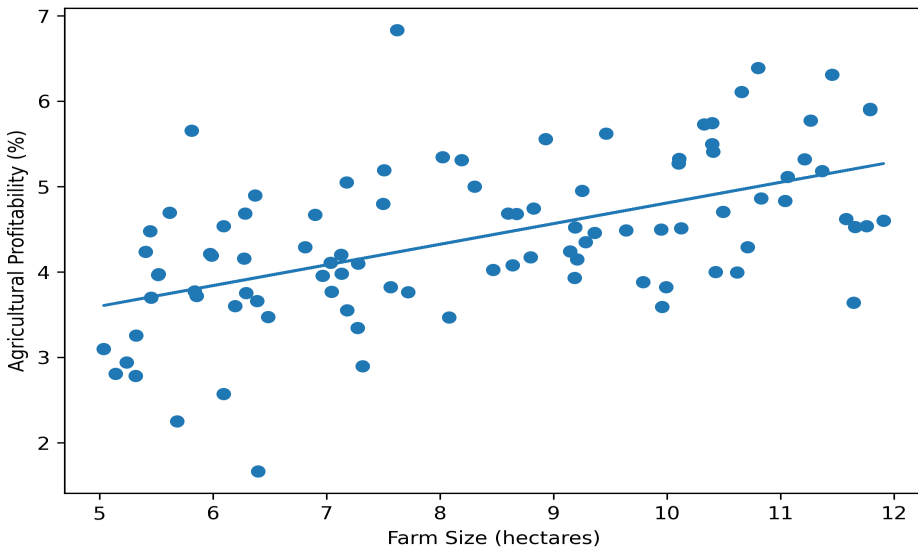
The results of the fixed effects regression model under Table 7 and 7A indicated that several structural and economic factors were significantly influencing agricultural profitability in the selected rural economies. Farm size however showed a positive and statistically significant impact on profitability, conveying that larger farms benefit

more from economies of scale where they get a cost advantage and channelisation of resources also gets improved.

Agricultural investment and exports also exhibited a positive and significant coefficients, suggesting that with an increase in financial support and stronger integration into agricultural markets the profitability levels gets increased. Further, use of Fertiliser demonstrated a positive impact highlighting the relevance of technological advanced inputs in enhancing agricultural productivity.

In contrast, agricultural labor showed a negative association with profitability, implying that higher dependence on labor may lead to reduction in production efficiency. The model explained approximately 61% of the variation in agricultural profitability, suggesting a comparatively stronger explanatory power of the selected variables. The graphical presentation of relation between Size of Farm and profitability in agriculture is highlighted under figure 2.

Figure 2. Farm Size vs Profitability (Scatter Plot)



Source: Author's calculation

Figure 2 presented above illustrates the association between size of the farm and agricultural profitability in the selected rural economies. The scatter plot indicates a positive relationship between the two variables, suggesting that larger farms tend to achieve higher profitability levels. This finding supports the regression results, which show that farm size has a statistically significant positive impact on agricultural profitability. The empirical results provided important insights into the determinants that influence agricultural profitability.

Conclusion

This study examines the key determinants of agricultural profitability in rural economies by employing panel data from Croatia, Serbia, Romania, Bulgaria and Hungary. The time period of the study ranges from 2005–2023. The investigation employed a fixed effects regression model to assess the impact of structural and economic factors on performance of agricultural enterprises. The results suggest that several variables play a crucial role in shaping agricultural profitability across the selected countries.

The findings showcase that size of farm has a positive and statistically significant effect on profitability. The larger agricultural enterprises are, greater they get benefit of economies of scale and better resource allocation and utilisation. Similarly, agricultural investment and exports were also found to have a positive impact over profitability, demonstrating the significance of financial support, development of infrastructure and market integration in enhancing the economic performance of agricultural enterprises.

The use of fertiliser also had positive effect, which emphasises the role of technological advanced inputs and use of modern production techniques in improving agricultural productivity.

In contrast, agricultural labor showcased a negative relationship with profitability, suggesting that greater reliance on labor-intensive production may lower efficiency in agricultural systems. These findings suggests that limited mechanisation and technological adoption may act as a productivity barrier in some rural economies.

Overall, the results of present study concludes that structural development, technological inputs and market participation are key determinants that influence profitability in agriculture sector.

The empirical findings provide several policy-implications for enhancing agricultural profitability in rural economies. Since size of farm was found to have a significantly positive influence on profitability, policies should be framed that facilitate land consolidation and promote cooperative farming as this may help small-scale farmers achieve economies of scale and benefit from low cost. In many rural areas production efficiency is limited by fragmented land ownership therefore, institutional mechanisms that promote land leasing, cooperative farming or producer organisations could promote optimum utilisation of resources and productivity.

The positive role of investment in agriculture sector showcased the significance of strengthening financial support mechanisms for the agricultural sector. Governments and financial institutions should rely on improving long-term agricultural credit, subsidies and promoting infrastructure development, specifically for small and medium agricultural enterprises. Government should also focus on targeted investment programs in irrigation systems, warehousing facilities and farm machinery that may help reduce production costs and strengthen agricultural competitiveness.

The results also suggested that greater integration into agricultural export markets can significantly lead to improvement in farm profitability. Therefore, policy makers should aim at improving market access, export logistics and quality assessment and certification systems which may enable farmers to demonstrate their products more effectively in international markets. To further improve the export potential of agricultural products, strengthening agricultural value chains and improving transportation and warehousing infrastructure could serve as an important measure.

The positive impact of using fertiliser indicated the relative importance of using advanced technological inputs to improve agricultural productivity. However, policies should aim at promoting efficient and sustainable use of inputs, including training programs for farmers, soil testing services and agriculture techniques that help farmers gain a competitive advantage. Such measures help farmers to make better use of fertiliser application without degrading the environment.

Finally, the negative relationship was observed between agricultural labor and profitability which suggests that over reliance on labor-intensive farming may reduce efficiency and hence reduce productivity. To address this problem policy makers should make efforts to focus on promoting mechanisation, advanced agriculture techniques and modern and environmental friendly farm management practices. Further, regular training programs and easy access to modern tools can help farmers improve productivity and yield while reducing non-productive labor costs.

Acknowledgements

This research was funded by the University of Slavonski Brod through the institutional research project “Digital Center for Student Internships, Research and Collaboration of the University of Slavonski Brod”, financed by the European Union – NextGenerationEU. The views and opinions expressed in this paper are solely those of the author and do not necessarily reflect the official position of the European Union or the European Commission. Neither the European Union nor the European Commission can be held responsible for them.

Conflict of interests

The authors declare no conflict of interest.

References

1. Bilenko, Y. (2022). Labor productivity in the agriculture, structural shifts and economic growth in the Central and Eastern European countries. *Agricultural and Resource Economics: International Scientific E-Journal*, 8(4), 5-32. <https://are-journal.com/are/article/view/599>
2. Birovljev, J., Đokić, D., Matkovski, B., & Kleut, Ž. (2017). Economic performances of agriculture of CEFTA and former CEFTA countries. *Economics of Agriculture*, 64(4), 1413–1424. <https://doi.org/10.5937/ekoPolj1704413B>

3. Burja, C., & Burja, V. (2016). Size and efficiency of the production factors in Romanian agriculture. *Economics of Agriculture*, 63(2), 361-374. <https://doi.org/10.5937/ekoPolj1602361B>
4. Csáki, C., & Jámbo, A. (2019). Convergence or divergence - Transition in agriculture of Central and Eastern Europe and Commonwealth of Independent States revisited. *Agricultural Economics – Czech*, 65(4), 160–174. <https://doi.org/10.17221/195/2018-AGRICECON>
5. Dimitrijević, M., Veselinović, P., & Ristić, L. (2023). State and perspectives of agriculture development in the Western Balkan countries. *International Review*, 1–2, 90-98. <https://doi.org/10.5937/intrev2302096D>
6. Florea, N. V., Duică, M. C., Ionescu, C. A., Duică, A., & Stănescu, S. G. (2021). An analysis of the influencing factors of the Romanian agricultural output within the context of green economy. *Sustainability*, 13(15), 8443. <https://doi.org/10.3390/su13158443>
7. Glauber, J. W., & Laborde Debucquet, D. (Eds.). (2023). *The Russia-Ukraine conflict and global food security*. International Food Policy Research Institute (IFPRI), Washington, DC. <https://doi.org/10.2499/9780896294394>
8. Haller, A. P., Dragolea, L. L., & Brumă, I. S. (2025). The dynamics of European agri-food sector and environmental challenges in Europe: An economic perspective. *Agricultural and Food Economics*, 13(67), 1-36. <https://doi.org/10.1186/s40100-025-00416-z>
9. Ion, R. A., Dobre, I., & Soproni, V. D. (2019). Efficiency versus competitiveness in Romanian agriculture: Case study. *Economic of Agriculture*, 66(3), 691-705. <https://doi.org/10.5937/ekoPolj1903691R>
10. Ivanović, S., Nastić, L., & Jeločnik, M.. Investment activity of Serbian farms comparing to neighboring countries: Application of FADN indicators. *Ekonomika*, 66(4), 74–87. <https://doi.org/10.5937/ekonomika2004074I>
11. Kubala, S. (2024). The impact of farm direction on the cost and quantity of used fertilizer. *International Entrepreneurship Review*, 10(2), 55–67. <https://doi.org/10.15678/IER.2024.1002.04>
12. Kusz, D., Zajac, S., & Dziekan, R. (2020). Regional diversification of investment outlays and labour profitability in agriculture in Poland. *Annals of the Polish Association of Agricultural and Agribusiness Economists*, 22(4), 116–126. <https://doi.org/10.5604/01.3001.0014.5686>
13. Macours, K., & Swinnen, J. (2000). Causes of output decline in economic transition: The case of Central and Eastern European agriculture. *Journal of Comparative Economics*, 28, 172-206. <https://doi.org/10.1006/jcec.1999.1643>
14. Mihailović, N., Radovanović, Ž., & Radovanović, S. (2023). Comparative financial analysis of fruit and vegetable juice production sectors in Serbia and Croatia. *Economics of Agriculture*, 70(3), 785–796. <https://doi.org/10.59267/ekoPolj2303785M>

15. Mijić, K., & Jakšić, D. (2017). The determinants of agricultural industry profitability: Evidence from Southeast Europe. *Custos e Agronegocio on line*, 13(1), 154–176.
16. Milošev, I. (2023). Determinations of profitability in the agricultural sector in Serbia. *Economics of Agriculture*, 70(4), 953–966. <https://doi.org/10.59267/ekoPolj2304953M>
17. Onegina, V., Megits, N., Antoshchenkova, V., & Boblovskyi, O. (2020). Outcome of capital investment on labor productivity in agriculture sector of Ukraine. *Journal of Eastern European and Central Asian Research*, 7(1), 12–25. <https://doi.org/10.15549/jeecar.v7i1.355>
18. Pawłowski, K. P., Czubak, W., Zmysłona, J., & Sadowski, A. (2021). Overinvestment in selected Central and Eastern European countries: Production and economic effects. *PLOS ONE*, 16(5), <https://doi.org/10.1371/journal.pone.0251394>
19. Petrović, D., Novović, M., & Šoškić, M. (2025). Comparative analysis of milling-bakery and confectionery industry in Serbia based on Benford's Law. *Economics of Agriculture*, 72(1), 13–32. <https://doi.org/10.59267/ekoPolj250113P>
20. Radosavljević, K., Paraušić, V., Mihailović, B., & Pantović, D. (2016). Assessing the satisfaction level of rural tourist households in Serbia with the economic sustainability dimension. *Economic of Agriculture*, 72(1), 45–62. <https://doi.org/10.59267/ekoPolj250145R>
21. Średzińska, J. (2019). Determinants of the financial situation of farms in European Union countries grouped by economic size. *Annals of the Polish Association of Agricultural and Agribusiness Economists*. XXI (4), 523–532. <https://doi.org/10.5604/01.3001.0013.5386>
22. Ženka, J., Žufan, P., Krtička, L., & Slach, O. (2015). Labour productivity of agricultural business companies and cooperatives in the Czech Republic: A micro-regional level analysis. *Moravian Geographical Reports*, 23(4), 14–25. <https://doi.org/10.1515/mgr-2015-0021>

THE ROLE OF HUMAN CAPITAL IN SHAPING ATTITUDES AND ADOPTING ORGANIC AGRICULTURE IN KOSOVO AND METOHIJA

Andelka Pindović¹, Ljiljana Arsić², Sanja Dobričanin³, Lela Ristić⁴

*Corresponding author E-mail: andjelka.tripkovic@pr.ac.rs

ARTICLE INFO

Original Article

Received: 06 April 2026

Accepted: 25 June 2026

doi:10.59267/ekoPolj2603783P

UDC

330.142.211:631.147(497.115)

Keywords:

human capital, workforce, organic agriculture, adoption of practices, agricultural holdings, Kosovo and Metohija.

JEL: Q12, Q13, J24, O13

ABSTRACT

This paper examines the role of human capital and workforce characteristics in shaping attitudes and adopting organic agricultural practices in Kosovo and Metohija. The research is based on a quantitative approach, using survey data collected from agricultural producers and analyzed through multiple linear regression. The results indicate that the level of knowledge, perception of the importance of human capital, and workforce characteristics have a statistically significant impact on attitudes toward organic production, with the model explaining a substantial portion of the variability. The findings confirm that human capital represents a key determinant in the adoption of sustainable agricultural practices. The results further suggest that enhancing education, skills, and access to information can positively influence the development of organic agriculture. Therefore, strengthening training programs and institutional support for producers is recommended.

-
- 1 Andelka Pindović, Ph.D, Assistant Professor, University of Priština with temporary seat in Kosovska Mitrovica, Faculty of Economics, Kolašinska 156, Serbia, E-mail: andjelka.tripkovic@pr.ac.rs, ORCID ID (<https://orcid.org/0000-0002-3972-4933>)
 - 2 Ljiljana Arsić, Ph.D, Full Professor, University of Priština with temporary seat in Kosovska Mitrovica, Faculty of Economics, Kolašinska 156, Serbia, E-mail: ljiljana.arsic@pr.ac.rs, ORCID ID (<https://orcid.org/0000-0002-3582-8161>)
 - 3 Sanja Dobričanin, Ph.D, Associate Professor, University of Priština with temporary seat in Kosovska Mitrovica, Faculty of Economics, Kolašinska 156, Serbia, E-mail: sanja.dobricanin@pr.ac.rs, ORCID ID (<https://orcid.org/0000-0003-1804-9374>)
 - 4 Lela Ristić, Ph.D, Full Professor, University of Kragujevac, Faculty of Economics, Liceja Kneževine Srbije 3, 34000 Kragujevac, Serbia, E-mail: lristic@kg.ac.rs, ORCID ID (<https://orcid.org/0000-0002-4590-8261>)

Introduction

*“He who knows not, and knows not that he knows not, is a fool; shun him.
He who knows not, and knows that he knows not, is a child; teach him.
He who knows, and knows not that he knows, is asleep; wake him.
He who knows, and knows that he knows, is wise; follow him.”*

Confucius

In the twentieth century, a century of technological and scientific advancement, fundamental changes occurred in various areas of human life and work, which were also reflected in the agricultural sector (Tripković, 2024). Based on the principles of sustainable agriculture, and with the aim of understanding and determining its impact on the environment, innovative concepts and efficient agricultural methods have been developed, with organic agricultural production occupying a particularly important place (Bojičić & Tripković, 2023; Luković et al., 2026). As a new paradigm in the agrarian sector, organic production is increasingly recognized as a significant production concept attracting the attention of farmers, researchers, scientists, and the wider public (Radović et al., 2023). Organic agriculture is defined as production that relies on minimal use of chemical inputs, preservation of biodiversity, and sustainable management of natural resources, all with the aim of meeting the needs of present and future generations (Möhring et al., 2024). The fundamental principles of organic production are based on the rational use of natural resources, soil fertility preservation, biodiversity protection, and the reduction of negative environmental impacts. The growing global demand for organic products further stimulates farmers' interest in adopting this type of production. In contemporary literature, this form of agricultural production has been extensively studied by numerous authors worldwide from various theoretical and methodological perspectives, and it is increasingly applied in practice, as evidenced by the rising number of organic producers, the percentage of land under organic cultivation, and the number of livestock raised within organic farming systems in many countries (Ristić et al., 2023). According to data from the International Federation of Organic Agriculture Movements (IFOAM) and the Research Institute of Organic Agriculture (FiBL), global areas under organic agriculture have increased significantly in recent years. In 2017, approximately 69.8 million hectares of agricultural land were under organic production, and by 2020 this area had grown to around 75 million hectares, with more than 3.4 million producers worldwide. With continuous growth, by 2023, the organic agricultural area reached nearly 99 million hectares, while the number of organic producers exceeded 4.3 million (Willer & Trávníček, 2024).

Although organic agriculture offers numerous advantages, the process of its adoption is often complex and influenced by various economic, institutional, and social determinants. Among these, human capital stands out as a key determinant in the adoption of organic practices, encompassing farmers' knowledge, skills, experience, and capabilities. As noted by Tripković et al. (2023, p. 66), organic agriculture, as a form of sustainable agricultural system, requires land, resources, and, ultimately, people who

must be motivated, committed, and intellectually agile to produce in accordance with ethical and ecological standards. Creating the necessary conditions and providing human resources for the development and competitiveness of organic agriculture—including infrastructure, incentive measures, and various facilitative policies—requires a series of actions and development programs (Stanojević et al., 2015). By investing in education, training, and skill development programs tailored to organic agriculture, stakeholders can enhance human capital and stimulate the continuous growth and sustainability of organic agriculture (Tomaš-Simin et al., 2024). Ignjatijević et al. (2022) argue that human capital in organic agriculture affects both production and financial outcomes, while the socio-economic characteristics of producers can influence the development of this production system. A higher level of human capital enables farmers to better understand and implement new production techniques, manage risks, and adapt their operations to contemporary market demands (Nguyen To-The et al., 2025). Furthermore, the importance of human capital is also reflected in the structure of the labor force on farms, which in many rural areas largely relies on family labor. In such conditions, knowledge and experience are transferred among household members, ensuring continuity in production and strengthening farm capacities (Hatzenbuehler & Peña-Lévano, 2022).

In the specific socio-economic context of Kosovo and Metohija, the agricultural sector is not only a source of livelihood but also provides social security for a large number of poor and elderly people (Bojičić & Tripković, 2022). Despite significant natural and economic potential, and a strong desire to eliminate the widely accepted extensive farming practices, the modernization of the agricultural sector in Kosovo and Metohija has, in some ways, remained incomplete. A limited level of formal education, insufficient practical experience in modern production techniques, and inadequate institutional support represent key barriers to the wider adoption of organic practices. Nevertheless, a recorded annual growth of 24.1% and a ten-year growth of 1,692.8% in areas under organic land place Kosovo and Metohija among the territories with the most dynamic development of organic agriculture in Europe (Bojičić & Tripković, 2023; FiBL–IFOAM, 2023). In order to cope with changes occurring on the global stage, farmers in Kosovo and Metohija need to improve their knowledge and skills to perform highly productive tasks. Considering the high unemployment rate in the region, enhancing farmers' knowledge should be a primary strategy for growth and development in all districts, enabling multiple benefits through self-employment or family-based businesses (Tripković, 2024).

Starting from the identified theoretical and empirical gaps in understanding the role of human capital in organic production, this paper aims to examine the influence of knowledge levels, labor force characteristics, and socio-demographic attributes of farmers on the implementation of agricultural practices on farms in Kosovo and Metohija. Special attention is given to identifying the key determinants of human capital and understanding their relationship with farmers' attitudes and perceptions, in order to provide a basis for designing effective support measures and improving the sustainable development in the agricultural sector.

Methodology

The research was conducted with the aim of examining the importance of human capital in organic agricultural production, as well as determining the relationships between knowledge levels, labor force characteristics, and perceptions of organic production on farms in Kosovo and Metohija. The main objective of the research was to identify the human capital factors that influence the adoption of organic practices. Secondary objectives include analyzing the correlation between farmers' knowledge of organic production and their attitudes and perceptions, examining the role of labor force characteristics in the application of organic methods, and assessing the impact of socio-demographic characteristics on attitudes and practices in organic agriculture.

The empirical research was carried out using a quantitative approach in the period from December 2023 to March 2024, with a survey questionnaire as the primary data collection instrument. The sample included 431 farmers from 18 municipalities in Kosovo and Metohija. The sample was formed using a convenience sampling method, taking into account the availability of respondents and the specifics of field research in the observed region. Respondents were characterized by various socio-demographic features, including gender, age, municipality of residence, level of education, income level, and marital status. Additionally, data were collected on farm characteristics, such as the type of agricultural activity, the number of household members involved in agricultural activities, and the duration of engagement in agriculture.

The research instrument consisted of three thematic sections. The first section covered socio-demographic data, the second assessed the level of knowledge about organic production and the prevalence of organic practices, and the third section examined attitudes toward the importance of human capital, labor force characteristics, and perceptions of organic production. Respondents used a five-point Likert scale, where 1 indicated strong disagreement and 5 indicated strong agreement with the statements. The internal consistency of the scales was verified using Cronbach's alpha coefficient, confirming the reliability of the instrument for measuring the observed constructs.

Data analysis included descriptive statistics, correlation analysis using Pearson's coefficient, multiple linear regression, and principal component analysis (PCA) method. Factor analysis was applied to identify latent dimensions of human capital, labor force characteristics, and perceptions of organic production, enabling the reduction of a larger number of variables into a smaller number of significant factors. The adequacy of factor analysis was tested using the KMO measure and Bartlett's test of sphericity, and all statistical analyses were performed using IBM SPSS Statistics Version 26. Respondents were informed about the purpose of the research, and their participation was voluntary, ensuring compliance with ethical research standards.

Results

Of the total number of respondents, 55% were male and 45% were female, with an average age of 39 years. The youngest respondent was 18 years old, while the oldest was 80 years old. The average income of respondents ranged between 51,000 and 100,000 dinars, while slightly more than a quarter of respondents (28.31%) reported income below 50,000 dinars (Tripković, 2024). The research covered four municipalities in northern Kosovo and Metohija (Kosovska Mitrovica – 13.2%, Zvečan – 10.2%, Leposavić – 6%, and Zubin Potok – 9.3%) and fourteen municipalities south of the Ibar River (Dragaš – 3.2%, Gračanica – 8.6%, Kosovo Polje – 2.1%, Kosovska Kamenica – 2.1%, Lipjan – 7.7%, Novo Brdo – 3.2%, Obilić – 8.6%, Pasjane – 5.1%, Priština – 2.6%, Prizren – 2.1%, Ranilug – 3.0%, Štrpce – 3.7%, Vitina – 2.6%, and Vučitrn – 6.7%) (Tripković, 2024). Other socio-demographic characteristics of respondents are presented in *Table 1*.

Table 1. Socio-demographic characteristics of respondents

		Number of Respondents (N)	Percentage (%)
Gender	male	237	55
	female	194	45
		Number of Respondents (N)	Percentage (%)
Educational Level	primary education	11	2.6
	secondary education	69	16.0
	higher education	197	45.7
	master's degree	153	35.5
	doctorate (PhD)	1	0.2
		Number of Respondents (N)	Percentage (%)
Marital Status	single	142	32.9
	cohabiting	19	4.4
	married	255	59.2
	divorced	13	3.0
	widowed	2	0.5

Source: Author's research

The analysis of the agricultural production structure shows that respondents are most often engaged in crop production (50.8%), while fruit growing is represented among 36.0% of respondents. On the other hand, viticulture is the least represented activity, practiced by 9.7% of respondents. Regarding the engagement of household members in agricultural activities, the results indicate that on some farms up to nine members are involved in agricultural activities, while the average number of engaged members, in almost all municipalities is three. Observed over time, the longest period of engagement in agriculture is thirty years, while the average duration is approximately ten years. In response to the question, *“Is organic production, as a new production concept, sufficiently represented on farms in Kosovo and Metohija?”*, slightly more than one-

third of respondents (35%) stated that this concept is partially represented. The most common reasons for this perception include a lack of understanding of the concept of organic production (39.7%) and the presence of misinformation (29.7%). Self-assessment results regarding knowledge of organic production show that the largest percentage of respondents rated their knowledge as good (42%). A significant proportion reported very good knowledge (31%), while 11% stated they have excellent knowledge in this area. A smaller number of respondents rated their knowledge as sufficient (10%) or insufficient (6%). Furthermore, 29.2% of respondents believe that human capital, combined with other elements of production (means and objects of labor), plays an important role in organic production, while 17.6% of respondents emphasize that human capital represents the backbone of organic production development.

Table 2. Respondents' attitudes regarding the importance of human capital in organic agricultural production

STATEMENT	MIN	MAX	AS	SD
Human capital is important for the development of organic production.	1	5	3.63	1.001
Human capital in organic production requires continuous learning and acquisition of new skills.	1	5	3.83	.961
Human capital in organic production involves monitoring and applying innovative approaches on farms.	1	5	3.84	.913
The workforce in organic production must be fully familiar with the principles of cultivating ecologically healthy food.	1	5	3.87	.947
A certain level of knowledge and skills in organic production directly leads to higher yields.	1	5	3.86	1.017
A certain level of knowledge and skills in organic production directly leads to lower costs.	1	5	3.66	1.055
Knowledge and skills in organic production are acquired through education, training, and work experience.	1	5	3.94	1.005
Σ	1	5	3.80	0.848

Source: Author's research

The importance of human capital at the overall scale level shows a high mean value ($AS = 3.80$; $SD = 0.848$), with scores ranging from 1 to 5. This average indicates a positive perception among respondents regarding the importance of human capital in organic agricultural production. The highest-rated statement was that "*knowledge and skills in organic production are acquired through education, training, and work experience*" ($AS = 3.94$; $SD = 1.005$).

Table 3. Respondents' attitudes regarding workforce characteristics in organic agricultural production

	MIN	MAX	AS	SD
Innovativeness	1	5	3.89	.844
Entrepreneurial spirit	1	5	3.97	.981
Commitment	1	5	4.09	.881
Diligence	2	5	4.03	.900
Responsibility	2	5	4.12	.902
Willingness to learn	2	5	4.07	.859
Patience	1	5	4.11	.968
Σ	1	5	4.04	.905

Source: Author's research

Regarding respondents' attitudes toward the characteristics of the workforce in organic agricultural production, the overall mean score was $AS = 4.04$; $SD = 0.905$, with values ranging from 1 to 5. The obtained average indicates an above-average presence of these traits. When evaluating individual workforce characteristics, respondents rated *responsibility* highest ($AS = 4.12$; $SD = 0.902$) and *patience* closely behind ($AS = 4.11$; $SD = 0.968$), while *innovativeness* ($AS = 3.89$; $SD = 0.844$) and *entrepreneurial spirit* ($AS = 3.97$; $SD = 0.981$) received the lowest scores.

Table 4. Respondents' attitudes toward organic agricultural production

	MIN	MAX	AS	SD
Organic production is a promising agricultural activity.	1	5	3.84	.937
Organic production achieves a higher level of productivity.	1	5	3.72	.900
Teamwork is very important in organic production.	1	5	3.93	.871
I possess a certain level of knowledge about the basic principles of organic production.	1	5	3.76	1.060
I have successfully mastered the skills necessary for engaging in organic production.	1	5	3.81	.983
I make high-quality and cost-effective business decisions on my farm.	1	5	3.87	1.010
I continuously follow innovations in organic production and apply them on my farm.	1	5	3.82	1.113
Σ	1	5	3.82	.982

Source: Author's research

The third and final scale of the questionnaire refers to respondents' perceptions of organic agricultural production. On this scale, the average score was $AS = 3.82$; $SD = 0.982$. The results indicate that respondents consider *teamwork* in organic agricultural production to be the most important factor ($AS = 3.93$; $SD = 0.871$). In contrast, the statement that organic production achieves a *higher level of productivity* received the lowest rating ($AS = 3.72$; $SD = .900$).

In the following section of the paper, a correlation matrix of the analyzed variables is presented, enabling a systematic examination of the relationships among the key indicators in the study.

Table 5. Correlation matrix of the analyzed variables

	1	2	3	4	5	6	7	8	9	10	11	12	13
1	1												
2	-.119	1											
3	-.093	.097	1										
4	-.077	-.252	.431	1									
5	-.030	.334	.236	-.111	1								
6	-.171	-.005	-.022	-.026	.036	1							
7	-.090	.616	-.102	-.191	.283	.259	1						
8	.031	-.031	.106	.069	.155	.064	-.036	1					
9	-.125	.126	.021	.036	.269	.101	.154	.329	1				
10	-.145	.236	.040	-.076	.042	.114	.284	.129	.109	1			
11	.067	.024	.058	.044	.091	.025	.131	.067	.197	.310	1		
12	.074	.013	.052	-.084	.090	.044	.106	.081	.062	.117	.647	1	
13	-.040	.151	.040	.044	.174	.143	.239	.276	.385	.300	.624	.535	1
* $p < 0.005$													
** $p < 0.001$													
LEGEND													
1 – gender							8 – representation of organic production						
2 – age							9 – level of knowledge about organic production						
3 – income level							10 – importance of human capital						
4 – education level							11 – human capital in organic production						
5 – marital status							12 – characteristics of workforce in OP						
6 – household workforce participation							13 – attitudes toward OP						
7 – years of engagement in agriculture													

Source: Author's research

Based on the obtained correlations, a multiple linear regression model was applied in further analysis to examine the predictive strength of selected independent variables in explaining respondents' attitudes toward organic agricultural production.

Table 6. Regression model: Level of knowledge about organic production, importance of human capital, workforce characteristics in organic production, length of engagement in agriculture, and educational attainment as predictors of respondents' attitudes toward organic agricultural production

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.719 ^a	.518	.512	3.71243

Model	Sum of Squares	Df	Mean Square	F	Sig.
Regression	6282.526	5	1256.505	91.169	.000 ^b
Residual	5857.404	425	13.782		
Total	12139.930	430			

	B	Std. Error	Beta	t	Sig.
Constant (Attitudes toward OP)	2.064	1.423		1.450	.148
Level of knowledge about organic production	1.448	.186	.272	7.799	.000
Importance of human capital	.359	.043	.380	8.319	.000
Workforce characteristics in organic production	.283	.048	.255	5.909	.000
Length of engagement in agriculture	.089	.024	.131	3.738	.000
Educational attainment	.442	.238	.065	1.858	.064

Source: Author's research

After examining the interrelationships and predictive influence of individual variables through correlation and regression analysis, factor analysis was applied in the next phase of the research.

Table 7. Factor Analysis

KMO and Bartlett's Test

Kaiser-Meyer-Olkin	Measure of Sampling Adequacy	.906
Bartlett's test of Sphericity	Approx. Chi-Square	6445.762
	Df	210
	Sig.	.000

Total Variance Explained

Component	Total	Initial Eigenvalues	
		% of Variance	Cumulative %
1	9.716	46.267	46.267
2	2.276	10.837	57.104
3	1.576	7.504	64.608
4	1.097	5.222	69.830

Rotated Component Matrix

	Component			
	1	2	3	4
Human Capital in OP 1	.770			
Human Capital in OP 2	.738			
Human Capital in OP 3	.754			
Human Capital in OP 4	.711	.412		
Human Capital in OP 5	.754			
Human Capital in OP 6	.576		.432	
Human Capital in OP 7	.706			
Characteristics of the Workforce in OP 1				.748
Characteristics of the Workforce in OP 2	.419	.452		.574
Characteristics of the Workforce in OP 3		.687		
Characteristics of the Workforce in OP 4		.737		
Characteristics of the Workforce in OP 5		.772		
Characteristics of the Workforce in OP 6		.790		
Characteristics of the Workforce in OP 7		.752		

	Component			
	1	2	3	4
Attitudes toward OP 1				.594
Attitudes toward OP 2			.522	.601
Attitudes toward OP 3			.463	.499
Attitudes toward OP 4			.774	
Attitudes toward OP 5			.832	
Attitudes toward OP 6			.781	
Attitudes toward OP 7			.822	

Source: Author's research

Discussion

The analysis of the obtained data highlights the crucial role of human capital, workforce characteristics, and producers' attitudes, providing insight into the factors that may influence the development and implementation of organic practices in Kosovo and Metohija. Furthermore, the results can be placed within the context of existing research, revealing both similarities and differences in the perception and practical implementation of organic production.

The variable "gender" shows a statistically significant relationship with the following variables:

1. "age in years" ($p = 0.013$; $\rho = -0.119$);
2. "household workforce participation" ($p = 0.000$; $\rho = -0.171$);
3. "level of knowledge about organic production" ($p = 0.010$; $\rho = -0.125$);
4. "importance of human capital" ($p = 0.002$; $\rho = 0.145$).

The observed differences can be interpreted within the context of the broader socio-economic and institutional characteristics of the agricultural sector, where the roles of men and women are defined differently. In many rural areas, the organization of work on family farms, the distribution of responsibilities, and access to resources remain partially conditioned by traditional gender roles. Mladenović and Bojičić (2021) note that women in Kosovo and Metohija more often engage in activities such as retail trade and small-scale production, including food production and service activities that do not require significant physical effort, while men are more represented in sectors such as transport, large-scale production, and wholesale trade. The FAO (2023) emphasizes that gender can influence access to education, agricultural training, and information about innovations in agriculture, which indirectly affects the knowledge level of agricultural producers. Furthermore, research indicates that greater involvement of women in agricultural production may contribute to a wider adoption of environmentally responsible practices, as women tend to demonstrate a stronger inclination toward

preserving natural resources and sustainable farm management (Valencia et al., 2021). In this context, a gender perspective represents an important analytical framework for understanding how knowledge, experience, and competencies are developed and applied in organic agricultural production.

The variable “*age in years*” shows a statistically significant relationship with the following variables:

1. “*income level*” ($p = 0.043$; $\rho = 0.097$);
2. “*education level*” ($p = 0.000$; $\rho = -0.252$);
3. “*marital status*” ($p = 0.000$; $\rho = 0.334$);
4. “*years of engagement in agriculture*” ($p = 0.000$; $\rho = 0.616$);
5. “*level of knowledge about organic production*” ($p = 0.000$; $\rho = 0.126$);
6. “*human capital in organic production*” ($p = 0.000$; $\rho = 0.236$);
7. “*attitudes toward OP*” ($p = 0.002$; $\rho = 0.151$).

A strong correlation between age and the length of engagement in agriculture is expected, as accumulated production experience increases over time. Long-term experience in agriculture contributes to the development of practical knowledge and a better understanding of production processes, which may also influence the perception of the importance of human capital in organic production. Klerkx and Rose (2020) confirm that farmers’ experience is an important factor in the adoption of sustainable and organic production practices. The negative correlation between age and formal education can be explained by generational differences in access to education, as younger generations are more likely to have higher levels of formal education. However, the results indicate that formal education is not the only source of knowledge, since older farmers acquire a significant level of practical competencies through work experience. The scientific literature emphasizes that the combination of education, experience, and continuous learning represents an important element in the development of human capital in agriculture (Doss et al., 2017).

The variable “*income level*” shows a statistically significant relationship with the following variables:

1. “*marital status*” ($p = 0.000$; $\rho = 0.236$);
2. “*years of engagement in agriculture*” ($p = 0.035$; $\rho = -0.102$);
3. “*representation of organic production*” ($p = 0.028$; $\rho = 0.106$).

The correlation between income level and marital status may indicate the importance of family structure and joint labor within agricultural households, as farms with a larger number of active members tend to have greater production capacities and potentially

higher economic stability. Bojičić and Tripković (2022) confirm that farms in urban areas and municipal centers usually have fewer members, most often up to three, whereas farms in rural areas more frequently include four to five members, typically representing two-generation or extended families. Eti (2025) emphasizes that the socio-economic characteristics of farms, including family structure and labor availability, can influence the economic performance of agricultural production. The relationship between income and length of engagement in agriculture suggests that economic results in agriculture depend not only on experience but also on technology, financial resources, and market conditions. Ogunya and Tijani (2022) point out that the adoption of modern and sustainable production practices can improve the economic efficiency of agricultural households.

The variable “*education level*” shows a statistically significant relationship with the following variables:

1. “*marital status*” ($p = 0.022$; $\rho = -0.111$);
2. “*years of engagement in agriculture*” ($p = 0.000$; $\rho = -0.191$).

The correlation between education level and marital status confirms the influence of social and family structures on an individual’s educational attainment in agricultural communities. Additionally, the relationship between education and the length of engagement in agriculture shows that the intensity and duration of agricultural involvement are not always directly associated with the level of formal education. These findings are consistent with the research of Eti (2025) and Ogunya and Tijani (2022), which emphasize that human capital, including education and continuous training, plays an important role in the adoption of new technologies, resource management, and market access, while social and family factors may influence opportunities for educational development in agricultural communities.

The variable “*marital status*” shows a statistically significant relationship with the following variables:

1. “*years of engagement in agriculture*” ($p = 0.000$; $\rho = 0.283$);
2. “*representation of organic production*” ($p = 0.000$; $\rho = 0.155$);
3. “*level of knowledge about organic production*” ($p = 0.000$; $\rho = 0.269$);
4. “*attitudes toward OP*” ($p = 0.000$; $\rho = 0.174$).

The correlation between marital status and the analyzed variables confirms that socio-demographic factors influence the adoption of new practices and education within agricultural communities. There is evidence that social and family aspects, including marital status, may affect access to information, labor, and resources necessary for engagement in organic agriculture and the development of relevant knowledge (Sapbamrer & Thammachai, 2021). Moreover, the same authors (Sapbamrer &

Thammachai, 2021) emphasize that technology, information, and access to advisory support form the foundation for shaping farmers' attitudes and knowledge toward sustainable systems. Without adequate knowledge and a positive attitude, the adoption of organic agriculture may be hindered, regardless of long-term experience in traditional farming.

The variable "*household workforce participation*" shows a statistically significant relationship with the following variables:

1. "*years of engagement in agriculture*" ($p = 0.000$; $\rho = 0.259$);
2. "*level of knowledge about organic production*" ($p = 0.036$; $\rho = 0.101$);
3. "*human capital in organic production*" ($p = 0.018$; $\rho = 0.114$);
4. "*attitudes toward OP*" ($p = 0.003$; $\rho = 0.143$).

The correlation between household member involvement and variables such as length of engagement in agriculture, level of knowledge about organic production, human capital, and attitudes toward organic farming highlights the importance of collective work and mutual support within households. The involvement of more household members enables better allocation of labor resources, sharing of knowledge and experience, as well as greater capacity to adopt innovations and sustainable practices in agriculture. Sapbamrer and Thammachai (2021) note that active participation of family members in agricultural activities positively influences the adoption of new technologies and organic production systems. Raveloaritiana and Wanger (2024) emphasize that both attitudes and knowledge levels regarding organic production depend on household involvement, as members actively engaged in production often exchange information, learn from each other, and support the implementation of sustainable practices, leading to increased productivity and economic efficiency.

The variable "*years of engagement in agriculture*" shows a statistically significant relationship with the following variables:

1. "*level of knowledge about organic production*" ($p = 0.000$; $\rho = 0.154$);
2. "*importance of human capital*" ($p = 0.000$; $\rho = 0.284$);
3. "*human capital in organic production*" ($p = 0.000$; $\rho = 0.131$);
4. "*characteristics of workforce in OP*" ($p = 0.000$; $\rho = 0.106$);
5. "*attitudes toward OP*" ($p = 0.001$; $\rho = 0.239$).

The conditional relationship between the length of engagement in agriculture and variables such as knowledge of organic production, the importance and role of human capital, and workforce characteristics confirms that long-term experience in agriculture can contribute to the development of specific skills and a better understanding of organic production systems. Nguyen To The et al. (2025) argue that, although experience alone is

not sufficient for the full adoption of modern or sustainable practices, when combined with the development of human capital, it enables better resource management, knowledge transfer, and the application of innovations on agricultural farms. Additionally, long-term engagement in agriculture influences workforce characteristics, as practical competencies, teamwork, and organizational skills, which are crucial for the successful implementation of organic practice, develop over time. This aligns with findings that human capital in agriculture is not only individual knowledge but also a collective resource accumulated through experience and interaction among household members, thereby enhancing farm productivity and economic sustainability (Raveloaritiana & Wanger, 2024).

The variable “*representation of organic production*” shows a statistically significant relationship with the following variables:

1. “*level of knowledge about organic production*” ($p = 0.000$; $\rho = 0.329$);
2. “*attitudes toward OP*” ($p = 0.000$; $\rho = 0.276$).

The correlation between the prevalence of organic production and farmers’ knowledge and attitudes toward organic farming indicates that the adoption of organic practices on a farm depends on both cognitive and affective factors. Specifically, farmers with higher levels of knowledge about organic agriculture and more positive attitudes are more likely to implement organic production methods, which is expected, as they are better informed and more motivated to change production practices (Zhou & Ding, 2022). Farmers’ attitudes toward the social and ecological aspects of organic production play a significant role in their willingness and ability to apply sustainable practices. The position and perception of farmers, as well as their understanding of the benefits of organic production, influence the prevalence of organic systems on the farm, which is consistent with findings indicating a significant correlation between attitudes and the adoption of organic production (Canavari et al., 2022).

The variable “*level of knowledge about organic production*” shows a statistically significant relationship with the following variables:

1. “*importance of human capital*” ($p = 0.000$; $\rho = 0.109$);
2. “*human capital in organic production*” ($p = 0.002$; $\rho = 0.197$);
3. “*attitudes toward OP*” ($p = 0.000$; $\rho = 0.385$).

The interdependence of knowledge levels about organic production with the importance of human capital and attitudes toward organic farming indicates that farmers’ education and competencies are fundamental prerequisites for the successful implementation of sustainable practices. Zhou and Ding (2022), as well as Canavari et al. (2022), emphasize that higher levels of knowledge enable farmers to better understand the benefits and challenges of organic production, shaping their attitudes and facilitating the adoption of innovations. Furthermore, human capital, encompassing practical

experience, specific skills, and teamwork, plays a crucial role in knowledge transfer and the formation of positive attitudes toward sustainable methods. Therefore, policies and programs that support continuous learning and skill development in organic agriculture can significantly improve the productivity and quality of production on local farms.

The variable “*importance of human capital*” shows a statistically significant relationship with the following variables:

1. “*human capital in organic production*” ($p = 0.000$; $\rho = 0.310$);
2. “*characteristics of workforce in OP*” ($p = 0.036$; $\rho = 0.117$);
3. “*attitudes toward OP*” ($p = 0.000$; $\rho = 0.300$).

The variable “*human capital in organic production*” shows a statistically significant relationship with the following variables:

1. “*characteristics of workforce in OP*” ($p = 0.000$; $\rho = 0.647$);
2. “*attitudes toward OP*” ($p = 0.000$; $\rho = 0.624$).

The variable “*characteristics of workforce in OP*” shows a statistically significant relationship with the following variable:

1. “*attitudes toward OP*” ($p = 0.000$; $\rho = 0.535$).

Milardo (2025) and Rizzo et al. (2024) emphasize that organic production functions as a complex system in which education, the adoption of innovative principles, and understanding of sustainable techniques directly influence farmers’ readiness to implement new methods, while the development of human capital, including formal education and continuous learning, represents a primary factor enabling this process. Furthermore, international reviews show that socio-demographic and psychological factors, such as access to information, education level, and positive attitudes toward sustainable practices, significantly increase the likelihood of adopting innovative methods, including organic production, as these components shape the perception of benefits and practical readiness to apply new techniques (Rizzo et al., 2024). These findings confirm that knowledge and attitudes are not passive consequences of experience but active mechanisms that enable agricultural households to integrate organic farming concepts into production models. At the same time, the research results have significant implications for designing educational programs, advisory services, and support policies that promote continuous learning, knowledge exchange, and human capital development in rural areas. Such a synergy of knowledge, competencies, and attitudes forms the foundation for the long-term improvement of sustainable organic production and the economic stability of agricultural households.

The results of the conducted multiple linear regression analysis indicate that the model has a high level of statistical significance. The correlation coefficient between the predictor and dependent variables is $R = 0.719$, indicating a strong relationship

between the independent variables and respondents' attitudes toward organic agricultural production. The coefficient of determination, $R^2 = 0.518$, shows that the model explains 51.8% of the variability in the dependent variable, meaning that more than half of the variation in attitude formation can be explained by the analyzed predictors: level of knowledge about organic production, the importance of human capital, workforce characteristics, length of engagement in agriculture, and formal education. The adjusted coefficient of determination, Adjusted $R^2 = 0.512$, indicates that the model maintains a high explanatory power even after correcting for the number of included independent variables, confirming the stability of the regression model. The standard error of the estimate is 3.712, reflecting a relatively low deviation of the actual values from those predicted by the model. The statistical significance of the model is further supported by the ANOVA test results ($F = 91.169$; $p = 0.000$), indicating that the regression model as a whole is statistically significant and that at least one of the independent variables significantly contributes to explaining the variability of the dependent variable. Among the analyzed predictors, based on the significance levels of the standardized β coefficients, it can be observed that:

- *the level of knowledge about organic production* ($\beta = .272$) is a statistically significant predictor of respondents' positive attitudes toward organic agricultural production;
- *the importance of human capital* ($\beta = .380$) is a statistically significant predictor of respondents' positive attitudes toward organic agricultural production;
- *workforce characteristics in organic production* ($\beta = .255$) are statistically significant predictors of respondents' positive attitudes toward organic agricultural production;
- *years of engagement in agriculture* ($\beta = .131$) is a statistically significant predictor of respondents' positive attitudes toward organic agricultural production;
- *education level* ($\beta = .065$) is not a statistically significant predictor of respondents' positive attitudes toward organic agricultural production.

Overall, the results of the regression analysis confirm that respondents' attitudes toward organic agricultural production are primarily shaped by knowledge, the perceived importance of human capital, and workforce characteristics, confirming the key role of human capital. Similar findings have been reported in studies indicating that education, knowledge, and experience of agricultural producers are significant factors in shaping attitudes and readiness to adopt organic production practices (Läpple & Kelley, 2013; Wollni & Andersson, 2014; Erokhin, 2022). Furthermore, Knowler and Bradshaw (2007) emphasize that human capital, encompassing farmers' knowledge, skills, and experience, has a substantial impact on the adoption of innovations and the implementation of sustainable agricultural systems.

To examine the structure of the questionnaire and identify latent dimensions explaining the variability of the analyzed statements, factor analysis was applied using the Principal Component Analysis (PCA) method. Before performing the factor analysis, the adequacy of the data was assessed. The Kaiser-Meyer-Olkin (KMO) measure yielded a value of 0.906, indicating a very high degree of sample adequacy for factor analysis, while Bartlett's test of sphericity showed a statistically significant result ($\chi^2 = 6445.762$; $p = 0.000$), confirming sufficient intercorrelations among variables to justify factor extraction. The results of the initial eigenvalues analysis revealed four components with values greater than 1, in line with Kaiser's criterion for retaining factors. The first component has an eigenvalue of 9.716 and explains 46.267% of the total variance, indicating its dominant influence within the data structure. The second component accounts for 10.837% of the variance, the third 7.504% and the fourth 5.222% of the total variance. After factor extraction, Varimax rotation with Kaiser normalization was applied to achieve a clearer factor structure. The rotation converged after six iterations, indicating the stability of the obtained solution. Analysis of the rotated factor matrix shows that the statements group into several clearly defined factors:

- The first factor encompasses statements related to the importance of human capital in organic production, with factor loadings ranging from (0.576 – 0.770). This indicates that respondents consistently recognize knowledge, skills, and competencies as crucial elements for successful organic production.
- The second factor includes variables associated with workforce characteristics, such as entrepreneurial spirit, responsibility, diligence, and willingness to learn, with factor loadings ranging from (0.419 – 0.790). The high loadings indicate a clear dimension describing the personal and professional traits of agricultural producers.
- The third factor pertains to respondents' attitudes toward organic agricultural production, including their perception of the prospects of organic production, level of knowledge, and ability to make business decisions on the farm, with loadings ranging from 0.463 – 0.832.
- The fourth factor represents a smaller but relevant dimension, encompassing specific aspects of the perception of organic production and the application of certain principles in practice, with moderate loadings ranging from 0.412 – 0.601.

Conclusion

Based on the results of the conducted empirical analysis, as well as theoretical considerations regarding the importance of human capital in modern agriculture, it can be observed that the process of adopting organic agricultural practices is not determined solely by economic factors, but largely depends on the knowledge, skills, experience, and attitudes of agricultural producers. In this context, human capital and labor force characteristics emerge as key determinants shaping producers' readiness to adopt innovations and sustainable production models. The obtained results indicate that the level of knowledge, perception of the importance of human capital, and agricultural experience are statistically significant factors influencing the formation of attitudes toward organic production. At the same time, the results of the regression analysis confirm that the analyzed factors explain a substantial portion of the variability in respondents' attitudes, further emphasizing their relevance in the context of organic agriculture development. From a broader socio-economic perspective, these findings suggest that improving human capital is a prerequisite not only for the development of organic production but also for the sustainable development of rural areas. Based on the results, the following recommendations can be formulated:

- *Strengthening education and professional development:* Training programs for farmers should be developed by combining theoretical knowledge and practical exercises. Special attention should be given to young farmers in order to ensure the long-term development of human capital and knowledge transfer to future generations.
- *Encouraging family labor participation:* Household members should be actively involved in all stages of production, with mechanisms created to enable systematic knowledge transfer and skill development.
- *Developing collaboration and communication networks:* Establishing local and regional farmers' associations and experience-sharing platforms can significantly accelerate the adoption of organic practices and motivate farmers to implement innovations.
- *Support through economic and technical measures:* It is important to provide subsidies, access to certification, advisory services, and planting material in order to encourage farmers to apply organic methods.
- *Promoting ecological awareness and sustainability values:* Educational programs should encourage and motivate farmers to understand the long-term benefits of organic production, both in terms of environmental conservation and economic sustainability of farms.
- *Focusing on the local specificities of Kosovo and Metohija:* When creating policies and support programs, it is essential to consider rural conditions, limited resources, and labor force structure at the local level in order to ensure effective and sustainable interventions.

Overall, the research results highlight that human capital and organized labor force represent the fundamental prerequisites for a successful transition to organic agriculture

in Kosovo and Metohija. The implementation of the recommended measures can lead to increased productivity, economic sustainability of farms, and long-term development of rural communities. In conclusion, the enhancement of human capital and labor force is not only a matter of individual farmer development, but also a key strategy for achieving sustainable and competitive agriculture in the region.

Conflict of interests

The authors declare no conflict of interest.

References

1. Bojičić, R., & Tripković, A. (2022). State of organic production in Kosovo and Metohija – great perspective or idea without the future. *Economics of Agriculture*, 69(2), 549–566. <https://doi.org/10.5937/ekoPolj2202549B>
2. Bojičić, R., & Tripković, A. (2023). Uticaj organske proizvodnje na poslovanje poljoprivrednih gazdinstava. *Ecologica*, 30(111), 375-382. <https://doi.org/10.18485/ecologica.2023.30.111.5>
3. Canavari, M., Gori, F., Righi, S., & Viganò, E. (2022). Factors fostering and hindering farmers' intention to adopt organic agriculture in the Pesaro-Urbino province (Italy). *AIMS Agriculture and Food*, 7(1), 108–129. <https://doi.org/10.3934/agrfood.2022008>
4. Doss, C., Meinzen-Dick, R., Quisumbing, A., & Theis, S. (2017). Women in agriculture: Four myths. *Global Food Security*, 16(1), 69-74. <https://doi.org/10.1016/j.gfs.2017.10.001>
5. Erokhin, V., Tianming, G., Chivu, L., & Andrei, J. V. (2022). Food security in a food self-sufficient economy: a review of China's ongoing transition to a zero hunger state. *Agricultural Economics/Zemědělská Ekonomika*, 68(12).
6. Eti, H. S. (2025). The effects of Perceptions of Economic Sustainability and Barriers on Organic Farming Omplementation. *Sustainability*, 17(2), 786. <https://doi.org/10.3390/su17020786>
7. Food and Agriculture Organization of the United Nations (FAO). (2023). *The status of women in agrifood systems*. <https://doi.org/10.4060/cc5343en> (accessed: February 19, 2026).
8. Hatzenbuehler, P. L., & Peña-Lévano, L. M. (2022). Adoption Potential of Sustainability Related Agriculture Technologies for Smallholder Farmers in the Global South. *Sustainability*, 14, 13176. <https://doi.org/10.3390/su142013176>
9. Ignjatijević, S., Vapa Tankosić, J., Puvača, N., Carić, M., Rajković, A., Lekić, S., Tomašević, V., Vapa, B., & Prodanović, R. (2022). Influence of human capital on the performance of organic milk production. *Mljekarstvo*, 72(3), 140-150. <https://doi.org/10.15567/mljekarstvo.2022.0303>

10. Klerkx, L., & Rose, D. (2020). Dealing with the game-changing technologies of Agriculture 4.0: How do we manage diversity and responsibility in food system transition pathways?. *Global Food Security*, 24, 100347. <https://doi.org/10.1016/j.gfs.2019.100347>
11. Knowler, D., & Bradshaw, B. (2007). Farmers' Adoption of Conservation Agriculture: A Review and Synthesis of Recent Research. *Food Policy*, 32(1), 25–48. <https://doi.org/10.1016/j.foodpol.2006.01.003>
12. Läpple, D., & Kelley, H. (2013). Understanding the uptake of organic farming: Accounting for heterogeneities among Irish farmers. *Ecological Economics*, 88, 11–19. <https://doi.org/10.1016/j.ecolecon.2012.12.025>
13. Luković, M., Pantović, D., & Čelić, I. (2026). Green human resources management in the environmental protection institutions: qualitative study in the Republic of Serbia. *BizInfo Blace*. <https://doi.org/10.71159/bizinfo260004L>
14. Milardo, R. (2025). The role of knowledge and innovation in organic farming systems: A systematic literature review. *Sustainability*, 17(14), 6563. <https://doi.org/10.3390/su17146563>
15. Möhring, N., Muller, A., & Schaub, S. (2024). Farmers' adoption of organic agriculture: A systematic global literature review. *European Review of Agricultural Economics*, 51(4), 1012–1044. <https://doi.org/10.1093/erae/jbae025>
16. Nguyen To-The, T., Tiet, T., Nguyen-Anh, T., & Nguyen-The, P. (2025). Impact of human capital and risk preferences on farmers' decisions towards sustainable farming practices: A meta-analysis. *Journal of Environmental Management*, 392, 126752. <https://doi.org/10.1016/j.jenvman.2025.126752>
17. Ogunya, L., & Tijani, A. (2022). Economic Efficiency of Organic Farming Adoption by Cocoa Farmers in Southwest, Nigeria. *International Journal of Agricultural Economics*, 7(1), 36–48. <https://doi.org/10.11648/j.ijae.20220701.16>
18. Radović, G., Zejak, D., & Pejanović, V. (2023). Agricultural budget in the function of organic agriculture development in Serbia and Montenegro. *Economic of Agriculture*, 70(2), 645–659. <https://doi.org/10.59267/ekoPolj2302645R>
19. Raveloaritiana, E., & Wanger, T. C. (2024). Decades matter: Agricultural diversification increases financial profitability, biodiversity, and ecosystem services over time. *arXiv*. <https://doi.org/10.48550/arXiv.2403.05599>
20. Ristić, L., Despotović, D., & Veselinović, P. (2023). Organska poljoprivreda kao faktor razvoja zelene ekonomije. *Ecologica*, 30(112), 505-515. <https://doi.org/10.18485/ecologica.2023.30.112.1>
21. Rizzo, G., Migliore, G., Schifani, G., & Vecchio, R. (2024). Key factors influencing farmers' adoption of sustainable innovations: A systematic literature review and research agenda. *Organic Agriculture*, 14, 57–84. <https://doi.org/10.1007/s13165-023-00440-7>

22. Sapbamrer, R., & Thammachai, A. (2021). A Systematic Review of Factors Influencing Farmers' Adoption of Organic Farming. *Sustainability*, 13(7), 3842. <https://doi.org/10.3390/su13073842>
23. Stanojević, J., Krstić, B., & Đekić, S. (2015). Analiza produktivnosti rada sektora poljoprivrede Republike Srbije. *Ekonomске teme*, 53(4), 479-494. <http://www.eknfak.ni.ac.rs/src/Ekonomске-teme.php>
24. Tomaš Simin, M., Glavaš-Trbić, D., Milić, D., & Janković, D. (2024). Human capital as a development factor of organic agriculture in the Republic of Serbia. *Economic of Agriculture*, 71(2), 485–501. <https://doi.org/10.59267/ekoPolj2402485T>
25. Valencia, V., Wittman, H., Jones, D., A., & Blesh, J. (2021). Public Policies for Agricultural Diversification: Implications for Gender Equity. *Frontiers in Sustainable Food Systems*, 7, 718449. <https://doi.org/10.3389/fsufs.2021.718449>
26. Willer, H., Trávníček, J., Meier, C., & Schlatter, B. (2024). *The World of Organic Agriculture: Statistics and Emerging Trends 2024*. Research Institute of Organic Agriculture (FiBL) & IFOAM – Organics International. https://www.fibl.org/fileadmin/documents/shop/1747-organic-world-2024_light.pdf (accessed 20 February 2026).
27. Wollni, M., & Andersson, C. (2014). Spatial patterns of organic agriculture adoption: Evidence from Honduras. *Ecological Economics*, 97, 120–128. <https://doi.org/10.1016/j.ecolecon.2013.11.010>
28. Zhou, X., & Ding, D. (2022). Factors Influencing Farmers' Willingness and Behaviors in Organic Agriculture Development: An Empirical Analysis Based on Survey Data of Farmers in Anhui Province. *Sustainability*, 14(22), 14945. <https://doi.org/10.3390/su142214945>
29. Младеновић, М., & Бојичић, Р. (2021). *Анализа ставова привредника из српске заједнице на Косову и Метохији о Мини Шенген иницијативи*. Међународни научни скуп „Значај Мини Шенгена за евроинтеграције Западног Балкана“, 12- 13. Новембар, Косовска Митровица, 150-168. [in English: Mladenović, M., & Bojčić, R. (2021). *Analysis of the attitudes of entrepreneurs from the Serbian community in Kosovo and Metohija toward the Mini Schengen initiative*. International Scientific Conference “The Importance of Mini Schengen for the European Integration of the Western Balkans,” November 12–13, Kosovska Mitrovica, 150–168.]
30. Трипковић, А. (2024). *Људски капитал и економски аспекти развоја органске пољопривредне производње на Косову и Метохији* (докторска дисертација). Универзитет у Приштини, Економски факултет, Косовска Митровица. [in English: Tripković, A. (2024). *Human Capital and Economic Aspects of the Development of Organic Agricultural Production in Kosovo and Metohija* (Doctoral Dissertation). University of Priština, Faculty of Economics, Kosovska Mitrovica.

ADVANCED PLS-SEM APPLICATIONS IN MANAGEMENT RESEARCH: MODERATION, PREDICTION, AND MANAGERIAL INSIGHTS FROM THE RAKIJA CASE

Milan Bubulj¹, Saša Kukulj², Sonja Zlatanov³, Slobodan Adžić⁴

*Corresponding author E-mail: sadzic@akademijahtw.bg.ac.rs

ARTICLE INFO

Original Article

Received: 15 April 2026

Accepted: 14 May 2026

doi:10.59267/ekoPolj2603805B

UDC

005:519.237.7]:663.52(497.11)

Keywords:

Rakija, Advanced PLS-SEM, Moderation and mediation analysis, Predictive and Decision-oriented analytics, Multigroup analysis, Agricultural research

JEL: B40, C30, M31

ABSTRACT

Recent methodological developments have expanded partial least squares structural equation modeling (PLS-SEM) beyond parameter estimation toward predictive and decision-oriented analytics. Building on a previously validated baseline PLS-SEM model of consumer purchasing behavior in the rakija market, this study demonstrates the analytical value of advanced PLS-SEM techniques using SmartPLS software. The analysis incorporates confirmatory tetrad analysis (CTA-PLS), bootstrapped mediation and moderation analysis, multigroup analysis (MGA), importance–performance map analysis (IPMA), and out-of-sample predictive assessment using PLSpredict. The results reveal conditional effects, segment-specific differences, and predictive patterns that remain undetected in baseline SEM applications. By systematically integrating multiple advanced procedures within a single empirical framework, the study illustrates how PLS-SEM can function as a comprehensive analytical toolkit for consumer and agribusiness research. The originality of the paper lies in demonstrating how advanced PLS-SEM techniques enhance interpretative depth, predictive relevance, and decision-oriented insights in culturally embedded markets.

-
- 1 Milan Bubulj, MA, Assistant, University Union – Nikola Tesla, Faculty of Management FAM, Address: Njegoševa 1a, 21205 Sremski Karlovci, Serbia, Phone: +381 21 2155045, E-mail: bubulj@famns.edu.rs, ORCID ID (<https://orcid.org/0009-0002-3184-3441>)
 - 2 Saša Kukulj, Ph.D., Assistant, University Union – Nikola Tesla, Faculty of Management FAM, Address: Njegoševa 1a, 21205 Sremski Karlovci, Serbia, Phone: +381 21 2155045, E-mail: sasa.kukulj@famns.edu.rs, ORCID ID (<https://orcid.org/0009-0001-2145-6133>)
 - 3 Sonja Zlatanov, Ph.D., Assistant Professor, Academy of Hospitality, Tourism, and Wellness, Address: Tošin Bunar 179d, 11070 Belgrade, Serbia, Phone: +381114561375, E-mail: szlatanov@akademijahtw.bg.ac.rs, ORCID ID (<https://orcid.org/0009-0007-5805-0341>)
 - 4 Slobodan Adžić, Ph.D., Full Professor, Academy of Hospitality, Tourism, and Wellness, Address: Tošin Bunar 179d, 11070 Belgrade, Serbia, Phone: +381114561375, E-mail: sadzic@akademijahtw.bg.ac.rs, ORCID ID (<https://orcid.org/0000-0002-8827-5492>)

Introduction

Partial least squares structural equation modeling (PLS-SEM) has become an increasingly prominent analytical approach in consumer and agribusiness research, primarily due to its flexibility, robustness to non-normal data, and suitability for complex models with limited sample sizes. While earlier applications of PLS-SEM largely focused on parameter estimation and variance explanation, recent methodological developments have significantly expanded its analytical scope. Contemporary PLS-SEM (Ringle et al., 2024; Radovanović, 2025) is no longer limited to estimating structural relationships but has evolved into a comprehensive framework for predictive assessment, conditional effect analysis, and decision-oriented analytics.

Despite these advances, a substantial portion of empirical research continues to employ PLS-SEM in a relatively basic manner, generally limiting the analysis to the validation of measurement models and the estimation of direct structural relationships. As a result, important insights related to moderation, mediation, segment-specific effects, and predictive relevance often remain unexplored. This underutilization is particularly evident in studies examining culturally embedded products, where consumer behavior is shaped by complex interactions among attitudes, traditions, and social norms. In such contexts, advanced PLS-SEM techniques offer the potential to uncover nuanced behavioral mechanisms that extend beyond average effects. SmartPLS is gaining recognition due to its intuitive interface and sophisticated reporting capabilities, which improve accessibility for researchers (Wong, 2013).

Building on a previously validated baseline PLS-SEM model of consumer purchasing behavior in the rakija market, this study aims to demonstrate the added analytical value of advanced PLS-SEM procedures (Adžić et al., 2026). The baseline model, including construct operationalization and fundamental structural relationships, has been established and validated in prior research and serves here as a reference point for further methodological extension. Rakija, often referred to as rakia or schnapps, is a distilled alcoholic drink deeply rooted in Serbia's cultural and traditional practices (Adžić, 2023). A noteworthy acknowledgment of this beverage is the inclusion of Serbian plum rakija or šljivovica on the UNESCO World Heritage List.

SEM offers advantages over conventional multiple regression and other statistical methods (Keith, 2019). A key assumption for interpreting regression coefficients in a causal framework is that exogenous variables are measured without error, which is unlikely to be the case. Measurement errors present considerable challenges in research, and SEM effectively addresses these challenges. PLS has developed into a causal-predictive approach within SEM, focusing on explaining the variance in the model's dependent variables (Chin et al., 2020; Miljković & Arsić, 2025). The underlying causal-predictive rationale corresponds to what Gregor (2006) describes as theories that explain and predict. SEM is particularly suited for investigating models derived from explaining and predicting theories, and the causal-predictive features of PLS-SEM make it especially appealing for research aimed at producing actionable recommendations.

The key advantages of SmartPLS Partial Least Squares Structural Equation Modeling over AMOS Covariance-Based Structural Equation Modeling include its ability to handle smaller sample sizes, accommodate complex models, and focus on prediction rather than solely on model fit (Hair et al., 2012). PLS-SEM effectively handles high measurement errors, unbalanced datasets, and latent variables, making it ideal for analyzing relationships among latent constructs, particularly in small datasets. It combines the strengths of structural equation modeling and partial least squares, enhancing the flexibility of research studies (Ahmed et al., 2024). PLS-SEM focuses on prediction and can effectively accommodate non-normal data distribution (Usakli & Rasoolimanesh, 2023; Radomirović et al., 2025). PLS-SEM emphasizes the maximization of explained variance, rendering it particularly advantageous for prediction-oriented studies. In contrast, CB-SEM is primarily designed to validate theoretical frameworks. PLS-SEM is especially useful in exploratory research contexts because it permits the incorporation of formative indicators that enhance the explanation and prediction of constructs (Hair et al., 2014).

The primary objective of this paper is not to re-estimate or replicate the basic structural model, but rather to illustrate how advanced PLS-SEM techniques enrich model interpretation and practical usefulness. It demonstrates how advanced PLS-SEM techniques can reveal relationships and predictive patterns that remain hidden in basic model applications, particularly in markets characterized by cultural specificity and heterogeneous consumer segments. In doing so, the paper provides both researchers and practitioners with a structured illustration of how PLS-SEM can be fully leveraged to support theory development, managerial decision-making, and policy-relevant insights in agribusiness and consumer research.

Materials and methods

The researchers performed an extensive examination of scholarly journals and verified research scales pertaining to different types of alcoholic beverages (Adžić, 2025). This study analyzed five previously published research scales: the Cultural impact of rakija (CIR) (Yap & Nan Chen, 2017; Barović et al., 2025), the Level of consumer involvement (LCI) (Calvo-Porral et al., 2020), the Factors to purchase rakija (FPR) (Kruger & Viljoen, 2022), the Attitudes toward rakija (ATR) and the Rakija purchase intentions (RRI) (Spears & Singh, 2004). The data collected from the survey was assessed utilizing SmartPLS version 4.1.1.4.

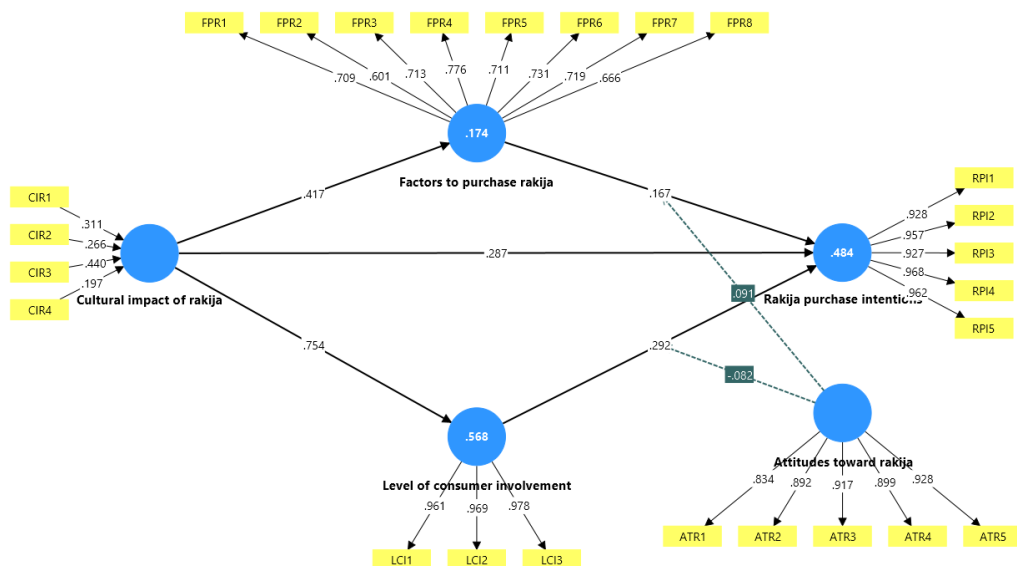
Results

Baseline PLS-SEM Model

The advanced analyses presented in this study build upon a previously validated baseline partial least squares structural equation model (PLS-SEM) of consumer purchasing behavior in the rakija market (Adžić et al., 2026). The baseline model specifies the core latent constructs and structural relationships grounded in consumer behavior theory

and cultural consumption literature. Construct operationalization, scale development, and data collection procedures are reported in detail in the preceding study and are therefore only briefly summarized here.

Figure 1. PLS-SEM model



Source: Adžić et al. (2026)

The baseline model was estimated using SmartPLS software and follows established PLS-SEM evaluation procedures (Figure 1). All constructs were modeled as reflective, and measurement model assessment confirmed internal consistency reliability, convergent validity, and discriminant validity based on composite reliability, average variance extracted (AVE), and heterotrait–monotrait (HTMT) ratios. The structural model demonstrated satisfactory explanatory power, with statistically significant path coefficients and acceptable levels of explained variance (R^2) for the endogenous constructs. Bootstrapping procedures were applied to assess the significance of direct and indirect effects.

Importantly, the purpose of the baseline model in the present study is not to replicate or re-evaluate its fundamental properties, but to serve as a methodological reference point for the application of advanced PLS-SEM techniques. By holding the core model structure constant, this study isolates the incremental analytical value provided by advanced procedures such as confirmatory tetrad analysis (CTA-PLS), moderation and mediation analysis, multigroup analysis (MGA), importance–performance map analysis (IPMA), and predictive assessment using PLSpredict. This approach ensures that any additional insights derived from the analysis can be attributed to methodological extension rather than changes in model specification.

Accordingly, the baseline PLS-SEM model functions as an analytical anchor that enables a systematic comparison between standard and advanced PLS-SEM applications. This

design strengthens the methodological contribution of the study by demonstrating how advanced techniques expand interpretative depth, uncover hidden heterogeneity, and enhance the practical relevance of SEM results in culturally specific agribusiness contexts.

Mediation analysis

Mediation occurs when a mediator construct intercedes between two directly related constructs, exogenous and endogenous constructs (Hair et al., 2021). Table 1 presents the results of the mediator analysis (indirect effects), including beta, t-statistics, and p-values. Both specific indirect effects of the LCI and FPR were statistically significant. In instances where the direct and indirect effects are both significant within a model and point in the same direction, we encounter a scenario referred to as complementary mediation (Zhao et al., 2010).

The mediators exhibit an indirect effect, resulting in lower beta values than direct effects, as their value comes from multiplying two decimal numbers whose values are below one. Thus, the established statistical significance is deemed more critical than the effect size, which is anticipated to be small. According to Hayes (2017), an effect size that approaches zero is often regarded as small, but the further the beta of a mediated variable strays from zero, the more substantial the perceived influence. The impact should always be evaluated against a reference point or a relevant factor.

Table 1. Results of the mediator analysis (indirect effects)

	β	t-statistics	p-values
SPECIFIC INDIRECT EFFECTS			
CRI -> LCI-> RPI	.220	4.512	.000
CRI -> FPR-> RPI	.070	3.585	.000
TOTAL INDIRECT EFFECTS			
CRI -> RPI	.290	6.407	.000

Source: Authors' calculations

Moderation effects

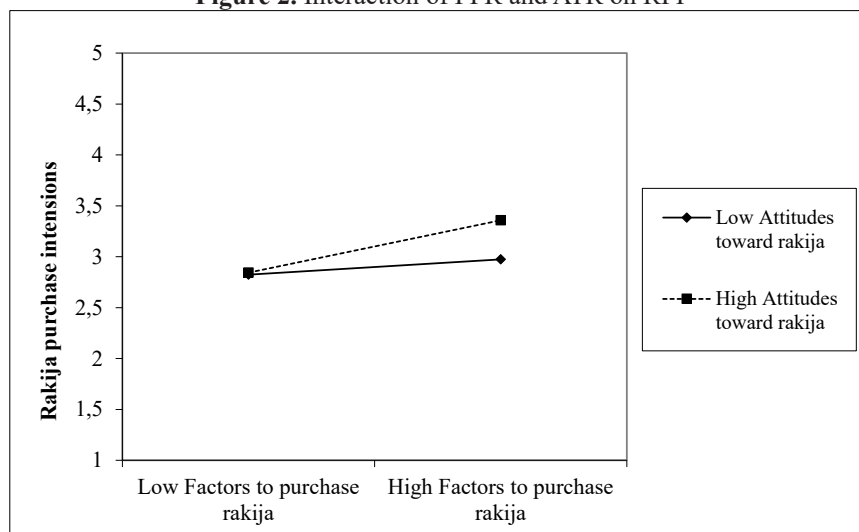
An additional variable in the analysis might change our comprehension of the direct relationships under investigation. When moderation is involved, the strength or direction of the relationship between two variables is affected by a third variable (the moderator). In other words, the connection between the two constructs shifts depending on the value of the moderator variable (Hair et al., 2021). Table 2 presents the moderating impact of ATR on the hypothesized relationships between FPR and RPI and the moderating impact of ATR on the hypothesized relationships between the LCI and RPI. The results showed that the interaction term of ATR x FPR had a significant positive effect on RPI, but ATR x LCI had an insignificant negative effect on RPI. This implies that the variable ATR only positively moderates the relationship between FPR and RPI .

Table 2. Results of the moderator analysis (interaction effects)

	β	t-statistics	p-values
ATR x FPR -> RPI	.091	2.125	.034
ATR x LCI-> RPI	-.082	1.619	.105

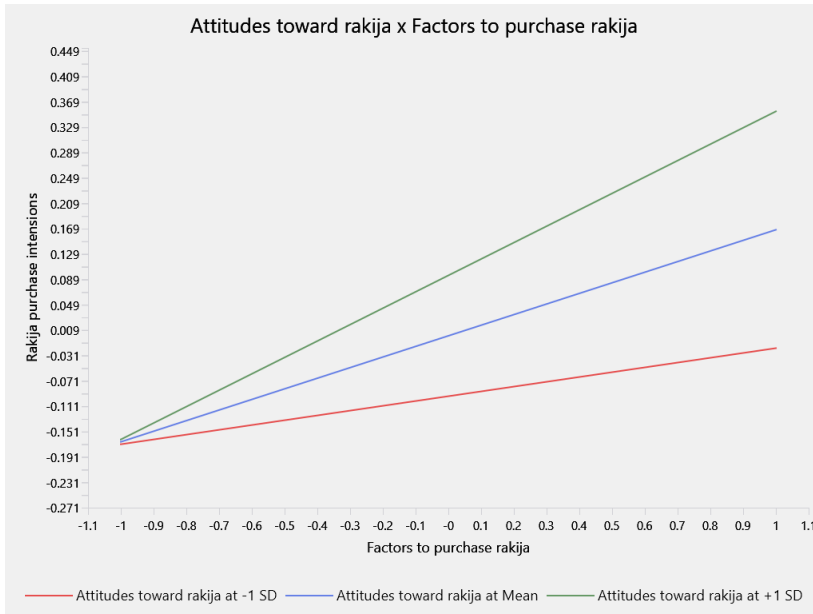
Source: Authors' calculations

In addition to understanding the elements of moderator analysis, interpreting the results is often challenging. Consequently, graphical representations of these results facilitate comprehension and the formulation of conclusions. A prevalent method for depicting the outcomes of moderation analysis is through the use of a slope plot, which provides the most comprehensible outcomes (Hasan, 2025). Figure 2 shows the slope analysis of the significant interaction effect. The graph illustrates that the effects of FPR on RPI will be stronger if ATR are high and conversely, weaker when ATR are low.

Figure 2. Interaction of FPR and ATR on RPI

Source: Authors' calculations

Since version 4, SmartPLS has provided the possibility of a graphical simple slope analysis of the moderator effect. The three lines shown in Figure 3 illustrate the relationship between the FPR (x-axis) and RPI (y-axis). The central line signifies the relationship at the mean level of the moderating variable, Attitudes toward rakija. The remaining two lines depict the relationship between the FPR and RPI at higher (i.e., the mean value of ATR plus one standard deviation) and lower (i.e., the mean value of ATR minus one standard deviation) levels of the moderating variable, Attitudes toward rakija. It is evident that the relationship between the FPR and RPI is positive across all three lines, as demonstrated by their upward slope. Therefore, the simple slope plot verified our earlier argument regarding the positive interaction effect: higher levels of ATR corresponded to a more robust relationship between the FPR and the RPI, whereas lower levels of ATR resulted in a weaker relationship between these factors.

Figure 3. Simple slope analysis – ATR x FPR

Source: Authors' calculations

Table 3 presents the results of the structural model (total effects), including beta, t-statistics, and p-values. The only difference in this table compared to the previous results is the heightened total effect relationship between the CRI and RPI. This increased value of .577 is the sum of the direct effect of .287 and the total indirect effect of .290. This relationship represents the longest connection in the model, linking the first exogenous variable to the last endogenous variable. Because the beta is greater than .5, the effect size is considered large; however, it is lower than the same beta of the CB-SEM model, which was .61 for this relationship.

Table 3. Total effects

	β	t-statistics	p-values
ATR x FPR -> RPI	.091	2.125	.034
ATR x LCI-> RPI	-.082	1.619	.105
CRI -> FPR	.417	9.642	.000
CRI -> LCI	.754	33.326	.000
CRI -> RPI	.577	11.766	.000
FPR -> RPI	.167	3.687	.000
LCI-> RPI	.292	4.491	.000

Source: Authors' calculations

Predictive assessment

The last step of the structural model evaluation process requires evaluating the model's predictive power using PLSpredict. For a PLS path model to be effective in managerial

decision-making, it is essential that it yields generalizable results. Achieving generalizable results requires an evaluation of whether the findings are applicable to the data utilized in the model estimation and to other datasets that were not part of the estimation process. Consequently, researchers must evaluate the out-of-sample predictive capability of their model, or in a few words, its predictive power (Hair et al., 2021).

Our investigation centers on the key target construct of the model, which is Rakija purchasing intentions (RPI), and we utilize the root mean square error (RMSE) as the standard measure for assessing the prediction error associated with the indicators of this construct (Table 4). Initially, we analyzed five RPI Q²predict values. The results indicate that each of the five Q²predict values (RPI1, RPI2, RPIS3, RPIS4, and RPI5) exceeded zero. A positive Q²predict value indicates that the prediction error of the PLS path model is less than that of the most basic benchmark (i.e., the indicator means derived from the analysis sample), indicating that the PLS model surpasses the naïve benchmark.

The next analysis required a comparison of the RMSE values generated by the PLS-SEM analysis with those produced by the naïve linear regression model (LM) benchmark. Upon comparing the RMSE values, we observed that PLS-SEM analysis yielded lower prediction errors (i.e., smaller RMSE values) than LM across all five RPI indicators. Given that all indicators in the PLS-SEM analysis exhibited lower RMSE values than the naïve LM benchmark, it can be concluded that the model possessed substantial predictive power.

Table 4. PLSpredict MV summary

	Q ² predict
FPR1	.203
FPR2	.005
FPR3	-.005
FPR4	.128
FPR5	.017
FPR6	.019
FPR7	.037
FPR8	.073
LCI1	.504
LCI2	.550
LCI3	.526
RPI1	.353
RPI2	.366
RPI3	.377
RPI4	.338
RPI5	.329

Source: Authors' calculations

CTA-PLS results

Based on the data and model we established, we can apply three advanced models. The first, confirmatory tetrad analysis, was conducted to empirically evaluate whether the data aligned with formative or reflective measurement model specifications. To successfully address the challenge of precisely defining the measurement model, we performed an advanced SmartPLS analysis, particularly the confirmatory tetrad analysis for PLS-SEM (CTA-PLS). This analysis empirically assesses whether the data conforms to the formative or reflective measurement model specifications (Hair et al., 2024). A significant test statistic indicates that the measurement model is formative in nature. According to Lowry and Gaskin (2014), the threshold for acceptable model fit is 80%. A threshold of 80% indicates that if 80% of the measurement variables exhibit significant p-values, the variable is formative. CTA-PLS identified only one of the four latent variables (Consumer involvement level was excluded because it consisted of fewer than four measurement variables) as formative. All measurement items related to the variable CIR were significant (Table 5). Thus, we adjusted the direction of this variable's arrows in PLS-SEM to align them with the formative measurement model for the specified variable. The formative model of culture aligns with Schein's (2010) cultural model, where artifacts represent the most visible level of culture. Additionally, this logic (Hair et al., 2021) supports the assertion that CIR measurement variables build the concept of the cultural impact of rakija.

Table 5. Statistically significant results of the confirmatory tetrad analysis

CRI	Original sample (O)	T-statistics	p-values	CI low	CI up
1: CIR1,CIR2,CIR3,CIR4	.904	2.740	.006	.371	1.456
2: CIR1,CIR2,CIR4,CIR3	1.262	4.004	.000	.755	1.791

Source: Authors' calculations

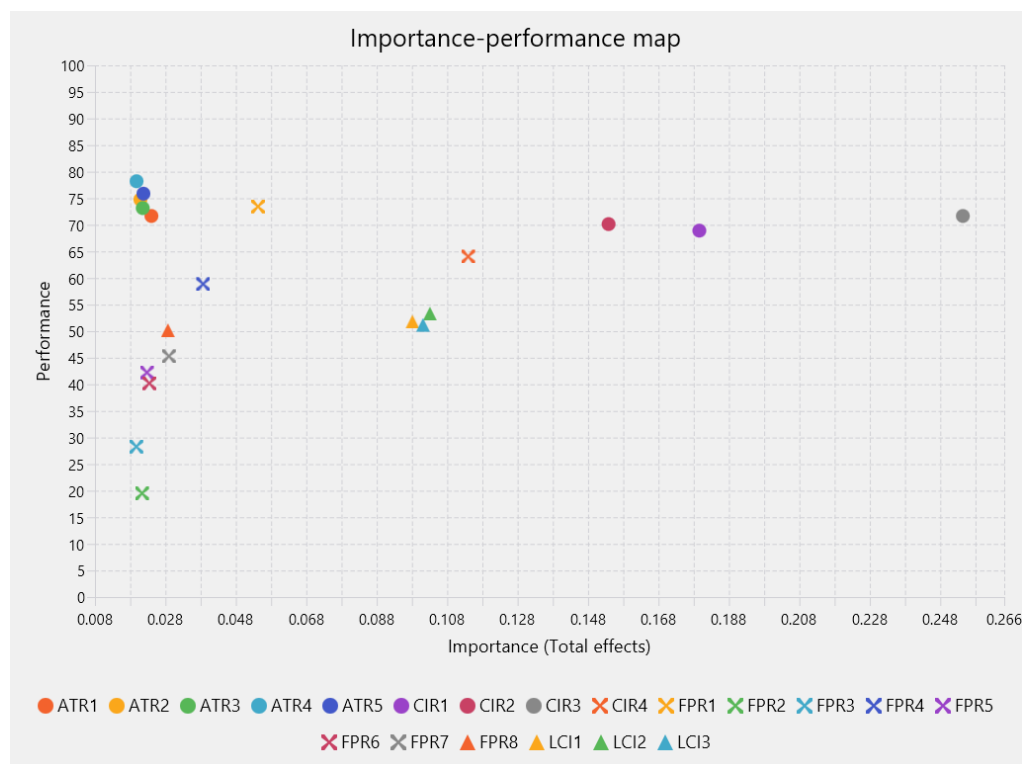
IPMA results

In this section, we present the importance-performance map analysis, a quantitative analysis for qualitative decision-making, and the multigroup analysis to examine the differences between group-specific path coefficients.

The analysis known as Importance-performance map analysis (IPMA), also known as priority map analysis, enhances the conventional results obtained from PLS-SEM by locating specific areas that require improvement. This provides a solid empirical basis for a more informed discussion on enhancing the performance of the key target constructs. Specifically, the IPMA contrasts the total effects, which reflect the importance of predecessor constructs in predicting a particular target construct, against their average latent variable scores, which denote their performance. The rationale behind this approach is to identify predecessor constructs that exhibit relatively high importance in predicting the target construct (i.e., those with a strong total effect) while simultaneously demonstrating relatively low performance (i.e., low average latent variable scores), thereby allowing targeted improvements to be made (Hair et al., 2021).

Figure 4 illustrates the SmartPLS IPMA model derived from our empirical data analysis. The indicators located in the lower right section of the IPMA model exhibit a high level of importance for the target construct, yet demonstrate low performance, and vice versa. These findings indicate that CIR3 warrants the utmost priority for enhancement. The priority indicator CIR3 is that Rakija has a pleasant taste. The unpleasant taste of rakija has been identified as a problem for some distillery producers (Adžić, 2023). IPMA analysis showed that taste is the most important factor in consumers' decisions regarding which rakija to purchase.

Figure 4. IPMA: RPI indicators



Source: Authors' calculations

MGA results

The multigroup analysis in SmartPLS evaluates the statistical significance of the differences among the group-specific path coefficients. Path coefficients derived from various samples typically exhibit numerical differences; however, the critical question is whether these differences are statistically significant. Multigroup analysis provides researchers with the necessary tools to address this question. Various approaches are available for conducting multigroup analyses in SmartPLS (Hair et al., 2024).

Table 6. Bootstrap MGA for the rakija and wine group

	Difference (Prefer rakija to wine - Prefer wine to rakija)	2-tailed (Prefer rakija to wine vs Prefer wine to rakija) p value
CRI -> FPR	.040	.616
CRI -> LCI	.005	.918
CRI -> RPI	-.070	.553
FPR -> RPI	.025	.795
LCI-> RPI	-.121	.351

Source: Authors' calculations

We implemented the bootstrap multigroup analysis (MGA) as recommended by Hasan (2025). The initial step involved generating groups within the data files. According to the CB-SEM analysis conducted by Adžić (2025), two independent multigroup models were developed. One group evaluated the model for respondents who consume rakija but prefer wine, while the other group assessed those who consume and prefer beer in comparison to those who consume and prefer rakija. The first multigroup results (Table 6) indicate that all differences observed between the rakija and wine groups were insignificant. The same result was obtained for the CB-SEM analysis.

The second multigroup results (Table 7) indicated that only one difference between the rakija and beer groups was statistically significant at the .05 level. The path coefficient for those who prefer rakija over beer is .109 ($p = .037$) higher than that for those who prefer beer over rakija, indicating that culture is an important factor influencing rakija consumers' purchasing behavior. This suggests that these consumers tend to purchase alcoholic beverages that are deeply embedded in the cultural and traditional practices of Serbia, in contrast to beer consumers, for whom culture and the origin of beer do not have a significant influence. While a comparable outcome was observed in the CB-SEM analysis, AMOS determined the difference at the overall group level rather than among the path coefficients specific to each group, which we recognize as a significant benefit of AMOS.

Table 7. Bootstrap MGA for the rakija and beer group

	Difference (Prefer rakija to beer - Prefer beer to rakija)	2-tailed (Prefer rakija to beer vs Prefer beer to rakija) p value
CRI -> FPR	-.013	.858
CRI -> LCI	.109	.037
CRI -> RPI	-.054	.618
FPR -> RPI	-.049	.624
LCI-> RPI	.031	.821

Source: Authors' calculations

Discussions and Conclusions

The results of this study demonstrate that advanced PLS-SEM techniques substantially enhance the analytical depth and practical relevance of consumer behavior models beyond what can be achieved through baseline SEM applications. By applying multiple advanced procedures within a single empirical framework, the analysis reveals conditional relationships, segment-specific effects, and predictive patterns that remain hidden in standard structural model estimation.

SmartPLS software is known for its practicality. It is designed to be user-friendly and does not necessitate the use of SPSS, unlike AMOS; only applications such as Excel are required to create databases. Additionally, descriptive statistics can be performed using SmartPLS. Its intuitive nature is evidenced by the significant or above-threshold results presented in tables with green fonts. Conversely, the results shown in red indicate problems. This color coding also aids graphical modeling by highlighting the variables that lack connections. Transitioning from AMOS to SmartPLS (Ringle et al., 2024) in its fourth version is not only a robust alternative to AMOS, as Wong (2013) suggests, but also a software with the user-friendly interface.

For researchers engaged in regression analysis, PLS-SEM presents a familiar framework that allows for swift comprehension and acceptance of SmartPLS. An analysis encompassing both latent and observed variables will yield a more comprehensive understanding. This will provide multiple perspectives and reveal a broader array of options for addressing theoretical and practical problems. Notably, the advanced method known as IPMA facilitates quantitative analysis for qualitative decision-making, thereby augmenting the traditional outcomes derived from PLS-SEM by pinpointing specific areas in need of enhancement. The IPMA serves as a genuine roadmap for managers to follow. Moreover, considering the benefits of PLS-SEM (Ahmed et al., 2024; Hair et al., 2012; Usakli & Rasoolimanesh, 2023), such as higher statistical power, the ability to handle smaller sample sizes, adaptation to complex models, efficient handling of high measurement errors and unbalanced datasets, efficient adaptation to non-normal data distributions, and focus on prediction rather than model fitting, we favor analyses grounded in PLS-SEM.

This study demonstrates the added value of advanced PLS-SEM techniques in consumer and agribusiness research using the rakija market as an empirical context. By extending a previously validated baseline model through moderation, mediation, multigroup, importance–performance, and predictive analyses, the paper illustrates how advanced PLS-SEM procedures uncover insights that remain inaccessible through basic SEM applications.

The contribution of this paper is both methodological and practical. Methodologically, it provides a structured illustration of how advanced PLS-SEM techniques can be systematically integrated within a single empirical study. Practically, it shows how these techniques enhance decision-oriented interpretation and predictive relevance in culturally specific markets.

Conflict of interests

The authors declare no conflict of interest.

References

1. Adžić, S. (2023). The way Serbian rakija distillers evaluate the quality and market position of their spirits. *Journal of Agricultural Sciences, Belgrade*, 68(2), 217–236. <https://doi.org/10.2298/JAS2302217A>
2. Adžić, S. (2025). Exploring cultural influences on national alcoholic beverage purchases: A full latent variable structural equation model. *International Journal of Wine Business Research*, 37(3), 445–475. <https://doi.org/10.1108/IJWBR-05-2024-0029>
3. Adžić, S., Bešić-Vukašinović, D., & Savić, I. (2026). Methodological and Practical advantages of PLS-SEM in management research: The case of rakija. *Economic of Agriculture*, 73(1), 217–232. <https://doi.org/10.59267/ekoPolj2601217A>
4. Ahmed, R. R., Streimikiene, D., Streimikis, J., & Siksnylyte-Butkiene, I. (2024). A comparative analysis of multivariate approaches for data analysis in management sciences. *E+MEkonomie a Management*, 27(1), 192–210. <https://doi.org/10.15240/tul/001/2024-5-001>
5. Barović, S., Božović, J., Brkljač, M., Vujanić, I., & Marković, S. (2025). Uticaj hrm prakse na zadovoljstvo zaposlenih i lojalnost gostiju u srpskom hotelijerstvu. *Oditor*, 11(3), 76-91. <https://doi.org/10.59864/Oditor52503SB>
6. Calvo-Porrá, C., Rivaroli, S., & Orosa-Gonzalez, J. (2020). How consumer involvement influences beer flavour preferences. *International Journal of Wine Business Research*, 32(4), 537–554. Emerald Insight. <https://doi.org/10.1108/IJWBR-10-2019-0054>
7. Chin, W., Cheah, J.-H., Liu, Y., Ting, H., Lim, X.-J., & Cham, T. H. (2020). Demystifying the role of causal-predictive modeling using partial least squares structural equation modeling in information systems research. *Industrial Management & Data Systems*, 120(12), 2161–2209. <https://doi.org/10.1108/IMDS-10-2019-0529>
8. Gregor, S. (2006). The Nature of Theory in Information Systems. *MIS Quarterly*, 30(3), 611. <https://doi.org/10.2307/25148742>
9. Hair, J. F., Hult, G. T. M., Ringle, C. M., & Sarstedt, M. (2021). *A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM)*. SAGE Publications.
10. Hair, J. F., Ringle, C. M., & Sarstedt, M. (2012). Partial Least Squares: The Better Approach to Structural Equation Modeling? *Long Range Planning, Analytical Approaches to Strategic Management: Partial Least Squares Modeling in Strategy Research*, 45(5), 312–319. <https://doi.org/10.1016/j.lrp.2012.09.011>
11. Hair, J. F., Sarstedt, M., Hopkins, L., & Kuppelwieser, V. G. (2014). Partial least squares structural equation modeling (PLS-SEM): An emerging tool in business research. *European Business Review*, 26(2), 106–121. (world). <https://doi.org/10.1108/EBR-10-2013-0128>

12. Hair, J. F., Sarstedt, M., Ringle, C. M., & Gudergan, S. P. (2024). *Advanced Issues in Partial Least Squares Structural Equation Modeling*. SAGE Publications, Incorporated.
13. Hasan, S. (2025). Essentials of SmartPLS 4: For Research and Data Analysis. Udemy. <https://www.udemy.com/course/essentials-of-smartpls-4-for-research-and-data-analysis/>
14. Hayes, A. F. (2017). *Introduction to Mediation, Moderation, and Conditional Process Analysis, Second Edition: A Regression-Based Approach* (Second edition). The Guilford Press.
15. Keith, T. Z. (2019). *Multiple Regression and Beyond: An Introduction to Multiple Regression and Structural Equation Modeling* (3rd edition). Routledge.
16. Kruger, M., & Viljoen, A. (2022). That old saying about wine and age: Identifying South African age-cohort preferences. *International Journal of Wine Business Research*, 34(4), 495–522. Emerald Insight. <https://doi.org/10.1108/IJWBR-06-2021-0033>
17. Lowry, P. B., & Gaskin, J. (2014). Partial Least Squares (PLS) Structural Equation Modeling (SEM) for Building and Testing Behavioral Causal Theory: When to Choose It and How to Use It. *IEEE Transactions on Professional Communication*, 57(2), 123–146. <https://doi.org/10.1109/TPC.2014.2312452>
18. Miljković, M., & Arsić, I. (2025). Determinisanje promena organizaciono-upravljačkih procesa u sistemu upravljanja. *Finansijski Savetnik*, 30(1), 55-74. <http://fa-journal.com/index.php/fa/article/view/3>
19. Radomirović, J., Krstić, S., Damnjanović, R. (2025). The impact of leadership on organizational creativity. *Akcionarstvo*, 31(1), 133-145. <https://doi.org/https://doi.org/10.65772/ak2025111>
20. Radovanović, T. (2025). Contribution to achieving sustainable development. *Održivi razvoj*, 7(1), 63-76. <https://doi.org/10.5937/OdrRaz2501063R>
21. Ringle, C. M., Wende, S., & Becker, J.-M. (2024). *SmartPLS* [Computer software]. Bönningstedt: SmartPLS. Retrieved from <https://www.smartpls.com>.
22. Schein, E. H. (2010). *Organizational Culture and Leadership*. Jossey-Bass Inc Pub.
23. Spears, N., & Singh, S. (2004). Measuring Attitude Toward the Brand and Purchase Intentions. *Journal of Current Issues and Research in Advertising*, 26, 53–66. <https://doi.org/10.1080/10641734.2004.10505164>
24. Usakli, A., & Rasoolimanesh, S. M. (2023). Which SEM to Use and What to Report? A Comparison of CB-SEM and PLS-SEM. In F. Okumus, S. M. Rasoolimanesh, & S. Jahani (Eds.), *Cutting Edge Research Methods in Hospitality and Tourism* (pp. 5–28). Emerald Publishing Limited. <https://doi.org/10.1108/978-1-80455-063-220231002>
25. Wong, K. K.-K. (2013). Partial least squares structural equation modeling (PLS-SEM) techniques using SmartPLS. *Marketing Bulletin*, 24(1), 1–32.

26. Yap, M. H. T. & Nan Chen. (2017). Understanding young chinese wine consumers through innovation diffusion theory. *Tourism & Hospitality Management*, 23(1), 51–68. <https://doi.org/10.20867/thm.23.1.3>
27. Zhao, X., Lynch, J. G., Jr., & Chen, Q. (2010). Reconsidering Baron and Kenny: Myths and Truths about Mediation Analysis. *Journal of Consumer Research*, 37(2), 197–206. <https://doi.org/10.1086/651257>

ECONOMIC FEASIBILITY OF FARM MACHINERY INVESTMENTS: A FARM-LEVEL INVESTMENT ANALYSIS

Dejan Vukosavljević¹, Danijela Vukosavljević², Milovan Mirkov³, Jovana Radulović⁴

*Corresponding author E-mail: milovanmirkov@yahoo.com

ARTICLE INFO

Original Article

Received: 21 April 2026

Accepted: 15 June 2026

doi:10.59267/ekoPolj2603821V

UDC 631.115:658.152]:631.3

Keywords:

farm mechanization, investment analysis, net present value, sensitivity analysis, farm-level economics, agricultural investment

JEL: Q12, Q14, G31

ABSTRACT

Investments in agricultural machinery represent an important factor in the modernization and increase in the productivity of agricultural production. However, high initial investment costs and relatively slow returns on capital often limit the investment decisions of small and medium-sized farms, especially in transitional agrarian economies. The paper analyzes investment in agricultural machinery of a typical agricultural farm that cultivates 20 hectares of agricultural land. The analysis was conducted using investment analysis methods based on discounted cash flows, including net present value (NPV), internal rate of return (IRR), scenario analysis and sensitivity analysis. The results show that the investment without institutional support is not financially justified, while the inclusion of the subsidy significantly improves the economic indicators of the project. The findings contribute to a better understanding of investment decisions in agribusiness and indicate the importance of institutional incentives for the modernization of agricultural production.

Introduction

Investments in agricultural machinery represent an important factor in the modernization and increase in the productivity of agricultural production. However, high initial

-
- 1 Dejan Vukosavljević, Associate Professor, Nemanjina 1A, University “Union - Nikola Tesla”, Faculty of Management - FAM, Sremski Karlovci, Serbia, E-mail: dejan.vukosavljevic@famns.edu.rs, ORCID ID (<https://orcid.org/0000-0001-7475-2764>)
 - 2 Danijela Vukosavljević, Associate Professor, Nemanjina 1A, University “Union - Nikola Tesla”, Faculty of Management - FAM, Sremski Karlovci, Serbia, E-mail: danijela.vukosavljevic@famns.edu.rs ORCID ID (<https://orcid.org/0000-0002-6967-5423>)
 - 3 Milovan Mirkov, Municipal Public Library “Veljko Petrović” Žabalj, Nikole Tesle 40, 21230 Žabalj, Serbia, E-mail: milovanmirkov@yahoo.com, ORCID ID (<https://orcid.org/0009-0008-0568-5121>)
 - 4 Jovana Radulović, PhD assistant, Belgrade Academy of Business and Art Vocational Studies, Kraljice Marije Street no. 73, 11050 Belgrade, Serbia, E-mail: jovana.radulovic@bpa.edu.rs, ORCID ID: (<https://orcid.org/0009-0005-8837-4385>)

investment costs and relatively slow returns on capital often limit investment decisions at the level of small and medium-sized farms, especially in transitional agrarian economies. In the literature on agrarian economics, it is emphasized that institutional and financial factors, including subsidies and the availability of financial instruments, can significantly influence the investment activity of agricultural producers and accelerate the process of production modernization (Kay et al., 2016; FAO, 2022). At the same time, some studies indicate that the economic justification of investments in mechanization largely depends on the structural characteristics of farms, especially on the farm size and the intensity of production resources use (Wang, Chu, & Chen, 2020). However, despite the growing number of research on investment decisions in agribusiness, relatively few studies systematically analyze the economic viability of investments in agricultural machinery at the level of individual farms through the integration of operational, financial and institutional factors that influence the realization of investment projects. Although, Covid-19 pandemic did not have a negative impact on financial performance across all industry sectors (Funawer, 2022; Marković & Đokić, 2025; Shen, Fu, Pan, Yu & Chen, 2020), the economic climate and markets can be affected very quickly by changes in exchange rates, interest rates and commodity prices (Vapa Tankosić et al., 2024). Today, in light of the improved institutional framework, development of global trade and financial integration, structural transformations in the organization of production, the field of traditional trade credit support has developed significantly (Čavlin et al., 2022; Miljković & Arsić, 2025). Measuring financial efficiency in terms of company profitability provides valuable information about necessary modifications to reduce potential business risks (Zielińska-Chmielewska, Kaźmierczyk, & Jaźwiński, 2022; Pantić et al., 2026). The existing research often focuses on macroeconomic or sectoral analyses, while microeconomic analyzes of investment decisions at the household level are relatively less common. In this paper, the economic justification of investment in agricultural machinery is analyzed on the example of a typical agricultural farm in Serbia. Special attention is paid to the impact of institutional incentives, credit financing and changes in key operating parameters on the economic viability of the investment. In accordance with that goal, the following research questions were formulated: (RQ1) whether investment in agricultural machinery is economically justified in conditions without institutional support, (RQ2) to what extent subsidies and credit financing affect the financial feasibility of investment projects and (RQ3) how changes in operational and financial parameters affect the stability of the investment project. Based on the research questions, three research hypotheses were defined, which assume that the investment without institutional support is not financially justified, that subsidies and favorable financial conditions significantly improve the economic sustainability of the investment.

Literature review

Investments in agricultural machinery increase productivity and contribute to modernizing of the agricultural production. Modern mechanization enables more efficient use of resources, increase in labor productivity and timely performance of agrotechnical operations, which can significantly affect yields and economic efficiency of production

(Pingali, 2007; FAO, 2022). Modern business environments are increasingly shaped by complex, interconnected risks stemming from environmental, social, technological and geopolitical disruptions (Vapa Tankosić et al., 2025). In addition to technological factors, the economic performance of agricultural enterprises is strongly influenced by the financial and organizational characteristics of production. Previous studies in the field of agribusiness economics emphasize that production efficiency, financial stability and market conditions together determine the sustainability of agricultural activities. Empirical research has shown that various operational and financial factors can significantly influence business performance in agricultural production systems. For example, research on beekeeping identified resource management, production organization and market conditions as important determinants of business performance in agricultural activities (Čavlin et al., 2023). Similarly, studies focused on the agri-food industry have shown that financial indicators such as liquidity and capital structure can significantly affect profitability and overall business performance in companies operating within the agricultural value chain (Čavlin et al., 2021). These findings highlight the importance of integrating production, financial and institutional perspectives when analyzing investment decisions in agriculture. In the context of making investment decisions at the farm level, the literature on the management of agricultural enterprises emphasizes the importance of applying standard methods of investment analysis. Methods based on discounted cash flows, such as net present value (NPV) and internal rate of return (IRR), are widely used in evaluating long-term investment projects in agribusiness. These methods enable the estimation of the economic value of an investment taking into account the time value of money and the expected future cash flows of the investment project (Gittinger, 1982; Kay, Edwards, & Duffy, 2016). In addition to operational and financial factors, investment decisions in agriculture are significantly conditioned by the agricultural policy instruments (Đurić et al., 2016; Tasić et al., 2026; Đurić et al., 2024). The banking sector is an important segment of the functioning of the state system, and as such is connected with the financing of social reproduction through loans and deposits (Bejatović, Vapa Tankosić, 2024). Public policies that include investment subsidies, direct payments and favorable credit lines can have a significant impact on the investment activity of agricultural producers. Empirical research shows that mechanization support programs can significantly increase investments in agricultural equipment and contribute to the modernization of production, especially in regions where mechanization is outdated or underdeveloped (FAO, 2022; Wang, Chu, & Chen, 2020). In the field of environmental policy, the findings have shown that there is no statistically significant relationship between attitudes toward environmental awareness (farm as business) and attitudes toward agri-environmental practices (Vapa-Tankosić et al., 2023). At the same time, investment decisions in agribusiness depend on market factors, such as the volatility of prices of agricultural products and the stability of farm incomes. Changes in market prices can significantly affect the financial viability of investment projects, while direct payments and other forms of institutional support can have a stabilizing effect on producers' incomes. In this sense, investment decisions in agriculture are often the

result of the interaction of operational, financial and institutional factors that together determine the economic viability of investment projects.

Materials and methods

The paper uses a case study approach combined with methods of investment analysis based on discounted cash flows (DCF), which enables the assessment of the economic justification of investment projects through the analysis of expected future cash flows and their present value. In assessing the economic justification of the investment, the basic indicators of the investment analysis were used: net present value (NPV) and internal rate of return (IRR). These indicators represent standard criteria for evaluating long-term investment projects because they enable the assessment of the profitability of the investment taking into account the time value of money (Gittinger, 1982; Kay, Edwards, & Duffy, 2016; Čavlin, Vojinović, & Vapa-Tankosić, 2024). The net present value of the investment project is calculated by discounting the expected future cash flows to the present value according to the following formula:

$$NPV = \sum_{t=0}^T \frac{CF_t}{(1+r)^t}$$

where CF_t represents the cash flow in year t , r discount rate, and T investment period of the project.

An investment project is considered economically justified if the net present value is positive and the internal rate of return exceeds the discount rate. In addition to the basic indicators of investment analysis, additional analytical tools were also applied in the work, including the profitability index, sensitivity analysis and scenario analysis of the investment project. Sensitivity analysis enables the assessment of the impact of changes in the key parameters of the investment on the economic value of the project, while the scenario analysis enables an overview of the possible economic outcomes of the investment project in different market and financial conditions (Boardman et al., 2018; Brealey, Myers, & Allen, 2020). The empirical analysis is based on the model of a typical agricultural farm engaged in arable production in the region of Vojvodina. The investment project refers to the purchase of a medium power tractor, and the analysis was carried out for an investment period of ten years. Using a case study allows for a more detailed analysis of investment decisions at the level of an individual farm and is a methodological approach that is often used in research on agrarian economics and farm management (Yin, 2018).

Table 1. Element of analysis by Method /Indicator

Element of analysis	Method / indicator	The purpose of the analysis
Assessment of the profitability of the investment	NPV, IRR	Assessment of the economic feasibility of the investment project
Relative efficiency of the investment	Profitability Index (PI), Cost Savings Ratio (CSR)	Assessment of the relationship between investment and economic benefits

Element of analysis	Method / indicator	The purpose of the analysis
Financial viability of the project	Debt Service Coverage Ratio (DSCR)	Assessment of ability to service credit obligations
Stability of results	Sensitivity analysis	Identification of key factors affecting NPV
Alternative investment outcomes	Scenario analysis	Evaluation of results in different market and financial conditions

Source: Authors' notes

Although the analysis is based on the model of a typical agricultural farm, this approach enables the identification of key economic determinants of investment decisions that are relevant to the wider segment of agricultural production.

Results

In order to illustrate the economic effects of investment decisions in agriculture, the paper uses a case study approach based on a typical agricultural farm model. The analysis focuses on the evaluation of the economic justification of the investment in agricultural machinery through the application of standard methods of investment analysis. The assumptions used in the analysis are based on the typical production and financial characteristics of agricultural farms in Vojvodina. The analysis is based on a typical agricultural farm, which cultivates 20 hectares of land and produces wheat, corn and sunflower. Data from the Census of Agriculture indicate that a significant part of the tractor fleet is older than two decades, which confirms the need to modernize agricultural machinery and increase investments in modern equipment (Republic Institute of Statistics, 2019). The farm is considering an investment in the purchase of a medium-power tractor in order to increase labor productivity and reduce the cost of using external machinery. Based on the estimated production results, the annual income amounts to approximately EUR 45,000, while the total production costs are approximately EUR 32,000.

Table 2. Basic financial indicators of the farm

Financial indicator	Amount (EUR)
Total assets	120,000
Own capital	90,000
Total liabilities	30,000
Annual income	45,000
Annual costs	32,000
Net profit	13,000

Source: Authors' calculations

Basic financial indicators are presented in the Table 2. Based on the estimated financial data, it is possible to calculate the basic indicators of the financial stability of the farm.

Current liquidity ratio

Assumed values: current assets: EUR 25,000 short-term liabilities: EUR 15,000

Liquidity ratio= $25.000/15.000=1.67$ (A coefficient value greater than 1 indicates that the farm has sufficient working capital to settle short-term obligations).

Debt-to-Asset ratio

Debt Ratio= $30.000/120.000=0.25$ (This indicator indicates that the farm has a relatively low level of indebtedness, which suggests a stable financial structure and the potential ability to finance new investment projects).

Basic assumptions of investment analysis

In order to assess the economic justification of the investment in agricultural machinery, an investment analysis based on the method of discounted cash flows (DCF) was conducted. This method enables the assessment of the value of the investment project by discounting the expected future cash flows to the present value. The analysis refers to the investment in the purchase of a tractor that is used in field production of a typical agricultural farm in the region of Vojvodina. The tractor is a key production resource in agricultural production because it enables the timely performance of agro technical operations, increasing work productivity and reducing the cost of using external machinery.

The initial value of the investment is EUR 60,000 and refers to the purchase of a medium-power tractor adapted to the needs of a farm with an area of approximately 20 hectares. The investment was analyzed over a ten-year investment period, which roughly corresponds to the economic life of agricultural mechanization in agricultural production (Table 3).

In the assessment of cash flows, it was assumed that the investment generates average annual operational savings in the amount of around EUR 8,000. These savings result primarily from a reduction in the cost of using external machinery, an increase in work efficiency and a more rational use of production resources.

When evaluating the cash flows, the fact that the maintenance costs of agricultural machinery can increase over time due to wear and tear and the need for servicing was also taken into account. Therefore, it is assumed that the net annual savings may decrease slightly in the later years of the investment period.

The residual value of the tractor at the end of the investment period was also taken into account. It was assumed that the residual value after ten years is approximately 25% of the initial investment value of the tractor, and this value is included in the cash flow of the last year of the investment period.

A discount rate of 8% was used to discount cash flows, which represents an approximation of the opportunity cost of capital in agricultural investments. In the agribusiness investment analysis literature, discount rates between 6% and 10% are often used as a realistic estimate of the cost of capital (Gittinger, 1982; Kay et al., 2016).

Table 3. Basic assumptions of the investment analysis

Parameter	Value
The initial value of the investment	60,000 EUR
Investment period	10 years
Farm area	20 ha
Average annual savings	≈ 8,000 EUR
Residual value of the tractor	25% of the investment value
Discount rate	8%

Source: Authors' calculations

The annual operational benefits of the investment are estimated at approximately EUR 8,000 (Table 4). These benefits arise primarily from a reduction in the cost of mechanization services, an increase in work efficiency and a better timeliness of performing agro technical operations. In addition, investment in more modern machinery can contribute to the reduction of certain operational losses in production and increase the overall efficiency of the use of production resources.

Table 4. The structure of operational benefits of investment in a tractor

A source of savings	Estimated annual savings (EUR)
Reducing the cost of mechanization services	3,000
Reduction of labor costs	2,000
Greater work efficiency and timeliness of operations	1,500
Smaller operating losses in production	1,500
Total annual savings	8,000
A source of savings	Estimated annual savings (EUR)

Source: Authors' calculations

Economic justification of the investment

a) Investment assessment scenario without subsidy

The agricultural holding is considering an investment in the purchase of a new tractor whose market value is EUR 60,000. The investment project was analyzed based on the assumptions defined in the previous chapter: an investment period of ten years, average annual operational savings in the amount of EUR 8,000 and a discount rate of 8%. The cash flow projection is based on the assumption that the investment generates approximately EUR 8,000 in annual operating savings over a ten-year investment period. In the last year of the project, the cash flow includes the residual value of the tractor, which is approximately 25% of the initial investment value.

The investment payback period is approximately 7.5 years, which represents the ratio of initial investment to annual operating savings.

Based on the discounting of future cash flows, the following results of the investment analysis were obtained: NPV (8%) ≈ -6.320 EUR IRR ≈ 6,7%

The obtained results indicate that the investment without subsidies does not generate

sufficient economic value at a discount rate of 8%. A negative net present value and an internal rate of return lower than the discount rate suggest that the investment project in this scenario has limited financial viability.

b) Scenario of investment assessment with subsidy

In practice, investments in agricultural machinery are often supported by public subsidy programs. In this scenario, it is assumed that the farm can obtain a subsidy in the amount of 40% of the investment value.

The total value of the subsidy amounts to:

$$40\% \times 60,000 = 24,000 \text{ EUR}$$

The net investment financed by the farm amounts to:

$$60,000 - 24,000 = 36,000 \text{ EUR}$$

The investment payback period in this case is approximately 4.5 years, which is significantly shorter than in the no-subsidy scenario. The results of the investment analysis are as follows: NPV (8%) $\approx$ 17.680 EUR IRR $\approx$ 18-19%

The positive net present value and relatively high internal rate of return indicate that the investment becomes financially justified with the support of public incentives intended for the modernization of agricultural production. The results of the investment analysis are presented in a summarized form, while the projection of cash flows is based on constant annual operating savings during the investment period.

c) Additional indicators of the economic justification of the investment

In addition to the net present value and the internal rate of return, additional indicators of the economic efficiency of the investment project were used in the analysis.

The profitability index (PI) represents the ratio between the present value of future cash flows and the initial investment value.

Table 5. The analysis of the Profitability Index

Scenario	PI flows (EUR)	Investment (EUR)	PI
No subsidy	53,680	60,000	0.89
With subsidy	53,680	36,000	1.49

Source: Authors' calculations

A value of PI less than 1 in the Table 5 in the scenario without subsidy confirms that the investment is not economically justified, while a value of PI greater than 1 in the scenario with subsidy indicates a financially attractive investment project.

The cost savings ratio (CSR) as an additional indicator of investment efficiency represents the ratio between annual operating savings and the value of the investment.

Table 6. The analysis of the Cost Savings Ratio

Scenario	Annual savings	Investment (EUR)	CSR
No subsidy	8,000	60,000	13.3%
With subsidy	8,000	36,000	22.2%

Source: Authors' calculations

The results (Table 6) show that the inclusion of the subsidy significantly increases the relative efficiency of the investment, because a larger part of the investment value is compensated annually through operational savings.

Financial feasibility of the investment

Investments in agricultural machinery are often financed by a combination of own funds, state subsidies and bank loans. Therefore, the analysis additionally considered the scenario in which the agricultural holding finances the purchase of a tractor with the help of a long-term investment loan. In the analyzed scenario, it is assumed that the farm uses a state subsidy in the amount of 40% of the investment value, while the remaining part is financed by a bank loan.

The basic parameters of credit financing are as follows: investment value: EUR 60,000, subsidy: EUR 24,000, loan amount: EUR 36,000, repayment term: 7 years, interest rate: 5% per year. Based on the above assumptions, the annual installments of the loan amount to approx. 6.200 EUR.

Table 7. Projection of cash flow and ability to service debt

Year	Operating cash flow (EUR)	Loan installment (EUR)	Net flow (EUR)	DSCR
1	8,000	6,200	1,800	1.29
2	8,000	6,200	1,800	1.29
3	8,000	6,200	1,800	1.29
4	8,000	6,200	1,800	1.29
5	8,000	6,200	1,800	1.29
6	8,000	6,200	1,800	1.29
7	8,000	6,200	1,800	1.29
8–10	8,000	0	8,000	-

Source: Authors' calculations

In the Table 7 the results show that the investment remains financially viable even in the case of credit financing, although in the first years it generates a relatively modest positive cash flow due to the obligation to repay the loan. After the end of the loan repayment period, the farm's net cash flow increases significantly. The financial viability of the investment can be additionally assessed using the Debt Service Coverage Ratio (DSCR), which represents the relationship between operating cash flow and the annual loan installment. In the analyzed scenario, this ratio is approximately 1.29, which indicates that the farm generates sufficient cash flow to pay off the loan obligations. In practice, financial institutions, in addition to the DSCR indicator, often use the Loan Life Coverage Ratio (LLCR), which assesses

the ability of the investment project to generate enough cash flow to repay the total debt during the lending period.

This scenario indicates the importance of availability of favorable credit lines for financing investments in agriculture. The combination of subsidies and loans enables agricultural holdings to realize investment projects that would be much more difficult to achieve without institutional support.

Sensitivity analysis and scenario analysis of the investment project

In order to assess the stability of the investment project, a sensitivity analysis has been conducted.

a) Sensitivity to operational parameters

This analysis examines how changes in key operating parameters affect the economic feasibility of an investment project. The most important variables were the amount of annual operating savings, the size of the agricultural holding and the potential growth of the volume of production.

Sensitivity to the amount of annual savings

In the first step, the sensitivity of the net present value of the investment (NPV) to changes in annual savings resulting from the use of new machinery was analyzed.

Table 8. Sensitivity of NPV to changes in annual savings

Annual savings (EUR)	NPV without subsidy (EUR)	NPV with subsidy (EUR)
6,000	-19,740	4,260
8,000	-6,319	17,681
10,000	7.101	31.101

Source: Authors' calculations

The results in the Table 8 show that the investment project is relatively sensitive to changes in the amount of annual operating savings. While the investment without the subsidy becomes financially justified only at a higher level of savings, the inclusion of the subsidy significantly improves the economic viability of the project.

Sensitivity to farm size

In addition to the amount of annual cash flows, the size of the agricultural holding is also a significant factor of investment sustainability. In the literature on investment decisions in agribusiness, farm size is often identified as one of the key factors influencing the scale of investment and the efficiency of the use of production resources (Wang et al., 2020).

In the basic scenario, it was assumed that the farm cultivates 20 hectares of agricultural land and achieves annual savings of approximately EUR 8,000. However, larger farms can achieve a higher degree of mechanization utilization, which leads to increased operational savings.

Table 9. Sensitivity of the investment project to the size of the farm

Farm area	Annual savings (EUR)	NPV with subsidy (EUR)
20 ha	8,000	17,681
25 ha	9,500	27,000
30 ha	11,000	36,000

Source: Authors' calculations

The results in the Table 9 show that increasing the arable area significantly improves the economic justification of the investment, which confirms the importance of economies of scale in agricultural production.

Production growth scenario

In addition to direct savings in mechanization costs, investment in a new tractor can also contribute to an increase in the volume of production thanks to faster and more timely performance of agro technical operations.

In this scenario, an increase in household income of approximately 7% was assumed, which corresponds to an additional income of approximately EUR 3,150 per year. As the increase in production also implies an increase in variable costs, it was assumed that about 30% of additional income goes to production costs. In this way, the net additional cash flow amounts to approximately EUR 2,200 per year.

The total annual cash flow of the investment in this scenario is approximately EUR 10,200, which significantly improves the economic indicators of the investment project.

A rough estimate shows that in this case the net present value of the investment with the subsidy can reach approximately EUR 38,800, which represents a significant increase compared to the base scenario.

These results indicate that the effects of investment in agricultural machinery do not only result from cost reduction, but also from a potential increase in productivity and yield in agricultural production.

b) Sensitivity to financial parameters

In addition to the operational parameters of the investment project, the economic justification of the investment can significantly depend on the financial conditions. In this part, the sensitivity of the investment project to changes in the discount rate and credit financing conditions is analyzed.

Sensitivity to changes in the discount rate

The discount rate is an estimate of the cost of capital or the investor's expected rate of return. The changes in the discount rate can significantly affect the net present value of an investment project.

Table 10. Sensitivity of NPV to changes in the discount rate

Discount rate	NPV without subsidy (EUR)	NPV with subsidy (EUR)
6%	-1.119	22,881
8%	-6,319	17,681
10%	-10,843	13.157

Source: Authors' calculations

The results in Table 10 show that an increase in the discount rate reduces the economic value of the investment project. Nevertheless, even at higher discount rates, investments with subsidies retain a positive net present value, which confirms the importance of public incentives for the realization of investments in agricultural machinery.

Sensitivity to credit financing conditions

The financial viability of an investment project may also depend on the conditions of credit financing (Table 11), especially the interest rate and the structure of the loan. In order to assess the stability of the project, different lending scenarios were considered for a loan in the amount of EUR 36,000 with a repayment term of seven years.

Table 11. The sensitivity of the investment project to the conditions of credit financing

Lending scenario	Estimation of the interest rate	Annual loan installment (EUR)	Net annual flow (EUR)	DSCR
EUR loan - fixed interest rate	5%	≈ 6,200	≈ 1,800	1.29
EUR loan – variable interest	7%	≈ 6,700	≈ 1,300	1.19
RSD loan - fixed interest rate	8%	≈ 7,000	≈ 1,000	1.14

Source: Authors' calculations

Debt Service Coverage Ratio (DSCR), which represents the relationship between operating cash flow and the annual installment of the loan, was used to assess the farm's ability to service the loan.

The results show that the investment remains financially viable in all observed lending scenarios, although the increase in the interest rate reduces the available cash flow of the farm and increases the financial risk of the investment project.

These results indicate that investment decisions in agriculture depend not only on the operational profitability of the investment project, but also on the financing conditions available to agricultural holdings.

c) Scenario analysis of the investment project

In addition to the standard sensitivity analysis, a scenario analysis of the investment project was carried out in order to assess the possible economic outcomes of the investment in different business conditions. Three basic scenarios were considered in the analysis: pessimistic, base and optimistic scenario. The pessimistic scenario assumes

a lower level of operational savings and less favorable financial conditions, while the optimistic scenario implies greater operational benefits from the investment and more favorable financial conditions. The base scenario corresponds to the assumptions used in the basic investment analysis.

Table 12. Scenario analysis of the investment project

Scenario	Annual savings (EUR)	Discount rate	NPV (EUR)
Pessimistic	6,000	10%	≈ -23,140
Basic	8,000	8%	≈ -6,319 (without subsidy) / 17,681 (with subsidy)
Optimistic	10,000	6%	≈ 13,601 (without subsidy) / 31,101 (with subsidy)

Source: Authors' calculations

The results of the scenario analysis in the Table 12 indicate that the economic justification of the investment project largely depends on the operational efficiency of the use of machinery and the cost of capital. In unfavorable conditions, the investment may remain financially unprofitable without institutional support, while more favorable operational and financial conditions significantly increase the economic value of the project. Such results confirm that public subsidies and stable financial conditions can play a key role in the realization of investment projects in agriculture.

Comparative analysis of scenarios

On the basis of previous analyses, a comparative analysis of different scenarios of the investment project was carried out. The goal of this analysis is to enable an overview of key economic indicators in different conditions of investment realization. In order to systematize the results of the investment analysis, a comparative scenario framework was constructed that enables an overview of the economic outcomes of the investment project in different operational and financial conditions.

Table 13. Comparative scenario framework for investment assessment

Investment scenario	Initial investment (EUR)	Annual cash flow (EUR)	NPV (EUR)	IRR
No subsidy	60,000	8,000	-6,319	6.7%
With subsidy	36,000	8,000	17,681	18-19%
Credit financing (subsidy + loan)	36,000	1,800 (first 7 years)	positive	>8%
Production growth (7%)	36,000	≈10,200	≈38,800	>20%
Larger farm (30 ha)	36,000	11,000	≈36,000	>20%

Source: Authors' calculations

The results of the comparative analysis in the Table 13 show that institutional factors, such as subsidies and the availability of credit financing, have a significant impact on the economic justification of investment projects in agriculture. While the basic scenario

without subsidies shows the limited financial viability of the investment, the inclusion of public incentives significantly improves the profitability indicators of the project.

In the scenario of credit financing, the net cash flow is reduced in the first years due to the obligation to repay the loan, while after the end of the loan repayment period it increases significantly. The scenario of a larger farm and the scenario of production growth indicate the importance of economies of scale and increased productivity for the long-term economic sustainability of investment projects in agribusiness. Comparative analysis of the scenarios shows that the economic sustainability of an investment project depends on the interaction of operational efficiency, financial conditions and institutional support. These results confirm the importance of public policies aimed at modernizing agricultural machinery and improving the productivity of agricultural farms.

Discussion

The results of the conducted investment analysis indicate several important aspects of making investment decisions in agricultural farms. First, the results of the basic scenario show that investment in agricultural machinery is not financially justified in conditions without institutional support. The negative net present value of the investment and the internal rate of return lower than the discount rate confirm hypothesis H1, according to which the investment in a tractor on a typical agricultural farm does not generate sufficient economic value without additional incentives. This result is consistent with the findings of numerous studies that indicate that investment in mechanization in small and medium farms is often limited by the amount of initial capital investment and relatively slow return on investment (Kay, Edwards, & Duffy, 2016). Second, the results of the scenario that includes the subsidy confirm the importance of institutional support for the implementation of investment projects in agriculture. The inclusion of a subsidy of 40% of the investment value significantly improves the economic indicators of the investment project, which is reflected in a positive net present value and a significantly higher internal rate of return. These results confirm hypothesis H2 and indicate the importance of public policies aimed at modernizing agricultural production, having in mind also ecological sustainability (Đurić et al, 2023). Similar conclusions are stated by FAO (2022), which points out that mechanization support programs can significantly increase productivity and investment activity in agriculture, especially in regions with outdated mechanization.

The third important finding refers to the financial feasibility of the investment project in terms of credit financing. The analysis shows that the combination of subsidies and a bank loan can enable the realization of the investment even in situations where the farm does not have sufficient own capital. A positive debt service coverage ratio (DSCR) indicates that the farm's operating cash flow enables stable servicing of credit obligations. This finding is consistent with the literature that emphasizes the importance of the availability of financial instruments for the implementation of investment projects in agriculture (Gittinger, 1982). The sensitivity analysis additionally shows that operational factors can have a significant impact on the economic justification of the

investment project. The importance of annual operating savings and the size of the farm is particularly emphasized. The results show that the increase in arable land leads to a better use of mechanization and an increase in the operational benefits of the investment, which confirms the importance of economies of scale in agricultural production. This finding is consistent with empirical research that shows that larger farms invest more often in mechanization and realize greater benefits from technological investments (Wang, Chu, & Chen, 2020).

The results of the scenario analysis additionally confirm the importance of the interaction of operational and financial factors in the assessment of investment projects. In unfavorable conditions, characterized by lower operational savings and higher cost of capital, the investment may remain financially unprofitable without institutional support. Conversely, more favorable operating and financial conditions can significantly increase the economic value of an investment project. Such findings confirm the comparative analysis of the scenarios (Table 13) which shows that the economic viability of the investment project depends on the combination of operational efficiency, financial conditions and institutional support.

Conclusion

The aim of this work was to evaluate the economic justification of investment in agricultural machinery on the example of a typical agricultural farm in Serbia. The analysis was carried out using investment analysis methods based on discounted cash flows, including net present value (NPV), internal rate of return (IRR) and sensitivity analysis of the investment project.

The findings show that the investment in mechanization without institutional support is not financially justified, because the negative net present value and the internal rate of return lower than the discount rate indicate limited economic viability of the project. This finding confirms hypothesis H1 and indicates that high initial investment costs can represent a significant obstacle to the modernization of production on small and medium-sized farms.

At the same time, the analysis of the scenario with the investment subsidy shows a significant improvement in the project's economic indicators, which confirms hypothesis H2. A combination of subsidies and credit financing can enable the realization of investment projects even in situations of limited own capital. The results of the sensitivity analysis further confirm hypothesis H3 and show that operational factors, such as the amount of annual savings and the size of the farm, have a significant impact on the economic viability of the investment.

In order to strengthen local food system development, during the EU accession, local farmers with small farm size (well below the EU average farm size), with lack of financing, sales and marketing skills, administrative and trading cost burdens, need to have support from official bodies at regional and local level (Cvijanović et al, 2020). In

this context, public policies that combine investment subsidies and available financial instruments can significantly contribute to the modernization of agricultural production and increase the competitiveness of the agricultural sector. Research findings indicate that the effectiveness of the mechanization support program does not depend only on the amount of the subsidy, but also on the availability of financial instruments that enable agricultural holdings to implement investment projects.

The research findings indicate that investment decisions in agriculture should be analyzed through an integrated analytical framework. This approach enables a broader understanding of investment decisions at the level of agricultural holdings, which often operate under conditions of limited access to capital and pronounced market uncertainties. This paper contributes to the literature on investment decisions in agribusiness through the application of investment analysis methods at the farm level and indicates the importance of institutional and market factors for the economic sustainability of investments in agricultural machinery. Our research has certain limitations, as the analysis is based on a simulated model of a typical agricultural farm. Future research could include an empirical analysis of a larger number of farms and a more detailed consideration of the influence of market and institutional factors on investment decisions in agribusiness.

Conflict of interests

The authors declare no conflict of interest.

References

1. Bejatović, G., Vapa - Tankosić, J. (2024). *Finansijska tržišta i institucije*. Faculty of Economics and Engineering Management, University Business Academy, Novi Sad.
2. Boardman, A. E., Greenberg, D. H., Vining, A. R., & Weimer, D. L. (2018). *Cost-benefit analysis: Concepts and practice* (5th ed.). Cambridge University Press, Cambridge UK.
3. Brealey, R. A., Myers, S. C., & Allen, F. (2020). *Principles of corporate finance* (13th ed.). McGraw-Hill Education, New York, NY.
4. Čavlin, M., Prdić, N., Ignjatijević, S., Vapa Tankosić, J., Lekić, N., & Kostić, S. (2023). Research on the determination of the factors affecting business performance in beekeeping production. *Agriculture*, 13(3), 686.
5. Čavlin, M., Tankosić, J. V., Miletić, V., & Ivaniš, M. (2021). Analysis of the impact of liquidity on the profitability in the medium and large meat processing enterprises in the Republic of Serbia. *Ekonomika poljoprivrede*, 68(3), 789–803.
6. Čavlin, M., Vojinović, Ž., & Vapa-Tankosić, J. (2024). *Upravljanje investicijama*. Novi Sad: FIMEK.

7. Cvijanović, D., Ignjatijević, S., Vapa Tankosić, J., Cvijanović, V. (2020). Do Local Food Products Contribute to Sustainable Economic Development? *Sustainability*, 12(7):2847, 1-18. DOI: 10.3390/su12072847
8. Đurić, K., Lukač Bulatović, M., Tomaš Simin, M., Glavaš Trbić, D. & Marković, T. (2024). Direct Payments as a Factor of Agriculture Development in the Republic of Serbia, *Journal of Agronomy Technology and Engineering Management (JATEM)*, 7(3), 1105-1113, DOI:10.55817/IEGH1390
9. Đurić, K., Tomaš Simin, M., Lukač Bulatović, M., Marković, T., & Glavaš Trbić, D. (2023). The contribution of agriculture to the realization of the concept of sustainable development. *Ekonomija - Teorija I Praksa*, 16(2), 81–97.
10. Đurić, K., Vukoje, V., & Tomaš Simin, M. (2016). Agrarni budžet kao oblik finansiranja poljoprivrede u Republici Srbiji i Hrvatskoj, *Agroekonomika*, (71), 13-21
11. FAO. (2022). *The state of food and agriculture 2022: Leveraging mechanization for sustainable agriculture*. Rome: Food and Agriculture Organization of the United Nations.
12. Funawer, R. (2022). Impact of the Covid-19 Pandemic on Companies Financial Performance: Is it the Same in all Industry Sectors?. *Asia Proceedings of Social Sciences*, 9(1), 231-232. [https://doi.org/ 10.31580/apss.v9i1.2310](https://doi.org/10.31580/apss.v9i1.2310)
13. Gittinger, J. P. (1982). *Economic analysis of agricultural projects*. Baltimore: Johns Hopkins University Press.
14. Kay, R. D., Edwards, W. M., & Duffy, P. A. (2016). *Farm management* (8th ed.). New York: McGraw-Hill Education.
15. Marković, M., & Đokić, M. (2025). Does the economic development of a country determine the performance of a circular economy? Records from the European Union. *Održivi razvoj*, 7(2), 25-42. <https://doi.org/10.5937/OdrRaz2502025M>
16. Miljković, M., & Arsić, I. (2025). Determinisanje promena organizaciono-upravljačkih procesa u sistemu upravljanja. *Finansijski Savetnik*, 30(1), 55-74. <http://fa-journal.com/index.php/fa/article/view/3>
17. Pantić, N., Lazarević, S., Ognjanović, J. (2026). International trade exchange of the Republic of Serbia: Analysis of exports, imports and trade balance in the period 2015–2024. *Akcionarstvo*, 32(2), 27-47. <https://doi.org/10.65772/ak2026206>
18. Pingali, P. (2007). Agricultural mechanization: Adoption patterns and economic impact. *Handbook of Agricultural Economics*, 3, 2779–2805.
19. Republic Institute of Statistics. (2019). *Census of Agriculture 2018 - Mechanization in Agriculture*. Belgrade: Republic Institute of Statistics.
20. Shen, H., Fu, M., Pan, H., Yu, Z., & Chen, Y. (2020). The impact of the COVID-19 pandemic on firm performance. *Emerging Markets Finance and Trade*, 56 (10), 2213-2230.

21. Tasić, S., Tomić, Žarko, & Marjanović, N. (2026). Inflacija i makroekonomska stabilnost Srbije: statistički pristup. *Oditor*, 12(2), 107-126. <https://doi.org/10.59864/Oditor62602ST>
22. Vapa Tankosić, J., Ignjatijević, S., Lekić, N., Kljajić, N., Ivaniš, M., Andžić, S. & Ristić, D. (2023). The Role of Environmental Attitudes and Risk for Adoption with Respect to Farmers' Participation in the Agri-Environmental Practices. *Agriculture*, 13, 2248. <https://doi.org/10.3390/agriculture13122248>
23. Vapa Tankosić, J., Lekić, N., Čavlin, M., Burnać, V., Mirkov, M., Prodanović, R., Bejatović, G., Prdić, N. & Mirjanić, B. (2025). Employee Perceptions of ESG Policy Implementation in Urban and Rural Financial Institutions. *Agriculture* 22025, 15, 1684. <https://doi.org/10.3390/agriculture15151684>
24. Wang, J., Chu, M., & Chen, K. (2020). Farm size, mechanization and agricultural investment decisions: Evidence from rural households. *Sustainability*, 12, 247.
25. Yin, R. K. (2018). *Case study research and applications: Design and methods* (6th ed.). Thousand Oaks, CA: Sage.
26. Zielińska-Chmielewska, A., Kaźmierczyk, J., & Jaźwiński, I. (2022)- Quantitative Research on Profitability Measures in the Polish Meat and Poultry Industries. *Agronomy*, 12, 92. <https://doi.org/10.3390/agronomy12010092>.

DEVELOPMENT OF SERBIAN AGRICULTURE THROUGH BRICS INTEGRATION: OPPORTUNITIES AND LIMITATIONS

Branko Mihailović¹, Vesna Popović², Gordana Radović³

*Corresponding author E-mail: brankomih@neobee.net

ARTICLE INFO

Original Article

Received: 08 May 2026

Accepted: 15 July 2026

doi:10.59267/ekoPolj2603839M

UDC

338.43:339.923BRICS(497.11)

Keywords:

Serbia, agriculture, BRICS, free trade agreements, agri-food exports, EU accession.

JEL: Q17, F13, F15, O13, P45

ABSTRACT

This study looks at Serbian agricultural growth from the perspective of BRICS integration, analyzing the advantages and disadvantages of this kind of involvement. With more than 5 million hectares of land used for agriculture and agri-food exports making up more than 20% of overall exports, Serbia has enormous agricultural potential, but it is still heavily reliant on the EU market. The study examines the extent of Serbia's agreements on free trade with the BRICS nations, such as the historic 2023 China-Serbia Free Trade deal and the 2021 EAEU deal, and evaluates how these agreements alter trade flows in important commodities as raspberries, corn, wheat, and cattle. The study generates data collected from FAOSTAT, the Statistical Office of the Republic of Serbia, Eurostat, USDA-FAS, and published peer-reviewed articles using desk research technique. Results show that although BRICS markets present real opportunities for diversification, major obstacles still exist, such as phytosanitary barriers, regulatory differences from European Union (EU) logistical and administrative bottlenecks, and geopolitical disputes resulting from Serbia's concurrent pursuit of EU membership. The study comes to the conclusion that while a dual-track approach is workable, its sustainability necessitates focused institutional modernization.

-
- 1 Branko Mihailović, Ph.D., Scientific Adviser, Institute of Agricultural Economics, Volgina Street no. 15, 11060 Belgrade, Serbia, Phone: +381 11 697 28 58, E-mail: brankomih@neobee.net, ORCID ID (<https://orcid.org/0000-0002-2398-6568>)
 - 2 Vesna Popović, Ph.D., Scientific Adviser, Institute of Agricultural Economics, Volgina Street no. 15, 11060 Belgrade, Serbia, Phone: +381 11 697 28 58, E-mail: vesna_p@iep.bg.ac.rs, ORCID ID (<https://orcid.org/0000-0003-1018-2461>)
 - 3 Gordana Radović, Ph.D., Senior Research Associate, Institute of Agricultural Economics, Volgina Street no. 15, 11060 Belgrade, Serbia, Phone: +381 11 697 28 58, E-mail: gordana.radovic09@gmail.com, ORCID ID (<https://orcid.org/0000-0001-9770-6306>)

Introduction

Due to the growth of emerging market countries, changing geopolitical alignments, and the proliferation of preferential trade agreements, global agricultural trade has experienced significant structural changes in the first quarter of the 21st century. The BRICS group, which was initially made up of Brazil, Russia, India, China, and South Africa, has become a major player in this changing environment. By 2021, it accounted for about 16% of worldwide agricultural exports, and with the addition of new members in 2024, it represented almost twenty percent of global agri-food trade (Glauben & Djuric, 2024).

These shifts present significant institutional dangers as well as strategic opportunities for small economies that are open like Serbia that are situated at the crossroads of several trading blocs. Serbia is a unique case study because it is a signatory to the Eurasian Economic Union (EAEU) Free Trade Agreement, an EU candidate state with long-standing preferential access to European markets, and, as of July 2024, the first European nation to sign a comprehensive free trade agreement with Beijing (Gecić Law, 2024). For the purpose of formulating agricultural policy, this set of overlapping trade connections produces a particularly complex environment.

In the Serbian economy, agriculture is structurally important. Serbia is one of the most agriculturally endowed economies in the Western Balkans, with over 5,056,000 hectares of agricultural land, or 0.7 hectares per person, and agri-food exports making up more than 20% of the nation's total merchandise exports, valued at about USD 4.7 billion in 2023 (SORS, 2023; USDA-FAS, 2024). In addition to being a major supplier of wheat, sunflower oil, sugar, and horticulture products, Serbia leads the world in the production of non-GMO corn and raspberries (ITA, 2024).

Serbian policymakers and academic experts are becoming increasingly interested in BRICS as a substitute structure for agricultural trade cooperation. The water resource management, food safety policy, and the exchange of best practices in sustainable production are among the specific fields of multilateral agricultural engagement identified by the BRICS Action Plan for Agricultural Cooperation, which was first introduced for the years 2017–2020 and later extended to 2024 (Singh, 2024). Together with Serbia's growing structure of bilateral agreements on free trade, these institutional measures create new market corridors that have the potential to drastically change the composition of the nation's agricultural export base.

Nevertheless, there are certain paradoxes in the quest for greater BRICS integration. The Common Agricultural Policies (CAP), the security of food laws, and phytosanitary standards must all be gradually harmonized with the EU *acquis* of communautaire as part of Serbia's ongoing EU membership process, which was formally started with status as a candidate granted in 2012 (European Commission, 2024). The existing scholarly work has not sufficiently addressed the structural difficulties created by simultaneously strengthening ties with BRICS nations, whose regulatory regimes differ significantly from EU norms.

By methodically analyzing the opportunity that BRICS integration presents for Serbian the development of agriculture as well as the institutional, legal, and geopolitical constraints that restrict its realization, this research seeks to close this gap. Using primary statistics sources from FAOSTAT, Statistical Office of the Republic of Serbia, Eurostat, USDA-FAS documents, and a corpus of published academic literature.

Literature review

BRICS (Brazil, Russia, India, China, and South Africa) is significant because it is a new economic, global, trade, and financial force that opposes globalization and the current geopolitical, economic, and financial division and unity of the world. (Pejanović et al., 2026). According to Glauben and Djuric's (2024) analysis published in *Intereconomics*, BRICS members are among the key players in global agri-food markets, along with the G7 nations and the EU. This is the most thorough recent evaluation of BRICS's overall structural position within global agri-food trade. According to their research, global agricultural exports increased by approximately a third in nominal currency terms in 2021, reaching nearly USD 2 trillion. The BRICS countries accounted for about 16% of this total, and under the wider BRICS+ configuration, that percentage is expected to rise to 20% (Glauben & Djuric, 2024).

In an article published in *Progress in Development Studies*, Bamidele (2025) explains the macro-structural aspect of what he refers to as the "BRICS-driven agrarian shift," contending that these emerging markets are significantly altering worldwide farming systems through supply chain reconfiguration, production, and trade patterns. According to Bamidele (2025), BRICS is the center of a "agricultural pivot" in which the group's place in the global division of labor is gradually being repositioned due to growing exports of agricultural products capacities and agro-processing activities. Insofar as it recognizes structural demand expansion as the primary driving force of BRICS agrarian market growth rather than merely tariff liberalization, this conceptualization offers a helpful theoretical foundation for Serbia's strategic evaluation of BRICS market potential.

Increasing numbers of academic research focused on policy has shown the institutionalization of agricultural cooperation among BRICS. In his comprehensive description of the BRICS Agricultural Cooperation Action Plan framework, Singh (2024) points out that by April 2024, Russia's BRICS presidency had called the first summit of the BRICS Working Group on Agriculture, with the encouragement of environmentally friendly farming, mutually beneficial trade improvement, and food security as the top priority. Growing populations, changes in the climate, and international instability are putting further strain on food security worldwide (Laamarti et al., 2026). The wider examination of institutions of the BRICS+ development at the Johannesburg Summit in 2023 and the Kazan Summit in 2024, both that are thoroughly studied by Maihold, Müller, and Átig (2024), who place BRICS's farming management progress in the global geopolitical environment of a multipolar system formation, supports the analytical structure established by Singh (2024). In *Frontiers*

in Sustainable Food Systems, Xin et al. (2024) thoroughly analyze the particular institutional structure of BRICS facilitation of trade for products from agriculture, which directly relates to possible Serbian market access. Xin et al. (2024) use an analysis of principal components analyzing trade facilitating parameters for BRICS members from 2009 to 2022 and a stochastic random frontier based gravity model to find that overall commerce facilitating in BRICS countries is still relatively low, with significant room for improvement.

The function of the New Development Bank (NDB), the multilateral development organization of the BRICS, has been investigated from the standpoint of monetary support for agricultural development in relation to investment in infrastructure for agri-food industries in emerging economies. For investment in agriculture in candidate economies like Serbia, the NDB's objective to fund sustainable development and infrastructure initiatives in BRICS and partner nations presents a theoretically substantial, albeit operationally embryonic, avenue. The NDB is framed as one of numerous alternative development financing mechanisms that challenge the institutional supremacy of Bretton Woods institutions in Lippert and Mair's (2024) larger evaluation of a multipolar world orders and EU strategic repositioning.

This result supports the previous investigation by Marković and Simonović (2025), presented in the same journal, which shows that, in contrast to bulk commodities like corn, where manufacturing expenses is the main competitive factor, quality of product rather than expenditure determines an a competitive advantage in quality-competitive products like frozen fruit and apples (Marković & Simonović, 2025). Serbia's unique positioning approach in the BRICS markets is significantly impacted by this quality-cost distinction.

Vapa-Tankosić et al. (2022) have analyzed Serbia's food safety policy in the context of EU standards harmonization, looking at the country's dual status as an EU applicant country and an active bilaterally FTA negotiator from the regulatory harmonization perspective. According to their study, which was presented in the Journal of Agronomy, Technology and Engineering Management, Serbia's access to other global markets, including BRICS destination countries, is simultaneously conditioned by European standards and technical barriers to EU market access, especially in the areas of sanitation, hygiene, welfare of animals, and environmental regulation (Vapa-Tankosić et al., 2022).

During the 2023 BRICS Johannesburg Summit and the 2024 Kazan Summit, the geopolitical discourse on Serbia's position among integration into the EU and BRICS engagement has significantly risen. According to the Pupin Institute's 2025 analytical assessment, Serbia's strategy is driven by three main factors: strategic bargaining power in its relationship with the EU and Western institutions; investment in infrastructure attraction according to the Belt and Road Initiative; and diversification of its economy and trade growth through a variety of agreements. The Pupin Institute (2025) acknowledges economic reasoning of broad diversification but also draws

attention to the basic diversity of the BRICS arrangement, pointing out that the countries are not united in thought, physical location, or tradition, and that their partnership is mainly founded on an opposition to Western superiority rather than shared principles. This institutional restriction limits the scope of an institutionalized farming-related partnership.

Vladisavljev (2025) of the Mercator Institute for China Studies (MERICS) evaluated Serbia's first BRICS+/China free trading agreement, which is the greatest significant bilateral economic development analyzed in this research. According to Vladisavljev's analysis of the initial year of FTA adoption, overall bilateral commerce between Serbia and China increased by 21% compared to the previous year to USD 7.4 billion in 2024. Nevertheless, 93% of Serbian exporting to China consisted of mining and copper products. Raspberry exports to China actually decreased from USD 1.2 million in 2023 to USD 832,000 in 2024 despite the tariff reduction, despite agricultural products like raspberries, apples, and beef—the politically supported beneficiary of the FTA—contributing only slightly to export growth (Vladisavljev, 2025). The current article attempts to contextualize this recorded discrepancy between FTA capacity and actual agriculture export performance within the larger structure of BRICS integration advantages and barriers.

When viewed jointly, the literature review demonstrates a glaring empirical gap: although bilateral negotiating dimensions of Serbia's major free trade agreements and the macroeconomic dynamics associated with BRICS agricultural trade have been studied separately, no previous study has methodically combined the commodity-specific analysis of competition, the regulation harmonization obstacles, and the geopolitical factors of conditioning into a cohesive evaluation of Serbia's agricultural progress possibilities by means of BRICS convergence.. This gap is filled in the current paper.

Materials and methods

This study uses a thorough desk research technique, which is characterized by the methodical gathering, synthesis, and critical evaluation of secondary information from reputable academic, statistical, and institutional sources. Considering the multidisciplinary characteristics of the subject matter, which includes geopolitical analysis, global trade policy, and agricultural economics, desk-based research approach is suitable for the current study. In agricultural economics, the methodology adheres to accepted norms for comprehensive synthesis of evidence.

The following sources provided primary statistical data: (i) the Food and Agriculture Organization of the United Nations' FAOSTAT database, which covers production, trade, and price series for Serbia and BRICS the member countries from 2010 to 2023; (ii) the Statistical Office of the Republic of Serbia (SORS), which includes preliminary findings of the 2023 Census of Agriculture and annual national accounts releases; (iii) Eurostat's agriculture and agri-food trade databases, which provide EU-standardized

comparative analysis statistics; and (iv) the United States Department of Agriculture – Foreign Agricultural Service (USDA-FAS) annually published country reports for Serbia, covering the years 2019–2024.

Two complimentary dimensions are integrated into the analytical framework. In order to determine Serbia's competitive specialization, a trade structure study first looks at the makeup and development of Serbian agri-food exports to BRICS markets using revealed comparative advantage (RCA) concepts. Second, the regulatory alignment assessment compares and contrasts Serbia's current phytosanitary and food safety laws with those that apply in important BRICS markets, paying special attention to Russia's EAEU technical regulations and China's import certification requirements.

With special attention to peer-reviewed works published in journals such as *Intereconomics – Review of European Economic Policy*, *Progress in Development Studies*, *EuroChoices*, and *Economics of Agriculture*, international academic literature was examined using databases like Elsevier, Springer, and ResearchGate. The BRICS Agricultural Cooperation Action Plans, the texts of the Serbia-EAEU Free Trade Agreement (2019/2021) and the Serbia-China Free Trade Agreement (2023/2024), and the Serbia Progress Reports for 2023 and 2024 from the European Commission are among the policy documents examined.

Results and Discussion

Structure and Importance of Serbian Agriculture

A comparatively significant number of family-owned small-holdings, which amount to 99.6% of all formally registered farming entities, in accordance to the 2023 Census of Agriculture, coexist with a lesser number of large-scale commercial farms that are centered in the fertile region of the Pannonian Plain of Vojvodina to form Serbia's agricultural industry (SORS, 2024). The total amount used agricultural area (UAA) as of 2023 is estimated at 3,239,373 hectares, of which 77.7% corresponds to arable land. With 61.7% of holdings growing animals, mainly pigs, cattle, and sheep, livestock farming is still a significant sector.

During the past ten years, agriculture's share of Serbian GDP has declined structurally, from an historical average value of roughly 8% (1995–2023) to 3.79% in 2023. This decline is indicative of an overall process of industrial improvement and economic structural transformation (TheGlobalEconomy.com, based on World Bank data, 2024). However, the industry's strategic worth extends far further than its fundamental impact on economic. As agricultural processing and the food-related sector are taken into consideration, food production and agriculture produce more than 10% of Serbia's general economic output and roughly 20% of all exported goods (ITA, 2024). With over 120,000 employees across more than 20,000 businesses, 90% of which are micro, small, or medium-sized, the food production sector alone accounts for over one-third of Serbia's total industrial sector (ITA, 2024).

The industry's fluctuation is demonstrated by quantitative volumetric output data from SORS. The 2022 agriculture year saw a notable 8.0% physical quantity decrease, which was attributed to the severe summer-time drought conditions and problems related to grain transportation within Black Sea ports resulting from the conflict between Russia and Ukraine (SORS, 2022; USDA-FAS, 2023). Such events affect food security (Glauber & Laborde Debucquet, 2023)

On the other hand, agricultural output volume had a robust 9.0% increase in 2023 (SORS, 2023). These variations highlight the industry's inherent production flexibility as well as its susceptibility to geopolitical and climatic changes. The main agricultural indicators for Serbia from 2019 to 2023 are shown in Table 1.

Table 1. Key Indicators of Serbian Agriculture, 2019–2023

Indicator	2019	2020	2021	2022	2023
Agricultural land (000 ha)	5,058	5,058	5,056	5,056	5,056
Arable land (000 ha)	3,297	3,295	3,294	3,294	3,239
Agri-food exports (USD bn)	3.8	3.9	4.5	5.0	4.7
Agri exports as % of total exports	21.0%	22.1%	21.5%	21.8%	20.5%
Agriculture % of GDP	5.6%	6.2%	5.9%	5.3%	3.8%
Agri production growth (vol.)	+3.1%	+2.8%	+4.2%	-8.0%	+9.0%

Source: SORS (2022; 2023; 2024); FAO FAOSTAT (2023); USDA-FAS (2024); authors' compilation.

The Trade Structure of Serbia with the BRICS Nations

Prior to the official BRICS+ growing, Serbia engaged with economies of the BRICS through agreements on preferential trade. On July 10, 2021, Serbia's previous dual trade liberalization arrangements with the Russian Federation as well as other post-Soviet nations were replaced and expanded upon by the Agreement on Free Trade with the Eurasian Economic Union, which covers Russia, Belarus, Kazakhstan, Kyrgyzstan, and Armenia.

About 99% of Serbian traded goods have advantageous access to a consolidated marketplace of 180–200 million customers thanks to the EAEU FTA, which is especially important for food and agricultural goods (Serbian Monitor, 2021; TASS, 2021). In front of the presidents of both nations, the historic Agreement on Free Trade among the People's Republic of China and the Republic of Serbia was signed on October 17, 2023, during the Third Belt and Road Initiative Forum in Beijing (China-CEE Institute, 2023). The agreement, which covers more than 20,000 products, came into effect on July 1, 2024. Approximately 90% of tariff lines may be eliminated under the FTA, and over 60% will have zero tariffs as soon as they go into effect. Up to 15 years will pass until 95% of tariff lines are fully liberalized (China Briefing, 2024). The deal offers urgent duty-free possession of fresh blueberries, apples, jams, dried plums, seeds, and beef for Serbian exports to agriculture. Within ten years, dairy, frozen raspberries, and other meat-based goods will become free of charges (Gecić Law, 2024). The

development of Serbian agri-food trade with the BRICS economies from 2019 to 2023 is shown in Table 2.

Table 2. Serbian Agri-food Exports to BRICS Countries, 2019–2023 (USD million)

Trade partner	2019	2020	2021	2022	2023
BRICS – Total agri exports (USD mn)	210	245	318	420	490
– Russia/EAEU	145	175	215	290	330
– China	12	14	18	22	28
– India	31	35	48	62	78
– Brazil / S. Africa	22	21	37	46	54
BRICS share of total agri exports	5.5%	6.3%	7.1%	8.4%	10.4%
EU share of total agri exports	60.1%	59.8%	60.4%	58.7%	57.3%

Source: SORS trade statistics; UN Comtrade (2023); USDA-FAS (2024); authors' calculations and estimates.

The BRICS share of Serbian agricultural exports increased steadily from roughly 5.5% in 2019 to 10.4% in 2023, according to the data. Due to their close proximity and longstanding bilateral economic ties, Russia and the EAEU group make up the largest BRICS market for Serbian agri-food products. Although growing from a low base, China's share is still small in total terms. This arrangement corresponds with Vladislavljev's (2025) results, which show that agricultural goods other than copper based products and minerals made up a small portion of Serbia's export portfolio to China in the first year of the China Free Trade Agreement's application.

Between USD 1.5 billion in 2014 to USD 6 billion in 2023 and then to USD 7.4 billion in 2024, bilateral commerce among Serbia and China increased by 21% annually, the largest expansion in one year in more than ten years (Vladislavljev, 2025). Nevertheless, as of 2024, copper and allied mining products accounted for 93% of Serbian exporting to China, leaving commodities from agriculture as a mostly untapped export potential.

Opportunities at the Product Level in BRICS Markets

There are several highly prospective product groups where comparative benefit meets available market prospects, according to an examination of Serbia's exports from agriculture profile in relation to BRICS market demand. A methodical summary of important agricultural goods, their production importance in Serbia, and their market value in the economies of the BRICS are shown in Table 3.

The most famous agricultural export from Serbia is raspberries. With a yearly output of about 100,000 tonnes, Serbia is one of the top manufacturers of frozen raspberries worldwide. Although Russia has historically been a significant market for Serbian raspberry exports under the EAEU FTA framework, the trajectory in the Chinese market has been more difficult: despite the FTA's implementation, raspberry exports to China dropped from USD 1.2 million in 2023 to USD 832,000 in 2024. This suggests that eliminating tariffs alone is not enough for overcoming non-tariff constraints, such as the phytosanitary certification standards, shortcomings in logistics for the cold chain, and

access to markets protocols unique to the Chinese food import regulatory framework (Vladislavljev, 2025).

Table 3. Key Serbian Agricultural Products and BRICS Market Opportunities

Product	Serbia production/ export	Key BRICS market	FTA status
Raspberries (frozen)	World leader; ~100,000 t/year	Russia, China	EAEU FTA (2021); China FTA (2024)
Wheat	~3.6 MMT production; 1.8 MMT for export	India, China	Partial; negotiation ongoing
Corn (non-GMO)	~5 MMT; global leader non-GMO	China, Russia	EAEU FTA; China FTA (2024)
Apples / Plums / Blueberries	Significant export volumes	China (priority)	Immediate zero tariff from July 2024
Beef / Meat	Growing sector; expanding exports	Russia, China	EAEU FTA; China 10- year liberalisation
Sunflower oil / Oilseeds	Important agro- industrial product	India, Russia	EAEU FTA (quota restrictions until 2025)

Source: ITA (2024); USDA-FAS (2023; 2024); Gecić Law (2024); China-CEE Institute (2023); authors' analysis.

Serbia's biggest proportional agricultural exports are non-GMO wheat and corn. In a typical yearly period, Serbia produces about 5 million metric tonnes of corn, which meets 4.2 MMT of domestic consumption and produces about 1 MMT for export (USDA-FAS, 2023). For BRICS economies like China and India, where customer and regulatory expectations for non-genetically modified kinds are growing, Serbia's place as a global leader in non-GMO maize production is especially pertinent. However, because around 80% of grain exports pass through Black Sea ports, Serbia's grain export activities were seriously affected in 2022, making it directly vulnerable to the Russia-Ukraine conflict (USDA-FAS, 2023). Plums, apples, blueberries, dried fruits, and other fresh and processed fruits are among the product categories for which the China Free Trade Agreement provides instantaneous, practical tariff decreases. Serbia's manufacturing capacity is in line with the rapidly growing middle-class demand for high-end fruit products in the Chinese and Indian markets. However, the EU food security evaluation (Food Safety News, 2024) and the Merics evaluation (Vladislavljev, 2025) both show that Serbian exports of these products to China have not yet materialized at scale, waiting for the setting up of dependable logistics routes and the resolution of phytosanitary certification barriers.

Serbia's Place in the BRICS Agricultural Cooperation Framework

Under the BRICS Agricultural Cooperation Action Plan, the BRICS nations have institutionalized cooperation in agriculture above bilateral trading arrangements. Food safety and hunger eradication, agricultural equipment transfer, facilitation of trade, management of water resources, and development financing through the New Development Bank are the five thematic pillars of the Plan, which was first introduced

at the 2017 Xiamen Summit and is extended through 2024 (Singh, 2024; Chinadaily, 2024). Table 4 evaluates each pillar's applicability to Serbia and highlights the main obstacles to participation.

Table 4. BRICS Agricultural Cooperation Framework: Relevance for Serbia and Key Constraints

Cooperation area	Relevance for Serbia	Potential constraints
Food security & hunger eradication	Access to BRICS demand markets; agri export diversification	SPS compliance differences; non-tariff barriers
Agricultural technology transfer	Precision farming; irrigation know-how	Lack of FDI-ready frameworks; IP protection gaps
Trade facilitation & tariff reduction	China FTA 2024; EAEU FTA 2021	Conflict with EU CAP alignment process
Water resource management	Only 8.3% of UAA irrigated; investment need	Capital-intensive; competing EU IPARD funds
Financing via New Development Bank (NDB)	Alternative to EU pre-accession funds	EU conditionality vs. BRICS non-conditionality tensions

Source: Singh (2024); BRICS (2023); European Commission (2024); SORS (2024); authors' analysis.

A deeper institutionalization of multilateral agricultural discourse inside the bloc is shown by the establishment of the BRICS Working Group on Agriculture, which was initially held under Russia's 2024 BRICS Chairmanship (Singh, 2024). The three priorities—sustainable output, mutual trading improvement, and food security—are generally in line with Serbia's goals for agricultural growth. However, in order to prevent conflicts with the CAP harmonization standards imposed under negotiations outlined in Chapters 11 and 12 of the EU joining procedure, Serbia's participation in BRICS agricultural governance systems must be standardized due to its status as an EU member state (EU Agricultural Policy Projects in Serbia, 2024). A potential major source of funding for Serbian farm infrastructure, especially irrigation networks, is the New Development Bank, which was founded as the global development funding arm of BRICS. Just 8.3% of Serbia's UAA was irrigated as of 2023, mostly through surface conventional methods of irrigation exploiting groundwater (SORS, 2024). Reducing the sector's weather-related productivity unpredictability requires investments in standard irrigation systems, but neither IPARD EU funding nor local public funding have been adequate to mobilize at scale (OECD, 2024). In theory, BRICS NDB cash might supplement EU pre-entrance assistance, but doing so would need Serbia formalizing its partnership with the NDB, a process that has geopolitical ramifications given the conditions of EU membership.

Discussions

The study's conclusions reveal a structural conflict at the heart of Serbia's agricultural policy perspective: the nation has real and expanding market access opportunities in the BRICS countries, but the system of institutions and regulations needed to convert these

possibilities into long-term export success is still lacking. Although Vladislavljev (2025) notes an analogous pattern in the initial year of the China Free Trade Agreement's introduction, where headline-grabbing increase in trade was primarily driven by mining-related exports rather than agricultural products, this gap between trade policy ambition and operational export capacity is not exclusive to Serbia. However, it is especially severe in the agricultural sector.

Strategic ambivalence has been a defining feature of Serbia's foreign policy orientation from a geopolitical standpoint, as it simultaneously pursues EU membership while preserving tight economic connections with Russia and forming strategic alliances with China. Serbia's alignment with the EU's Common Foreign and Security Policy dropped to 47% in 2024, the lowest level across Western Balkan candidate states, according to data from the Australian Institute of International Affairs (2025). According to a May 2025 survey, 60% of Serbian population are in favor of entering BRICS, while approval for joining the European Union has dropped to a record low of 46% against 44% opposed (Australian Institute of International Affairs, 2025). Nearer BRICS agricultural sector participation is popular locally due to these public opinion trends, but it involves the risk of joining the EU conditions, which could include the possible withdrawal of up to EUR 1.5 billion in pre-accessional financial support (nato.news-pravda.com, 2026).

Possibly the most complicated aspect is the regulatory constraint aspect. The Ministry of Agriculture, the Directorate of National Reference Laboratories (DNRL), and the inspection services are the three institutionalized components that support Serbia's food safety supervision framework. These organizations lack an integrated data exchange system and continue to be out of compliance with EU regulations, especially when it comes to inspected monitoring and sampling practices (Serbian Monitor, 2026). The fulfillment of requirements for certification particular to the BRICS countries is also hampered by this imbalance. For instance, each exporting establishment must obtain approved facility-level authorization under the Chinese food import regulation procedure. This procedure necessitates substantial administrative resources as well as cross-border veterinary and phytosanitary partnership, which Serbia is just now beginning to establish under the FTA framework (China-CEE Institute, 2023). Glauben and Djuric (2024) argue that strong protection and ideologically motivated de-risking efforts are high-risk endeavors that could jeopardize global food security, placing these bilateral concerns within the larger geopolitical dynamics underlying BRICS agricultural commerce. According to their analysis of the OECD Services Trade Restrictiveness Index, the BRICS nations have substantially enhanced their transportation services over the last ten years, coming close to G7 norms in air and maritime travel, but they are still far behind in logistical services, customs brokerage services, and e-commerce infrastructure. For Serbian exporters looking to enter BRICS countries, especially China and India, where intricate customs procedures and digital validation needs constitute significant non-tariff limitations, this infrastructural deficit is fundamental (Glauben & Djuric, 2024). A hierarchical structure of Serbian agro

products' preparedness for BRICS market penetration is revealed by the commodities-level research. Given existing trade flows, well-established infrastructure, and strong BRICS consumer demand, non-GMO corn and wheat are the closest to being ready for the market. Beef and horticulture products fall into the intermediate tier, where implementation timelines of three to five years are necessary to overcome regulatory obstacles through focused bilateral certificate arrangements. Considering their symbolic value, raspberries and processed fruit products encounter the most complicated non-tariff obstacles in Chinese and Indian markets, necessitating extensive cold-chain expenditures and bilateral administrative harmonization. There are some agri-food items with comparative advantage and promising prospects in the Chinese market, according to revealed comparative advantage indexes and tariff concessions. However, additional trade performance metrics, such as excessive product concentration, total net export competitiveness, prevalence of primary products, and minimal intra-industry trade due to severe supply limitations, reveal major flaws in Serbian agricultural products exports to China (Popović et al., 2025).

The BRICS integrated trend offers prospects for high-value processing of food from the standpoint of agribusiness expansion. Serbia's food processing sector, which employs 120,000 people and makes up one-third of all production, has the capacity to transition from exporting bulk commodities to processed agri-food goods that are more valuable in the BRICS markets (ITA, 2024). Serbia's current competitive advantage is in line with Chinese consumer preferences for premium European food items with organic standards and non-GMO verification; however, obtaining this premium necessitates substantial investments in export-market logistical services, branding, and labeling that exceed what individual small and medium-sized businesses can afford on their own.

Conclusions

In addition to recognizing a number of institutional, legal, and geopolitical obstacles that need to be methodically tackled if these possibilities are to be realized, this research has shown that BRICS membership offers significant and expanding prospects for Serbian agricultural growth. The following are the main empirical conclusions.

- First, the share of Serbian agricultural products exported to the BRICS countries increased from roughly 5.5% in 2019 to 10.4% in 2023, mostly due to increased trade with Russia and the EAEU, with China being a significant but mainly unexplored opportunity.
- Second, the China-Serbia Agreement on Free Trade of 2023/2024, which offers instant zero-tariff accessibility for important fruit products and a 10–15 year liberalization trend for beef, dairy, and frozen goods, is the most important single trade policy development for Serbian agriculture in recent years.
- Third, Serbia's agricultural growth targets are largely in line with the international frameworks provided by the BRICS Agricultural Cooperation

Arrangement, which includes the Action Plan prolonged until 2024 and the recently formed BRICS Working Group on Agriculture.

- Fourth, Serbian agriculture's small average farm dimensions and fragmented market architecture, ongoing phytosanitary and food safety regulatory deficiencies, insufficient cold-chain and export logistics infrastructure, and the geopolitical tension of simultaneously pursuing EU accession alignment and BRICS market integration all limit the realization of these possibilities.

The next set of policy suggestions are made in light of these results. In order to secure specific facility export licences for the most important product groups, the Serbian Ministry of Agriculture should allocate top priority to negotiating bilateral veterinary and phytosanitary equivalency agreements with China, India, and other BRICS nations. A hybrid finance system that maintains EU membership conditionality should be established by redesigning agricultural investment policies to allow co-financing between IPARD EU funding and possible NDB project loans. Using Serbia's current advantage in competition in the production of certified non-GMO wheat and corn, an export promotional plan should focus on the non-GMO premium category in Chinese and Indian consumer markets. Investing in logistics infrastructure, especially cold-chain facilities and intermodal transport linkages, is necessary to realize the potential for agricultural trade expansion provided by Serbia's BRICS-focused free trade agreement network.

The study's more general conclusion is that Serbia's dual approach to foreign policy, which aims to integrate into the EU while strengthening trade ties with the BRICS countries, is neither intrinsically incompatible nor necessarily viable. The rate and caliber of domestic institutional modernization, especially in agriculture regulatory and food safety systems, that establishes true compatibility between the demands of EU market access and BRICS market penetration will determine its durability. In order to estimate the dynamic trade creation and diversion effects of the China-Serbia free trade agreement across particular agricultural industry subsectors, further studies should use quantitative methods of trade modeling. Additionally, survey-driven company-level evaluation of Serbian exporters' preparedness to interact with BRICS marketplace accreditation and delivery standards should be carried out.

Acknowledgements

Paper is a part of research financed by the MSTDI RS, agreed in decision no. 451-03-33/2026-03/200009 from 5.2.2026.

Conflict of interests

The authors declare no conflict of interest.

References

1. Australian Institute of International Affairs. (2025). Serbia Between Brussels, Beijing, and Moscow: A Foreign Policy of Diversification. Australian Outlook, August 2025. Retrieved from <https://www.internationalaffairs.org.au>
2. Bamidele, S. (2025). BRICS Revolution: The global agrarian shift sparked by emerging economies. *India Quarterly*, 81(1), 43-58.
3. BRICS. (2023). XV BRICS Summit Johannesburg II Declaration. Sandton, South Africa, 23 August 2023. Retrieved from <https://www.gov.za/brics-summit-2023>
4. China Briefing. (2024). China-Serbia Bilateral Relations: Trade and Investment Outlook. Shanghai: Dezan Shira & Associates. Retrieved from <https://www.china-briefing.com>
5. China-CEE Institute. (2023). Serbia Political Briefing: Free Trade Agreement with the People's Republic of China. Weekly Briefing, Vol. 66, No. 1. Budapest: China-CEE Institute. Retrieved from <https://china-cee.eu>
6. European Commission – Directorate-General for Agriculture and Rural Development. (2024). Agri-food Trade Statistical Factsheet: Serbia. Brussels: European Commission. Retrieved from <https://agriculture.ec.europa.eu>
7. European Commission. (2024). Serbia 2024 Report. Commission Staff Working Document. SWD(2024) 228. Brussels: European Commission.
8. Food and Agriculture Organization of the United Nations (FAO). (2023). Statistical Yearbook: World Food and Agriculture 2023. Rome: FAO. doi:10.4060/cc8166en
9. Food and Agriculture Organization of the United Nations (FAO). (2023). FAOSTAT: Production, Trade and Prices Data. Rome: FAO. Retrieved from <https://www.fao.org/faostat>
10. Gecić Law. (2024). Serbia's Landmark Free Trade Agreement with China Takes Effect. Gecić Law Client Update, July 2024. Belgrade: Gecić Law. Retrieved from <https://www.geciclaw.com>
11. Glauben, T., & Djuric, I. (2024). BRICS: World Heavyweight in Agricultural Trade. *Intereconomics – Review of European Economic Policy*, 59(3), 160–166. doi:10.2478/ie-2024-0033
12. Glauber, J. W., & Laborde Debucquet, D. (Eds.). (2023). *The Russia-Ukraine conflict and global food security*. Intl Food Policy Res Inst.
13. International Monetary Fund (IMF). (2023). World Economic Outlook Database, October 2023. Washington, D.C.: IMF. Retrieved from <https://www.imf.org/en/Publications/WEO>
14. Kopilović, S. (2024). Serbia-China Free Trade Agreement: Excellent Prospects for Chemical and Agricultural Products. Serbian Monitor. Retrieved from <https://www.serbianmonitor.com/en/serbia-china-free-trade-agreement>

15. Laamarti, Y., Dorofeev, A., Botokanova, G., Murzakhmedova, G., Kashirin, S., & Adylbek, A. (2026). Role of BRICS in Global Food Security: Econometric Panel Modelling of Food Security Index, 2009-2024. *Frontiers in Sustainable Food Systems*, 10, 1748543.
16. Lippert, B., & Mair, S. (Eds.). (2024). The Multipolar World and the EU: Strategic Repositioning. SWP Research Paper. Berlin: German Institute for International and Security Affairs.
17. Maihold, G., & Müller, A. (2023). BRICS+: New Configuration, Same Tensions? SWP Comment, 2023/C 63. Berlin: Stiftung Wissenschaft und Politik.
18. Maihold, G., Müller, A., & Fürtig, H. (2024). BRICS Under Russian Presidency: The Kazan Summit and its Implications. SWP Comment, 2024/C 48.
19. Marković, M., & Simonović, Z. (2025). Competitiveness of the agri-food sector of Serbia through the perspective of unit values of exports and imports. *Economic of Agriculture*, 72(2), 469-481. <https://doi.org/10.59267/ekoPolj2502469M>
20. Ministry of Agriculture, Forestry and Water Management of Serbia (MAFWM). (2023). Agricultural Policy Overview 2023. Belgrade: MAFWM. Retrieved from <https://www.minpolj.gov.rs>
21. OECD. (2023). Services Trade Restrictiveness Index (STRI). OECD Statistics. Retrieved from <https://stats.oecd.org>
22. OECD. (2024). Western Balkans Competitiveness Outlook 2024: Serbia. Paris: OECD Publishing. doi:10.1787/3699c0d5-en
23. Pejanović, R., Radović, G., Zarić, G., Popović, V. (2026). Climate Change and Agriculture in Regional Economics of BRICS Countries. *Вестник Сибирского института бизнеса и информационных технологий*, 15(1), 105-112.
24. Popović, V., Radosavljević, K., Mihailović, B., Pătărlăgeanu, S. R., Subić, J., & Jeločnik, M. (2025). Agri-food export strategies in free trade agreements: The case study of Serbia in the Serbia-China FTA. *Amfiteatru Economic*, 27(69), 351-366. <https://doi.org/10.24818/EA/2025/69/351>;
25. Pupin Institute. (2025). BRICS and Serbia: Geopolitical Strategy, Economic Realities, and the Limits of Alignment. Belgrade: Pupin Institute. Retrieved from <https://www.pupin.org>
26. Republički zavod za statistiku Srbije (RZS). (2022). Ekonomska kretanja u Republici Srbiji u 2022. godini [Economic trends in the Republic of Serbia in 2022]. Beograd: RZS. [in English: Statistical Office of the Republic of Serbia (SORS). (2022). Economic trends in the Republic of Serbia in 2022. Belgrade: SORS.] Retrieved from <https://www.stat.gov.rs>

27. Republički zavod za statistiku Srbije (RZS). (2023). Ekonomska kretanja u Republici Srbiji u 2023. godini [Economic trends in the Republic of Serbia in 2023]. Beograd: RZS. [in English: Statistical Office of the Republic of Serbia (SORS). (2023). Economic trends in the Republic of Serbia in 2023. Belgrade: SORS.] Retrieved from <https://www.stat.gov.rs>
28. Republički zavod za statistiku Srbije (RZS). (2024). Popis poljoprivrede 2023 – Preliminarni rezultati [Census of Agriculture 2023 – Preliminary Results]. Beograd: RZS. [in English: Statistical Office of the Republic of Serbia (SORS). (2024). Census of Agriculture 2023 – Preliminary Results. Belgrade: SORS.] Retrieved from <https://www.stat.gov.rs>
29. Singh, B. (2024). Agricultural Cooperation Among BRICS Countries: A Panacea for Food Security in the Global South? *Eurasia Review*, October 28, 2024. Retrieved from <https://www.eurasiareview.com>
30. Tankosić, J. V., Puvača, N., Giannenas, I., Tufarelli, V., & Ignjatijević, S. (2022). Food safety policy in the European Union. *Journal of Agronomy, Technology and Engineering Management*, 5(2), 712-717. <https://doi.org/10.55817/EMRK6646>
31. The Western Balkans. (2024). Will Serbia Become a BRICS Member in 2024? Published June 15, 2024. Retrieved from <https://thewesternbalkans.com>
32. UN Comtrade. (2023). UN Comtrade Database on International Trade. New York: United Nations Statistics Division. Retrieved from <https://comtrade.un.org>
33. UNDP. (2023). Human Development Report 2023/2024. New York: United Nations Development Programme.
34. United States Department of Agriculture – Foreign Agricultural Service (USDA-FAS). (2023). Serbia: Grain and Feed Annual. GAIN Report. Belgrade: USDA-FAS. Retrieved from <https://www.fas.usda.gov>
35. United States Department of Agriculture – Foreign Agricultural Service (USDA-FAS). (2024). Serbia: Exporter Guide 2024. GAIN Report RB2024-0001. Belgrade: USDA-FAS. Retrieved from <https://apps.fas.usda.gov>
36. United States International Trade Administration (ITA). (2024). Serbia–Agricultural Sectors. Country Commercial Guide. Washington, D.C.: ITA. Retrieved from <https://www.trade.gov/country-commercial-guides/serbia-agricultural-sectors>
37. Vladislavljev, S. (2025). Has the China Free Trade Agreement Paid Off for Serbia? *MERICs Comment*. Berlin: Mercator Institute for China Studies. Retrieved from <https://merics.org/en/comment>
38. Xin, G., Khan, H., & Ling, X. (2024). The impact of BRICS trade facilitation on China's import and export trade in agricultural products. *Frontiers in Sustainable Food Systems*, 8, 1397350.

UNRAVELING THE DRIVERS OF ORGANIC FOOD PURCHASE INTENTIONS: A THEORY OF PLANNED BEHAVIOR PERSPECTIVE FROM SERBIA

Tamara Rajić¹, Ivana Ostojić², Marko Jovanović³, Predrag Jovanović⁴

*Corresponding author E-mail: iostojic@idn.org.rs

ARTICLE INFO

Original Article

Received: 16 May 2026

Accepted: 15 June 2026

doi:10.59267/ekoPolj2603855R

UDC 159.947.5:339.138]:631.1
47(497.11)

Keywords:

*Theory of planned behavior,
organic food consumption,
food safety concern, perceived
environmental knowledge,
PLS-SEM, emerging European
economies*

JEL: I12, Q00

ABSTRACT

The study aims to examine the determinants of Serbian consumers' purchase intentions related to organic food, building upon and enhancing the well-established framework of the Theory of Planned Behavior. Data collection by means of a web-based structured questionnaire has resulted in 461 responses, which have been subjected to Partial Least Squares Structural Equation Modeling (PLS-SEM), using SmartPLS 4. The study's findings indicate that favourable attitudes are the key driver of organic food purchase intentions and that they are shaped by food safety concern and perceived environmental knowledge. Significant others' expectations directly influence consumers' willingness to purchase organic food, and indirectly contribute to positive attitudes towards organic food. Organic food availability and affordability directly contribute to customers' purchase intentions and enhance positive influence of attitudes on purchase intentions. Theoretical and managerial implications have been discussed and limitations and future research directions are outlined.

-
- 1 Tamara Rajić, PhD, Research Associate, Institute of Social Sciences, Kraljice Natalije 45, Belgrade, Serbia, Phone:+381603680534, E-mail: trajic@idn.org.rs, ORCID ID (<https://orcid.org/0000-0002-2797-584X>)
 - 2 Ivana Ostojić, PhD, Research Associate, Institute of Social Sciences, Kraljice Natalije 45, Belgrade, Serbia, Phone:+381641613733, E-mail:iostojic@idn.org.rs, ORCID ID (<https://orcid.org/0000-0002-8608-9506>)
 - 3 Marko Jovanović, PhD Student, University of Belgrade, Faculty of Economics, Kamenička 6, Belgrade, Serbia, Phone: +381643000012, E-mail: jovanovicvrclj@gmail.com, ORCID ID (<https://orcid.org/0009-0004-5931-6496>)
 - 4 Predrag Jovanović, PhD, Associate Professor, University of Belgrade, Faculty of Organisational Sciences, Jove Ilića 154, Belgrade, Serbia, Phone: +381638119360, E-mail: predrag.jovanovic@fon.bg.ac.rs, ORCID ID (<https://orcid.org/0000-0003-0841-7022>)

Introduction

Over the last two decades, there has been a growing interest among both the public and research communities in the consumption of organic food and the key factors influencing it. This has been motivated by factors such as increasing consumer concern regarding pesticide and antibiotic residues in agricultural products, as well as concerns about environmental pollution and its impact on human health. Most previous studies are based on the Theory of Planned Behavior (TPB) and emphasize the importance of this theoretical framework in explaining the factors influencing the intention to purchase and consume organic food (Ngo et al., 2026; Mostafizur et al., 2025; Chan et al., 2025; Milojević et al., 2025; Loera et al., 2022). In contrast to developed economies (Gundala & Singh, 2021; Hong et al., 2023; Liu et al., 2021) and developing economies (Chan et al., 2025; Mostafizur et al., 2025; Amit Kumar 2021; Bonisoli & Tinoco-Egas, 2025; Rosić & Vilma Getman, 2025; Dinc-Cavlak & Ozdemir, 2022; Ngo et al., 2026), insufficient attention has been devoted in previous research to the determinants of organic food consumption and consumers' willingness to purchase organic food in developing European countries. Therefore, this research aims to expand knowledge about the factors contributing to the purchase of organic food, using Serbia as an example of a developing European country.

Some scholarly attention has been devoted thus far to organic food consumption and its determinants from the perspective of Serbian consumers. Vlahović et al. (2011) have shown that those who opt for organic food have a more positive attitude toward it and higher levels of education and income. Grubor et al. (2018) point to education and income as the main drivers and higher prices and unavailability as the key obstacles to organic food consumption among the urban population in Serbia. The outbreak of COVID-19 did not significantly alter the typical profile of the pre-pandemic organic food consumer, yet it drove a higher demand, with many willing to pay more for this type of produce due to heightened health concerns (Ćirić et al. 2020, Vapa Tankosić et al. 2022, Vapa Tankosić & Carić 2023). Additionally, Radojević et al. (2021) define three main groups of organic food consumers: those who buy it because of the occasional lower price, the highly informed ones with concerns for health, quality and life choices and the ones who value its health benefits but do not necessarily care about the origin of the produce. Interestingly, the consumers of organic food are primarily knowledgeable of its health benefits, while they largely remain uninformed about other positive aspects of purchasing these types of products (Čolović & Mitić, 2023; Mitić & Čolović, 2022).

In previous research on organic food in Serbia, insufficient attention has been given to the simultaneous examinations of inter-relationships among the determinants of purchase intention and their influence on the intention to purchase organic food. To address this gap in the existing literature on Serbia, this study is grounded in the TPB and aims to emphasize the relative importance of the key determinants of consumers' willingness to purchase organic food. The remainder of the paper is structured as follows. The next section provides a brief review of the relevant literature, based on which the research

hypotheses are developed. The following section presents the research methodology, after which the results and discussion of the main findings are reported. Based on the empirical results, the theoretical contributions of the study and policy recommendations are highlighted, followed by the study's limitations and suggestions for future research.

Literature review and hypotheses development

The Theory of Planned Behavior (Ajzen, 1991), developed by Icek Ajzen in the 1980s, assumes that human behavior is directly guided by behavioral intention, which is shaped by three key factors: attitudes (positive/negative evaluation), subjective norms (perceived social pressure), and perceived behavioral control (self-confidence, i.e., the ease or difficulty of performing the behavior that reflects previous experience). A study examining the factors influencing the intention to purchase organic food in Vietnam confirmed that consumer attitudes towards organic food have a positive effect on purchase intention (Ngo et al., 2026). Numerous studies revealed that a positive attitude toward organic food influences purchase intention and behavior (Chan et al., 2025; Božić & Knežević, 2025; Loera et al., 2022; Bonisoli & Tinoco-Egas, 2025; Sultan et al., 2020). Based on the existing literature, the following hypothesis is formulated: *H₁: Attitudes towards organic food positively affect customers' purchase intentions.*

Food safety encompasses consumers' concerns about the presence of residues in food caused by chemical treatments, fertilizers, and added substances such as preservatives, which are commonly linked to farming practices (Yee et al., 2005). Nguyen et al.'s (2019) study has revealed a significant impact of food safety concerns on Vietnamese consumers' attitudes toward organic meat. Similarly, food safety concerns emerged as the most influential determinant of Scottish consumers' attitudes toward organic food (Michaelidou & Hassan, 2008). Many studies have also supported this relationship (Dinc-Cavlak & Ozdemir, 2022; Tan et al., 2021; Waqas & Hong, 2019). Based on extant literature, the following hypothesis is posited: *H₂: Food safety concern positively affects customers' attitudes towards organic food.*

Environmental knowledge captures individuals' awareness of environmental challenges along with their understanding of key facts, concepts, and interconnections within the natural environment and its major ecosystems (Fryxell & Lo, 2003). Bonisoli and Tinoco-Egas's (2025) study in the domain of organic food consumption has revealed a significant impact of environmental knowledge on attitudes. Several studies have also supported this relationship (Roh et al., 2022; Hong et al., 2023, Amit Kumar 2021). Based on these previous findings, the following hypothesis is proposed: *H₃: Perceived environmental knowledge positively affects attitudes towards organic food.*

Bhakar et al. (2025) found that subjective norms emerge as a significant determinant of organic food purchase intention. This relationship has been supported in numerous other studies (Ngo et al., 2026; Radovanović, 2025; Hong et al., 2023; Mostafizur et al.,

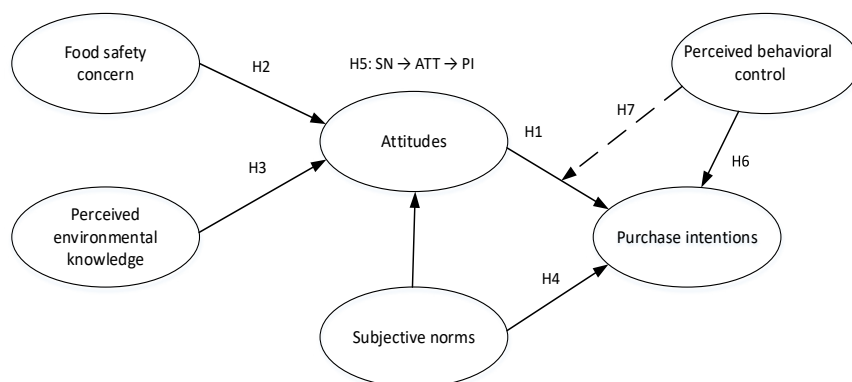
2025; Gundala et al., 2022). Grounded in the existing body of literature, the following hypothesis is developed: *H₄: Subjective norms directly affect customers' purchase intentions towards organic food.*

Research in the domain of sustainable consumption has indicated the influence of significant others' expectations on consumers' attitudes, which further lead to customers' sustainable behavior (Kristia et al., 2023). Research in the domain of organic food consumption has also revealed significant influence of subjective norms on attitudes, which further shape customers' purchase intentions. The mediating role of attitudes in the relationship between subjective norms and customers' green food purchase intentions has been supported by several other studies (Bhakar et al., 2025; Wongsachia et al., 2022; Gundala et al., 2022). In light of prior research, the following hypothesis is formulated: *H₅: Attitudes towards organic food mediate the impact of subjective norms on customers' purchase intentions towards organic food.*

Amit Kumar (2021) demonstrated that perceived behavioral control represents a significant predictor of consumers' green purchasing behavior. Other studies have also supported this relationship (Hong et al., 2023; Dinc-Cavlak & Ozdemir, 2022; Wang et al., 2019; Dorce et al., 2021). Therefore, the following hypothesis is proposed: *H₆: Perceived behavioral control positively and directly affect customers' purchase intentions towards organic food.*

La Barbera and Ajzen (2021) found that perceived behavioral control moderates the relationship between attitudes and behavioral intentions. Although the moderating influence of perceived behavioral control on the relationship between attitudes and behavioral intention has received less scholarly attention in the context of green consumption (Botha & Wieste, 2024; La Barbera & Ajzen, 2020), it is reasonable to assume that increased affordability and availability of organic food would contribute to the translation of favourable attitudes into purchase intentions. Therefore, the following relationship is proposed: *H₇: Perceived behavioral control moderates the impact of attitudes on customers' purchase intentions towards organic food.* Hypothesized relationships are summarized in Figure 1.

Figure 1. Conceptual model



Source: Authors' presentation

Materials and methods

Data collection

The cross-sectional survey was carried out on a convenience sample of adult respondents in Serbia, by means of a web-based structured questionnaire. Data collection was anonymous. Respondents were recruited via e-mail accounts and social media advertising. Prospective respondents were informed about the purpose of the study and informed consent was sought from the survey participants, prior to the questionnaire fulfillment. Data were collected in the period from December 2024 to June 2025. In total, 461 completely filled out questionnaires were entered into data analysis.

Measurement instrument

Constructs included in the study were measured by multiple items, which were adapted from previous research. Questionnaire items were slightly modified to fit the context of the study. Pilot-testing of the questionnaire was performed prior to the large-scale survey, which enabled minor modifications related to the wordings and sequence of the questionnaire items, to enhance its readability and comprehensibility. Four items, borrowed from the study of Rausch and Kopplin (2021), were used to measure attitudes (e.g., *Generally, I have a favorable attitude towards organic food*). Three items, borrowed from the study of Nguyen et al. (2019), were used to measure food safety concern (e.g., *I am very concerned about the presence of antibiotics and preservatives in food*). Four items, adapted from the study of Rausch and Kopplin (2021), were used to measure perceived environmental knowledge (e.g., *I understand how I could reduce negative environmental consequences of my behavior*). Three items from the study of Rausch and Kopplin (2021) were used to measure subjective norms (e.g., *My family expects me to buy sustainable food*). Perceived behavioral control was measured using four items which were proposed in accordance with the study of Shin and Hancer (2016) (e.g., *Whether I will purchase organic food is entirely up to me*). Three items, borrowed from the study of Shin et al. (2017), were used to measure purchase intentions (e.g., *I plan to purchase organic food in the future*). Questionnaire items were measured on a 7-point Likert-type scale, anchored by 1-strongly disagree and 7-strongly agree.

Data analysis

Partial least squares structural equation modeling (PLS-SEM), following Anderson and Gerbing's (1988) two-step procedure, was applied to examine proposed hypotheses. Measurement model analysis was performed first, to assess internal consistency reliability and validity of the constructs, which was followed by structural model analysis. Moderation analysis was applied to examine whether the relationship between attitudes and purchase intentions depended on the level of perceived behavioral control. Data analyses were performed using SmartPLS 4 (Ringle et al., 2024).

Results

Measurement model analysis

Internal consistency reliability of the constructs was supported by Cronbach's alpha and composite reliability (CR) values, which exceeded the threshold of 0.70 (Hair et al., 2017). Evidence in support of convergent validity was provided by the average variance extracted values (AVEs) exceeding the threshold of 0.50, as displayed in *Table 1*, which indicated that the items measured the constructs they were intended to measure. The majority of outer loadings were above the lower threshold of 0.708, as suggested by Hair et al. (2017), which provided additional evidence in support of convergent validity. Several outer loadings which were below the threshold of 0.708, but above the value of 0.40, were retained in the model, as no adverse effect was produced related to the constructs' reliability.

Table 1. Descriptive statistics, reliability and validity assessment

Constructs	Items	Outer loadings	t-values*	Cronbach's alpha	CR	AVE	Mean	SD
Attitudes	ATT1	0.904	59.302	0.929	0.950	0.825	5.872	1.286
	ATT2	0.918	78.474					
	ATT3	0.937	106.228					
	ATT4	0.872	53.110					
Purchase intentions	PI1	0.926	96.570	0.920	0.949	0.862	4.706	1.590
	PI2	0.945	128.904					
	PI3	0.914	82.027					
Perceived behavioral control	PBC1	0.906	19.809	0.753	0.802	0.579	4.901	1.568
	PBC2	0.698	6.678					
	PBC3	0.656	5.871					
Subjective norms	SN1	0.896	62.173	0.900	0.938	0.833	3.033	1.744
	SN2	0.916	100.620					
	SN3	0.926	89.972					
Food safety concern	FSC1	0.811	24.541	0.872	0.921	0.795	6.156	1.171
	FSC2	0.933	71.055					
	FSC3	0.926	76.746					
Perceived environmental knowledge	PEK1	0.822	32.687	0.895	0.927	0.761	5.757	1.138
	PEK2	0.883	36.313					
	PEK3	0.904	63.240					
	PEK4	0.879	52.409					

Note: * $p < 0.001$

Source: Authors' calculations

The square root of AVE value of each construct which surpassed correlations among respective construct and every other construct in the model provided evidence in support of discriminant validity (Fornell & Larcker, 1981), i.e. that the constructs were truly distinct from each other. Additional evidence in support of discriminant validity was provided by the heterotrait-monotrait (HTMT) ratios, which were below the threshold of 0.85, as suggested by Henseler et al. (2015). Additional evidence in support of

discriminant validity was provided by applying the bootstrapping procedure with 5000 subsamples and 95% Bias-corrected and accelerated (BCa) confidence interval method, which indicated that none of the confidence intervals related to the HTMT ratios included the value of 1, as suggested by Hair et al. (2017). Results displayed in *Table 2* provide evidence in support of discriminant validity of the constructs.

Table 2. Discriminant validity assessment – Fornell-Larcker criterion, HTMT ratio

	ATT	PI	PBC	SN	FSC	PEK
ATT	0.908	0.714 [0.645; 0.744]	0.132 [0.068; 0.169]	0.419 [0.347; 0.485]	0.521 [0.404; 0.618]	0.425 [0.311; 0.528]
PI	0.662	0.928	0.299 [0.200; 0.407]	0.522 [0.438; 0.598]	0.404 [0.303; 0.497]	0.335 [0.235; 0.430]
PBC	0.162	0.341	0.761	0.262 [0.161; 0.361]	0.044 [0.021; 0.056]	0.258 [0.143; 0.365]
SN	0.388	0.479	0.282	0.913	0.187 [0.095; 0.276]	0.176 [0.096; 0.266]
FSC	0.482	0.371	0.015	0.176	0.892	0.360 [0.250; 0.471]
PEK	0.393	0.306	0.217	0.166	0.315	0.872

Note: ATT – Attitudes, PI – Purchase intentions, PBC – Perceived behavioral control; SN – Subjective norms, FSC – Food safety concern; PEK – Perceived environmental knowledge; diagonal values represent the square roots of AVEs; values displayed below the diagonal represent correlations among the constructs; values above the diagonal refer to the HTMT ratios, values in square brackets represent confidence intervals corresponding to the HTMT ratios

Source: Authors' calculations

Structural model analysis

To avoid misleading conclusions stemming from high multicollinearity in the inner model, variance inflation factor values (VIFs) were inspected first. According to Hair et al. (2022), VIF values equal to or above 5 would indicate critical collinearity. As all VIF values in the structural model were below the suggested threshold, collinearity among the constructs was not at a critical level, which enabled the examination of structural paths in the following stage.

A bootstrapping procedure in PLS-SEM, using 5000 subsamples and 95% bias-corrected and accelerated (BCa) confidence interval method, was applied to estimate hypothesized relationships. As none of the confidence intervals stemming from the bootstrapping procedure included zero, all hypothesized relationships were supported by the data. Attitudes towards organic food emerged as a significant determinant of customers' purchase intentions (H_1 : $\beta=0.553$, $p<0.001$). Both food safety concern (H_2 : $\beta=0.317$, $p<0.001$) and perceived environmental knowledge (H_3 : $\beta=0.182$, $p<0.01$) significantly contributed to attitudes. Subjective norms emerged as a significant direct determinant of purchase intentions (H_4 : $\beta=0.203$, $p<0.001$). In addition, the impact of subjective norms on purchase intentions was also partially mediated by attitudes (H_5 :

$\beta=0.140$, $p<0.001$). The study indicated significant direct effect of perceived behavioral control on purchase intentions (H_6 : $\beta=0.182$, $p<0.001$). In addition, the effect of attitudes on purchase intentions was positively moderated by perceived behavioral control (H_7 : $\beta=0.089$, $p<0.05$), which will be elaborated in more detail in the following subsection.

The coefficient of determination (R^2) which indicates the proportion of variance in endogenous variable which is accounted for by the model, was examined to assess the model's predictive ability. Explained variance in behavioral intentions of 53.8% was above the acceptable threshold in consumer behavior research which amounts to 20% (Hong et al., 2023), indicating acceptable predictive validity of the proposed model. The strength of the direct relationships was assessed on the basis of Cohen's (1988) effect size (f^2), according to which values of 0.02, 0.15 and 0.35 indicate weak, moderate and substantial effect size, respectively. Taking into account the effect size, there is a substantial impact of attitudes on purchase intentions ($f^2=0.542$) and attitudes are moderately influenced by food safety concern ($f^2=0.134$). Hence, managerial actions aimed at enhancing the demand for organic food should primarily address these two constructs. The results of structural model analysis are summarized in *Table 3*.

Table 3. Structural model evaluation

Hypothesized relationships	Structural paths	t-values	95%(BCa)CI		Results	Effect size (f^2)	VIF
			LBCI	UBCI			
H1: ATT $\rightarrow$ PI	0.553	14.692*	0.479	0.627	Supported	0.542	1.184
H2: ESC $\rightarrow$ ATT	0.317	5.985*	0.204	0.414	Supported	0.134	1.233
H3: PEK $\rightarrow$ ATT	0.182	3.293**	0.077	0.295	Supported	0.043	1.281
H4: SN $\rightarrow$ PI	0.203	4.923*	0.122	0.283	Supported	0.076	1.260
H5: SN $\rightarrow$ ATT	0.140	6.722*	0.103	0.185	Supported		
H6: PBC $\rightarrow$ PI	0.182	4.848*	0.105	0.254	Supported	0.072	1.104
H7: PBC $\times$ ATT $\rightarrow$ PI	0.089	2.498***	0.020	0.159	Supported	0.016	1.027
$R^2(PI)=0.538$; $R^2(ATT)=0.391$							

Note: * $p<0.001$; ** $p<0.01$; *** $p<0.05$; LBCI – lower bound of the confidence interval, UBCI – upper bound of the confidence interval

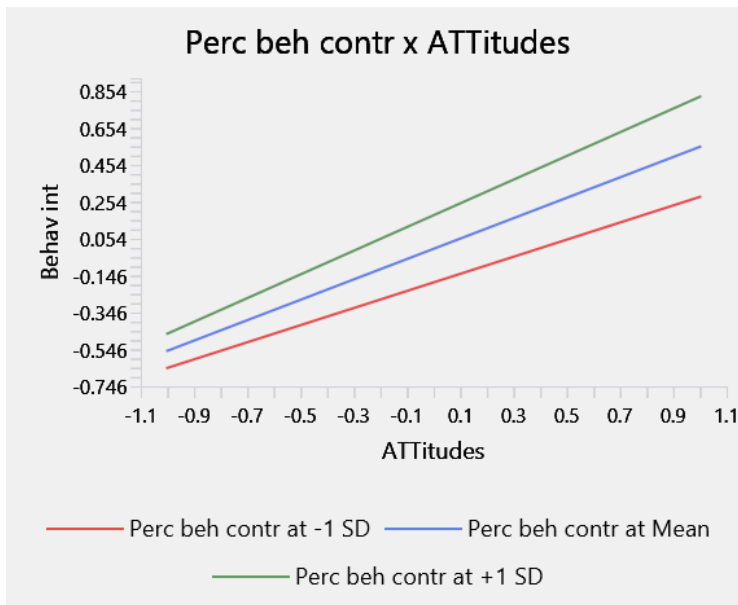
Source: Authors' calculations

Moderation analysis

Moderation analysis was performed to examine whether the strength of the relationship between attitudes towards organic food and customers' purchase intentions depended on the level of perceived behavioral control. The analysis revealed statistically significant positive moderating effect of perceived behavioral control on the relationship between attitudes and purchase intentions ($\beta=0.089$, $p<0.05$), providing support to hypothesis H_7 . This finding indicates that the relationship between attitudes and purchase intentions is not constant, but one standard deviation increase in perceived behavioral control above the mean would yield an increase in a simple effect of attitudes on purchase intentions by 0.089. This implies that the relationship between attitudes and purchase intentions is stronger (the slope is steeper) at a higher level of perceived behavioral control, i.e.

an increase in perceived behavioral control would strengthen the impact of attitudes on purchase intentions (*Figure 2*). Effect size (f^2) of a moderator indicates an extent to which the moderation contributes to the explanation of an endogenous variable. According to Hair et al. (2022), it is reasonable to expect a rather limited effect size in case of a moderation analysis, taking into account that an average value based on previous research is equal to 0.009. In light of this, values of 0.005, 0.01 and 0.025 point to small, medium, and large effect sizes of a moderation (Kenny, 2018). Therefore, the moderation effect in the present study of 0.016 could be considered as medium.

Figure 2. The moderating effect of perceived behavioral control



Source: Authors' calculations

Discussion

Findings of the study point to attitudes as the most prominent direct determinant of purchase intentions towards organic food, which corroborates recent findings in the context of organic food consumption in Europe (Mostafizur et al., 2025; Loera et al., 2022). Therefore, hypothesis H_1 has been supported. Both food safety concern and perceived environmental knowledge emerged as positive determinants of attitudes, supporting hypotheses H_2 and H_3 . However, the stronger impact of food safety concern indicates that, from the perspective of Serbian consumers, personal benefits act as a more influential driver of organic food purchases, in comparison with concern for environmental preservation, which complies with Chan et al.'s (2025) claim of personal considerations of health and well-being as crucial motivators of organic food purchases. The positive influence of food safety concerns on attitudes has also been confirmed in previous studies (Dinc-Cavlak & Ozdemir, 2022; Tan

et al., 2021; Nguyen et al., 2019). Positive impact of perceived environmental knowledge on attitudes toward organic food implies that consumers who are more knowledgeable about environmental issues and how to mitigate them are more predisposed towards organic food. Several recent studies have also indicated that environmental knowledge and consciousness contribute to favourable evaluation of organic food. The positive effect of environmental knowledge on attitudes is also confirmed by other studies (Bonisoli & Tinoco-Egas, 2025; Roh et al, 2022; Hong et al., 2023, Amit Kumar 2021).

Research demonstrates that subjective norms have a significant and positive effect on consumers' purchase intentions toward organic food, providing empirical support for hypothesis H₄. This indicates that consumers are more likely to purchase organic food when significant others such as family, friends, or society support this behavior. This result is consistent with previous research (Ngo et al., 2026; Bhakar et al., 2025; Mostafizur et al., 2025; Hong et al., 2023; Gundala et al., 2022). In addition, attitudes have been found to mediate the relationship between subjective norms and purchase intention supporting H₅, which is similar to the results obtained by Bhakar et al., 2025; Kristia et al., 2023; Wongsachia et al., 2022; Gundala et al., 2022. This suggests that consumers who feel socially encouraged to purchase organic food are more likely to develop favorable attitudes, which subsequently strengthen their purchase intentions. These findings emphasize the importance of positive attitudes towards organic food and offer deeper insight into how subjective norms shape consumer intentions.

Research findings indicate that perceived behavioral control positively influences consumers' intentions to purchase organic food, thereby providing empirical support for hypothesis H₆. This suggests that organic food affordability and availability lead to customers' willingness to purchase such products, which corresponds with the findings reported in earlier studies (Amit Kumar, 2021; Hong et al., 2023; Dinc-Cavlak & Ozdemir, 2022; Wang et al., 2019; Dorce et al., 2021).

When individuals perceive a higher level of control over their behavior, the relationship between their attitudes and intentions to purchase organic food becomes stronger. Consistent with this, the findings support H₇, confirming that perceived behavioral control moderates the impact of attitudes on customers' purchase intentions towards organic food. This implies that the more capable individuals feel of purchasing organic food, the stronger the influence of their attitudes on their intentions, and the greater the likelihood that they will actually engage in such behavior. This relationship has been confirmed by previous studies (Botha & Wieste, 2024; Barbera & Ajzen, 2021; La Barbera & Ajzen, 2020). To improve effectiveness, communication strategies should emphasize how simple and beneficial it is to buy organic food, while also helping to reduce perceived obstacles such as higher prices, extra effort, and limited consumer knowledge.

Conclusions

Theoretical and practical implications

The present study bears theoretical and managerial relevance. From a theoretical perspective, it contributes to the body of knowledge on sustainable food consumption by examining interrelationships among the determinants and their contribution to organic food purchase intentions, in thus far under-studied context of an emerging European economy. The study also provides important insights for marketers and policy-makers. Taking into account significant effect of food safety concern and perceived environmental knowledge on attitudes, marketers of organic food would benefit by emphasizing health-related benefits of their products and by educating customers on environmental footprint of food consumption. Knowledge on health related benefits of organic food and how consumption choices can contribute to environmental preservation would enhance positive attitudes towards organic food and customers' purchase intentions towards organic food.

Significance of subjective norms as a determinant of intentions also bears relevance for marketers. Significance of perceived behavioral control indicates that improved affordability and availability of organic food would facilitate transition from positive perceptions into actual purchases of organic food. Incentives to motivate more widespread production of organic food and its distribution should be considered by respective authorities. When it comes to local organic food production, measures to regain and instill customer trust into local producers, taking into account affairs from the recent past in the area of organic food production in Serbia, should be high on the agenda of responsible authorities, which points to the relevance of more thorough qualitative and quantitative research of customers' perceptions related to organic food produced in Serbia.

On the production side, numerous incentives supporting organic agriculture are already available, whereas comparable support measures targeting consumers remain relatively limited. Within the context of the influence of PBC on purchase intention, one potential measure is the introduction of monthly green vouchers of a fixed value that households could exclusively use for the purchase of organic food products. Additionally, the adoption of a National Organic Food Strategy could substantially contribute to the development of the organic sector by integrating organic production with public health, sustainable development, tourism, and education policies. Such a strategy could encourage public institutions, including preschools, schools, student canteens, and hospitals, to prioritize the procurement of food from certified organic producers. This would enhance the accessibility of organic food to the broader population while simultaneously promoting healthier dietary habits among younger consumers from an early age. Furthermore, greater attention should be devoted to incorporating organic food into support measures aimed at rural tourism development. One possible policy instrument could involve the introduction of subsidies or tax incentives for rural tourism households that incorporate certified locally produced organic food into their gastronomic offerings. Such measures would strengthen the linkage between organic agriculture and rural tourism, increase

demand for domestically produced organic products, and contribute to the creation of authentic tourism experiences based on local and sustainable food systems.

Limitations and future research directions

Several limitations of the study should be noted. Convenience sampling and data collection by means a web-based questionnaire advertised via social media, or a delivery of a link to the survey via e-mail accounts, represent the most concerning among the study's drawbacks. This mode of non-probability sampling excluded those prospective respondents who are not social media users and who do not have an active e-mail account. Cross-sectional design of the study indicates that structural relationships revealed by this research should be regarded with caution, which calls for future replications using longitudinal survey design or experimental research. Future research would benefit from a more representative sample of Serbian customers and the examinations of eventual cross-generational differences in customers' perceptions and intentions related to organic food. This would enable tailored marketing strategies to increase organic food purchases.

Acknowledgements

The paper was written as part of the 2026 Research Program of the Institute of Social Sciences with the support of the Ministry of Science, Technological Development and Innovation of the Republic of Serbia.

Conflict of interests

The authors declare no conflict of interest.

References

1. Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, 50(2), 179–211. [https://doi.org/10.1016/0749-5978\(91\)90020-T](https://doi.org/10.1016/0749-5978(91)90020-T)
2. Amit Kumar, G. (2021). Framing a model for green buying behavior of Indian consumers: From the lenses of the theory of planned behavior. *Journal of Cleaner Production*, 295, 126487. <https://doi.org/10.1016/j.jclepro.2021.126487>
3. Anderson, J.C., & Gerbing, D.W. (1988). Structural equation modeling in practice: a review and recommended two-step approach. *Psychological Bulletin*, 103(3), 411-423. <https://doi.org/10.1037/0033-2909.103.3.411>
4. Bhakar, S., Bhakar, S. S., & Bhakar, S. (2023). Consumer knowledge, environmental concerns and subjective norms as predictors of consumer attitude and purchase intention: A study of organic food. *International Journal of Trade and Global Markets*, 17(2), 133–150. <https://doi.org/10.1504/IJTGGM.2023.130739>
5. Bonisoli, L., & Tinoco-Egas, R. (2025). When doing good feels heavy: The double-edged role of moral obligation in organic food choices. *Cleaner and Responsible Consumption*, 18, 100320. <https://doi.org/10.1016/j.clrc.2025.100320>

6. Botha, E. I., & Wiese, M. (2024). Modelling zero waste behavioural intent: The moderating role of perceived behavioural control and socio-demographic factors. *Cleaner and Responsible Consumption*, 12, 100177. <https://doi.org/10.1016/j.clrc.2024.100177>
7. Božić, K., & Knežević, V. (2025). Activity-based costing as a function of information support for modern management. *Oditor*, 11(2), 127-148. <https://doi.org/10.59864/Oditor62502KB>
8. Chan, T. J., Lim, S. H., Mohan, Y. M., Huam, H. T., Suki, N. M., & Kasim, M. A. (2025). Does health consciousness matter? Factors influencing consumer buying behavior of organic food products through an extended theory of planned behavior. *British Food Journal*, 127(10), 3723–3743. <https://doi.org/10.1108/BFJ-09-2024-0975>
9. Čolović, M., & Mitić, V. Č. (2023). The main motives for buying organic food in people of the former Yugoslavia. *British Food Journal*, 125(6), 2257–2274. <https://doi.org/10.1108/BFJ-06-2021-0651>
10. Ćirić, M. R., Ilić, D. S., Ignjatijević, S. D., & Brkanlić, S. D. (2020). Consumer behaviour in online shopping organic food during the Covid-19 pandemic in Serbia. *Food & Feed Research*, 47(2), 149–158. <https://doi.org/10.5937/ffr47-28815>
11. Dinc-Cavlak, O., & Ozdemir, O. (2024). Using the Theory of Planned Behavior to Examine Repeated Organic Food Purchasing: Evidence from an Online Survey. *Journal of International Food & Agribusiness Marketing*, 36(2), 147–176. <https://doi.org/10.1080/08974438.2022.2068102>
12. Dorce, L. C., da Silva, M. C., Mauad, J. R. C., de Faria Domingues, C. H., & Borges, J. A. R. (2021). Extending the theory of planned behavior to understand consumer purchase behavior for organic vegetables in Brazil: The role of perceived health benefits, perceived sustainability benefits and perceived price. *Food Quality and Preference*, 91, 104191. <https://doi.org/10.1016/j.foodqual.2021.104191>
13. Fornell, C.G. & Larcker, D.F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research*, 18(1), 39-50. <https://doi.org/10.1177/002224378101800104>
14. Fryxell, G. E., & Lo, C. W. H. (2003). The Influence of Environmental Knowledge and Values on Managerial Behaviours on Behalf of the Environment: An Empirical Examination of Managers in China. *Journal of Business Ethics*, 46(1), 45–69. <https://doi.org/10.1023/A:1024773012398>
15. Grubor, A., Milicevic, N., & Djokic, N. (2018). Serbian Organic Food Consumer Research and Bioeconomy Development. *Sustainability*, 10(12), 4820. <https://doi.org/10.3390/su10124820>
16. Gundala, R. R., Nawaz, N., Harindranath, R. M., Boobalan, K., & Gajenderan, V. K. (2022). Does gender moderate the purchase intention of organic foods? Theory of reasoned action. *Heliyon*, 8, e10478. <https://doi.org/10.1016/j.heliyon.2022.e10478>

17. Gundala, R.R., & Singh, A. (2021). What motivates consumers to buy organic foods? Results of an empirical study in the United States. *PLoS ONE* 16(9): e0257288. <https://doi.org/10.1371/journal.pone.0257288>
18. Hair, J.F.Jr., Hult, G.T.M., Ringle, C.M., & Sarstedt, M. A. (2017). *Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM)*, Second Edition. SAGE Publications, Ltd., London.
19. Hair, J.F.Jr., Hult, G.T.M., Ringle, C.M., & Sarstedt, M. A. (2022). *Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM)*, Third Edition, SAGE Publications, Inc., California.
20. Henseler, J., Ringle, C.M. & Sarstedt, M. (2015). A new criterion for assessing discriminant validity in variance-based structural equation modeling. *Journal of the Academy of Marketing Science*, 43(1), 115-135. <https://link.springer.com/article/10.1007/s11747-014-0403-8>
21. Hong, Y., Hu, J., Chen, M. & Tang, S. (2023). Motives and antecedents affecting green purchase intention: implications for green economic recovery. *Economic Analysis and Policy*, 77, 523-538. <https://doi.org/10.1016/j.eap.2022.12.005>
22. Kenny, D. A. (2018). Moderation. Retrieved from: <https://davidakenny.net/cm/moderation.htm>
23. Kristia, K., Sandor Kovacs, & Erdey Laszlo. (2023). Food delivery platform and food waste: Deciphering the role of promotions, knowledge, and subjective norms among Indonesian generation Z. *Cleaner and Responsible Consumption*, 11, 100152. <https://doi.org/10.1016/j.clrc.2023.100152>
24. La Barbera, F., & Ajzen, I. (2020). Control Interactions in the Theory of Planned Behavior: Rethinking the Role of Subjective Norm. *Europe's Journal of Psychology*, 16(3), 401-417. <https://doi.org/10.5964/ejop.v16i3.2056>
25. La Barbera, F., & Ajzen, I. (2021). Moderating role of perceived behavioral control in the theory of planned behavior: A preregistered study. *Journal of Theoretical Social Psychology*, 5(1), 35-45. Portico. <https://doi.org/10.1002/jts5.83>
26. Liu, C., Zheng, Y., & Cao, D. (2021). An analysis of factors affecting selection of organic food: Perception of consumers in China regarding weak signals. *Appetite*, 161, 105145. <https://doi.org/10.1016/j.appet.2021.105145>
27. Loera, B., Murphy, B., Fedi, A., Martini, M., Tecco, N., & Dean, M. (2022). Understanding the purchase intentions for organic vegetables across EU: A proposal to extend the TPB model. *British Food Journal*, 124(12), 4736-4754. <https://doi.org/10.1108/BFJ-08-2021-0875>
28. Michaelidou, N., & Hassan, L. M. (2008). The role of health consciousness, food safety concern and ethical identity on attitudes and intentions towards organic food. *International Journal of Consumer Studies*, 32, 163-170. <https://doi.org/10.1111/j.1470-6431.2007.00619.x>

29. Milojević, S., Beke-Trivunac, J., & Knežević, S. (2025). The impact of adopting international public sector accounting standards on corruption: transparency and financial accountability. *Akcionarstvo*, 31(1), 77-84. <https://doi.org/10.65772/ak202516>
30. Mitić, V., & Čolović, M. (2022). The main demographic characteristics of customers and the frequency of purchases organic food. *Economics of Agriculture*, 69(2), 349–364. <https://doi.org/10.5937/ekoPolj2202349M>
31. Mostafizur R. M., Asma K. M., Islam, M., & Kotani, K. (2025). Drivers for sustainable food purchase intentions: Prosocial attitudes for future generations and environmental concerns. *Future Foods*, 11, 100609. <https://doi.org/10.1016/j.fufo.2025.100609>
32. Ngo, T. T. A., Le, T. N. T., Phan, T. Y. N., & Le, T. B. N. (2026). Exploring the influence of health consciousness, environmental consciousness, knowledge, and trust in shaping purchase intentions of Generation Z towards organic food. *Journal of Agriculture and Food Research*, 27, 102839. <https://doi.org/10.1016/j.jafr.2026.102839>
33. Nguyen, H.V., Nguyen, N., Nguyen, B.K., Lobo, A., Vu, P.A. (2019). Organic Food Purchases in an Emerging Market: The Influence of Consumers' Personal Factors and Green Marketing Practices of Food Stores. *International Journal of Environmental Research and Public Health*, 16(6), 1037. <https://doi.org/10.3390/ijerph16061037>.
34. Radojević, V., Tomaš Simin, M., Glavaš Trbić, D., & Milić, D. (2021). A profile of organic food consumers-Serbia case-study. *Sustainability*, 13(1), 131. <https://doi.org/10.3390/su13010131>
35. Radovanović, T. (2025). Contribution to achieving sustainable development. *Održivi razvoj*, 7(1), 63-76. <https://doi.org/10.5937/OdrRaz2501063R>
36. Rausch, T. M., & Kopplin, C. S. (2021). Bridge the gap: Consumers' purchase intention and behavior regarding sustainable clothing. *Journal of Cleaner Production*, 278, 123882. doi:10.1016/j.jclepro.2020.123882
37. Ringle, C. M., Wende, S., & Becker, J.-M. (2024). SmartPLS 4 [Computer software]. Bönningstedt: SmartPLS. Available from <https://www.smartpls.com>
38. Roh, T., Seok, J., & Kim, Y. (2022). Unveiling ways to reach organic purchase: Green perceived value, perceived knowledge, attitude, subjective norm, and trust. *Journal of Retailing and Consumer Services*, 67, 102988. <https://doi.org/10.1016/j.jretconser.2022.102988>
39. Rosić, M., & Vilma Getman, R. (2025). Menadžerski aspekti timova i grupa. *Finansijski Savetnik*, 30(1), 95-105. <http://fa-journal.com/index.php/fa/article/view/5>
40. Shin, Y. H., & Hancer, M. (2016). The role of attitude, subjective norm, perceived behavioral control, and moral norm in the intention to purchase local food products. *Journal of Foodservice Business Research*, 19(4), 338–351. <https://doi.org/10.1080/15378020.2016.1181506>

41. Shin, Y. H, Im, J., Jung, S. E. & Severt, K. (2017) Consumers' Willingness to Patronize Locally Sourced Restaurants: the Impact of Environmental Concern, Environmental Knowledge, and Ecological Behavior, *Journal of Hospitality Marketing & Management*, 26(6), 644-658. <https://doi.org/10.1080/19368623.2017.1263821>
42. Sultan, P., Tarafder, T., Pearson, D., & Henryks, J. (2020). Intention-behaviour gap and perceived behavioural control-behaviour gap in theory of planned behaviour: moderating roles of communication, satisfaction and trust in organic food consumption. *Food Quality and Preference*, 81, 103838. <https://doi.org/10.1016/j.foodqual.2019.103838>
43. Tan, B. C., Lau, T. C., Sarwar, A., & Khan, N. (2022). The effects of consumer consciousness, food safety concern and healthy lifestyle on attitudes toward eating "green". *British Food Journal*, 124 (4), 1187–1203, <https://doi.org/10.1108/BFJ-01-2021-0005>
44. Vapa Tankosić, J., & Carić, B. (2023). Tržište organskih proizvoda i stavovi potrošača o organskim proizvodima. *International Journal of Economic Practice and Policy*, 20(1), 58–67. <https://doi.org/10.5937/skolbiz1-49126>
45. Vapa Tankosić, J., Hanić, H., & Bugarčić, M. (2022). Consumer's characteristics and attitudes towards organic food products in times of COVID-19 pandemic. *Economic of Agriculture*, 69(2), 469–481. <https://doi.org/10.5937/ekoPolj2202469V>
46. Vlahović, B., Radojević, V., & Živanović, I. (2011). Research on consumer attitudes of organic food consumption in Serbia. *Economic of Agriculture*, 58 (3), 443- 456. <https://doi.org/10.22004/AG.ECON.244943>
47. Wang, X., Pacho, F., Liu, J., & Kajungiro, R. (2019). Factors Influencing Organic Food Purchase Intention in Developing Countries and the Moderating Role of Knowledge. *Sustainability*, 11(1), 209. <https://doi.org/10.3390/su11010209>
48. Waqas, A., & Hong, C. (2019). Study on Consumer Behaviour and Food Safety of Organic Products in Pakistan. *E3S Web of Conferences*, 78, 02021. <https://doi.org/10.1051/e3sconf/20197802021>
49. Wongsachia, S., Naruetharadhol, P., Schrank, J., Phoomsom, P., Sirisoonthonkul, K., Paiyasen, V., Srichaingwang, S., & Ketkaew, C. (2022). Influences of Green Eating Behaviors Underlying the Extended Theory of Planned Behavior: A Study of Market Segmentation and Purchase Intention. *Sustainability*, 14(13), 8050. <https://doi.org/10.3390/su14138050>
50. Yee, W. M. S., Yeung, R. M. W., & Morris, J. (2005). Food safety: building consumer trust in livestock farmers for potential purchase behaviour. *British Food Journal*, 107(11), 841–854. <https://doi.org/10.1108/00070700510629788>

MACHINE LEARNING-DRIVEN PREMIUM ESTIMATION IN CROP INSURANCE: LEVERAGING CLIMATE AND COMMODITY MARKET BIG DATA

Marija Koprivica¹, Kristina Bradić², Mirjana Gligorijević³, Milica Kočović De Santo⁴

*Corresponding author E-mail: marija.koprivica@ekof.bg.ac.rs

ARTICLE INFO

Original Article

Received: 21 May 2026

Accepted: 15 July 2026

doi:10.59267/ekoPolj2603871K

UDC 368.5.025.7:004.8]:[551.5
8:339.13

Keywords:

Crop insurance, drought, machine learning, climate data, gradient boosting, logistic regression

JEL: G22, Q14, Q54

ABSTRACT

This study proposes a machine learning-driven framework for premium estimation in crop insurance against drought risk, integrating climatic and commodity market data. The methodology combines a Logistic Regression model for predicting drought probability with an Extreme Gradient Boosting model for forecasting commodity prices and crop yields, using regional datasets from Vojvodina and Šumadija. The results show strong predictive performance across regions and metrics. Findings confirm that drought occurrence, yield and price volatility are driven by climatic and spatial heterogeneity, underscoring the need for region-specific premium setting. The study demonstrates the potential of machine learning techniques to support more risk-sensitive and actuarially consistent pricing in agricultural insurance.

Introduction

Since the 1980s, the number of natural disasters with severe economic repercussions has tripled, while the expansion of settlements in risk-prone regions has magnified both the frequency and magnitude of losses associated with climate-induced events (Intergovernmental Panel on Climate Change, 2023). The resulting escalation

-
- 1 Marija Koprivica, PhD, Full Professor, Faculty of Economics and Business, University of Belgrade, Kamenička 6, 11000 Beograd, Phone: +381641470084, E-mail: marija.koprivica@ekof.bg.ac.rs, ORCID ID (<https://orcid.org/0000-0003-4239-2252>)
 - 2 Kristina Bradić, MSc, Teaching Assistant, Faculty of Economics and Business, University of Belgrade, Kamenička 6, 11000 Beograd, Phone: +381691071999, E-mail: kristina.bradic@ekof.bg.ac.rs, ORCID ID (<https://orcid.org/0009-0008-9198-2770>)
 - 3 Mirjana Gligorijević, PhD, Full Professor, Faculty of Economics and Business, University of Belgrade, Kamenička 6, 11000 Beograd, Phone: +381658465005, E-mail: mirjana.gligorijevic@ekof.bg.ac.rs, ORCID ID (<https://orcid.org/0000-0002-1144-442X>)
 - 4 Milica Kočović De Santo, PhD, Senior Research Associate, Institute of Economic Sciences, Belgrade, Phone: +381603499333, E-mail: milica.kocovic@ien.bg.ac.rs, ORCID ID (<https://orcid.org/0000-0003-3304-7801>)

in exposure of assets and populations, compounded by the intensification of natural hazards, has placed agricultural landscapes under particular strain, notably through water deficits and the degradation of soil microbial biodiversity, ultimately threatening societal resilience and food availability (Botzen, 2016)"container-title": "Weather and Climate Extremes", "DOI": "10.1016/j.wace.2015.10.002", "ISSN": "2212-0947", "language": "en-US", "note": "publisher: Elsevier", "page": "70-79", "source": "www.sciencedirect.com", "title": "Trends in weather related disasters – Consequences for insurers and society", "volume": "11", "author": [{"family": "Botzen", "given": "W. J. Wouter"}], "issued": {"date-parts": ["2016", 3, 1]}}, "schema": "https://github.com/citation-style-language/schema/raw/master/csl-citation.json"}

An effective insurance system serves as a crucial risk-transfer and pooling mechanism, distributing losses across time and space and diversifying underwritten exposures across various sectors and hazard types. However, the growing severity and clustering of natural catastrophes increasingly undermine this stabilising function. Among climate-related risks, drought poses a particularly complex challenge for agricultural insurance due to its cumulative nature, spatial heterogeneity, and strong dependence on both climatic conditions and market dynamics. Drought-related losses are reflected not only through yield reductions but also through price fluctuations in commodity markets, which directly affect premium adequacy. This study aims to develop a region-specific, data-driven framework for drought insurance pricing in Serbia, thereby supporting premium accuracy and sustainability amid rising climate variability.

Contemporary frameworks, such as supply-side models (Aerts & Botzen, 2011; Brunette et al., 2015), demand-side models (Birghila et al., 2022; Islam et al., 2022) it is expected that climate change will alter future risks of natural disaster events considerably and, as a consequence...", "DOI": "10.1111/risa.13884", "language": "en", "source": "onlinelibrary.wiley.com", "title": "Risk-layering and optimal insurance uptake under ambiguity: With an application to farmers exposed to drought risk in Austria", "title-short": "Risk-layering and optimal insurance uptake under ambiguity", "URL": "https://onlinelibrary.wiley.com/doi/10.1111/risa.13884", "author": [{"family": "Birghila", "given": "Corina"}, {"family": "Pflug", "given": "Georg"}, {"family": "Hochrainer-Stigler", "given": "Stefan"}], "accessed": {"date-parts": ["2025", 10, 27]}}, {"id": "892", "uris": ["http://zotero.org/users/13081216/items/MKRRDSBU"], "itemData": {"id": "892", "type": "article-journal", "abstract": "This research attempted to develop a damage-based crop insurance model using satellite remote sensing imagery and field surveys of flash flood regions in Bangladesh. A normalized difference water index (NDWI, partial equilibrium model (Tesselaar et al., 2020) income inequalities imply that not all households can afford flood insurance. The uptake of flood insurance in voluntary markets may decline when flood risk increases as a result of climate change. This increase in flood risk may cause substantially higher risk-based insurance premiums, reduce the willingness to purchase flood insurance, and worsen problems with the unaffordability of coverage for low-income households. A socio-economic tipping-point can occur when the functioning of a formal flood insurance system is hampered

by diminishing demand for coverage. In this study, we examine whether such a tipping-point can occur in Europe for current flood insurance systems under different trends in future flood risk caused by climate and socio-economic change. This analysis gives insights into regional inequalities concerning the ability to continue to use flood insurance as an instrument to adapt to changing flood risk. For this study, we adapt the “Dynamic Integrated Flood and Insurance” (DIFI) and agent-based model (de Ruig et al., 2022; Dubbelboer et al., 2017) analyse insurance market responses to climate risk and policy uncertainty. However, their application has largely been confined to flood insurance. Existing research on crop drought insurance predominantly focuses on behavioural, policy, and conceptual aspects of insurance adoption, with limited emphasis on data-driven pricing. Studies such as Cabeza-Ramírez et al. (2024) explore farmers’ perception of climate change and drought insurance, emphasising the role of demand-side factors in determining insurance uptake. Similarly, Madaki et al. (2023) examine the key determinants of agricultural insurance adoption in Nigeria using a logit regression model. The literature also highlights the importance of marketing-related factors, such as product communication, distribution channels, and the adaptation of insurance products to farmers’ specific needs, for the broader acceptance of agricultural insurance schemes (Stojanović et al., 2012).

A more limited strand of the literature addresses drought risk from a pricing and actuarial perspective, often within the context of index-based and parametric insurance schemes. More broadly, climate change has important implications for the design and effectiveness of weather insurance contracts (Kapphan et al., 2012). Several studies focus on the selection and calibration of drought indicators for insurance design and risk assessment (e.g., Eze et al., 2020; Bucheli et al., 2021, Wu & Yang, 2024), highlighting the importance of spatial heterogeneity and index choice in effective risk transfer. Other contributions develop region-specific index-based insurance products and discuss implications for premium setting (Hohl et al., 2021, Barratt et al., 2025). In this context, Crane-Droesch (2019) argues that increasing climate variability requires more data-oriented approaches to regional risk assessment and insurance pricing. Koprivica et al. (2024) propose a premium-rating framework for index-based crop insurance covering both flood and drought risks, combining loss-cost and average-yield methods calibrated on Serbian crop data. Despite these contributions, machine learning-based frameworks that integrate climatic indicators and market variables for drought insurance pricing remain largely unexplored, particularly in Southeastern Europe.

This study addresses that gap by developing a machine learning-driven framework for premium estimation in crop drought insurance that integrates climatic and commodity market data. While much of the literature focuses on yield- or index-based insurance design, this study adopts a revenue-based pricing perspective that explicitly incorporates commodity price dynamics. Specifically, the research leverages high-resolution climate indicators, such as the aridity index and consecutive dry days, together with crop yield data, commodity market prices and exchange rate to quantify drought risk and enable actuarially consistent premium setting. By combining environmental and economic

datasets, the study addresses the challenge of accurately pricing climate-induced agricultural risks at a regional scale, with a focus on Serbia's main agricultural regions (Vojvodina and Šumadija). The proposed framework supports more risk-sensitive and adaptive premium setting, contributing to the robustness of agricultural insurance systems under evolving drought risk conditions.

Materials and methods

The methodological framework integrates climatic and economic datasets obtained from two data sources. Climatic data stem from the Digital Atlas of Serbia and include two drought-related indicators, the aridity index (AI) and consecutive dry days (CDD), covering the period 1950–2020 for Serbia's main agricultural regions, Vojvodina and Šumadija. The Statistical Office of the Republic of Serbia provides annual data on crop yields and market prices for wheat, soybeans and corn.

The CDD indicator quantifies the maximum number of consecutive days with precipitation below 1 mm, capturing short-term drought persistence. The forest aridity index (AI) is an aridity indicator originally developed for forest ecosystems. Following Führer et al. (2011), the index is calculated as:

$$AI = 100 \cdot \frac{T_{VII-VIII}}{(P_{V-VII} + P_{VII-VIII})}, \quad (1)$$

where $T_{VII-VIII}$ represents the mean temperature during the July-August period, while P_{V-VII} and $P_{VII-VIII}$ denote the accumulated precipitation from May to July and from July to August, respectively.

Climatic data from the Digital Atlas of Serbia were originally stored in NetCDF format. To facilitate subsequent analysis, these data were converted into a tabular structure comprising five attributes: *latitude*, *longitude*, *time*, *AI*, and *CDD*. The *time* variable was converted into an annual format. Climatic observations were then merged across indicators using common spatial and temporal coordinates (year, latitude, and longitude). Geographic coordinates were rounded to three decimal places to avoid potential floating-point inconsistencies.

To ensure spatial specificity and regional relevance, a regional filtering procedure was applied to climatic data. Grid points within the latitude range 44.7°–46.2° N and longitude range 18.8°–21.0° E were selected to represent the Vojvodina region. Similarly, grid points within 43.7°–44.6° N latitude and 19.5°–21.3° E longitude were used to delineate the Šumadija region.

For each region, observations were grouped by year to compute the annual mean aridity index, the mean number of consecutive dry days, and the standard deviation of consecutive dry days (σ_{CDD}). These summary indicators capture both the average intensity of drought conditions and their interannual variability within each region.

The proposed drought insurance pricing framework is grounded in fundamental actuarial principles of risk-based pricing, linking climatic variability to insurer expected financial exposure. In non-life insurance, the net premium is composed of two components: the expected loss $E(L)$ and a risk loading that accounts for uncertainty around expected outcomes. Following the standard-deviation principle of insurance premium calculation (Bühlmann, 1985), the risk loading is specified as proportional to the variability of drought conditions, measured by the standard deviation of consecutive dry days (). The resulting pricing specification is given by:

$$\text{Net premium} = E(L) + \lambda \times \sigma_{CDD}, \quad (2)$$

where $E(L)$ denotes the expected loss, λ is an exogenous risk-loading parameter reflecting the insurer's sensitivity to drought-related uncertainty, and σ_{CDD} measures the interannual variability of consecutive dry days.

The expected loss component $E(L)$ in (2) is derived through a two-stage statistical-actuarial procedure. In the first stage, the probability of drought occurrence is estimated. The second stage quantifies the financial severity of drought in terms of revenue losses, defined as the difference between expected and realised yields, valued at forecasted market prices and scaled by the insured land area. Thus, the expected loss is defined as:

$$E(L)_t = (Y_{exp} - Y_{drought})_t \times P(drought = 1)_t \times P_t \times A_t, \quad (3)$$

where Y_{exp} denotes the expected yield, $Y_{drought}$ denotes the yield under drought conditions, $P(drought=1)_t$ is the estimated probability of drought occurrence, P_t is the projected crop price, and A_t is the insured area.

Expected yields are generated using a separately developed Extreme Gradient Boosting (XGBoost) model for crop yield prediction (Chen & Guestrin, 2016; Radosavljević et al., 2025). The dataset is obtained from the Statistical Office of the Republic of Serbia, which reports crop yields measured in tons per hectare for the period from 1947 to 2025. The model incorporates the one-year lag of crop yields, the aridity index, cumulative dry days, and the variance of cumulative dry days as explanatory variables. The dataset is divided into training and testing samples using an 87-13% split. Yields under drought conditions are proxied by historical yield observations recorded during years identified as drought periods.

To quantify the probability of drought occurrence, this study employed a logistic regression model, a well-established statistical learning method widely used in hydrology, climatology, and environmental risk assessment. Logistic regression models the probability of a binary event. In our study, the probability of a drought is a function of a set of climatic explanatory variables. Specifically, the feature engineering provides the construction of the deviation of the annual aridity index from its long-term mean (defined as AI anomaly variable in logistic regression model), and the standard deviation of the consecutive dry days. Following a study on climate trend modelling (Vinnarasi et

al., 2023) the time-varying characteristics observed in the historical precipitation data questions the reliability of SPI and motivated the development of nonstationary SPI. To overcome some of the limitations in the existing nonstationary drought indices, a new framework for drought index is proposed, incorporating the temporal dynamics in the precipitation. The proposed drought index is developed by coupling the joint deficit index with the extended time sliding window-based nonstationary modeling (TSW-NSM, we include a trend variable and a quadratic trend to address potential nonlinear changes in drought probability over time. The trend variable is defined as the difference between the observation year and the first year in the sample.

Mathematically, the model expresses the conditional probability of drought occurrence as:

$$P(y_i = 1|X_i) = \frac{1}{1 + \exp[-(\beta_0 + \beta_1 x_{1i} + \beta_2 x_{2i} + \dots + \beta_k x_{ki})]} \quad (4)$$

where $P(y_i=1|X_i)$ denotes the probability of drought occurrence for observation i , x_{ji} are the climatic predictors, and $\beta_0, \beta_1, \dots, \beta_k$ are parameters estimated through maximum likelihood estimation (Hosmer et al., 2013). The coefficient β_j represents the change in the log-odds of drought occurrence associated with a one-unit increase in x_j , holding other predictors constant.

Drought conditions were defined using a composite drought indicator constructed as the sum of standardised anomalies of the forest aridity index and consecutive dry days ($DI = Z_{AI} + Z_{CDD}$). A drought year was identified when the drought indicator DI exceeded the 75th percentile of its historical distribution within the region. This approach ensures a stable classification of extreme climatic stress events while avoiding assumptions about the underlying distribution of the drought indicator.

In crop insurance, revenue-based policies indemnify income losses rather than physical losses alone, implying that commodity market prices are critical to both loss assessment and premium setting. The crop price, entering the expected loss component, is not treated as an exogenous variable but is endogenously forecasted using an Extreme Gradient Boosting (XGBoost) model. Gradient boosting approximates complex nonlinear functions by iteratively combining regression trees, thereby enabling the estimation of nonlinear and interaction effects without presupposing a specific functional form (Friedman, 2001). This flexibility is particularly advantageous for agricultural markets, where nonlinearities arise from supply constraints, weather shocks, and policy interventions.

The dataset on market prices is obtained from the Statistical Office of the Republic of Serbia and spans the period from 1994 to 2024. Given that agricultural commodity prices exhibit non-stationary and heteroskedastic dynamics, prices are modeled in logarithmic space in order to stabilise variance and reduce prediction error. Since commodity price formation is strongly influenced by macroeconomic and agro-climatic conditions, the XGBoost model incorporates the following explanatory variables: the Global Food Price Index, Agricultural Producer Price Index (specific to each crop), aridity index,

consecutive dry days (CDD), variance of CDD, and the mean annual EUR/RSD exchange rate. Additionally, feature engineering allows construction of lagged price variables, as predictors to ensure an ex-ante information set. The inclusion of autoregressive terms is well supported in the empirical literature on commodity markets, where prices exhibit strong serial dependence (Deaton & Laroque, 1992; Pindyck & Rotemberg, 1990). The dataset is divided into training and testing subsets, where the training sample covers the period from 1994 to 2018, while the testing sample includes the subsequent years.

Results

The logistic regression models were estimated separately for the Vojvodina and Šumadija regions. The estimated specification for Vojvodina is given by:

$$\text{logit}(p) = -3.44 + 0.566 \cdot AI_{anomaly} + 0.415 \cdot \sigma_{CDD} + 0.041 \cdot trend - 0.0006 \cdot trend^2$$

while the corresponding specification for the Šumadija region is:

$$\text{logit}(p) = 0.28 + 0.897 \cdot AI_{anomaly} - 0.028 \cdot \sigma_{CDD} - 0.162 \cdot trend - 0.0002 \cdot trend^2.$$

The logistic regression results indicate the model explains drought probability reasonably well in both regions. For Vojvodina, the model achieves a pseudo R^2 of 0.403 and is statistically significant according to the likelihood ratio test ($p < 0.001$), while for Šumadija, the model shows even stronger explanatory power with a pseudo R^2 of 0.564. The anomaly of the aridity index has a positive and highly significant coefficient. This result implies that years characterised by a higher aridity index relative to the long-term average are associated with a higher probability of drought. On the other hand, unlike the Šumadija model, in the Vojvodina model, the standard deviation of the consecutive dry days variable suggests that fluctuations in the dry days increase the probability of drought events. The time trend variables are insignificant in both models. (The detailed logistic regression results are provided in the Appendix).

Table 1. Logistic Regression Model Performance

Performance Metrics	Value
Accuracy	0.8667
Precision	0.7778
Recall	0.7778
F1-score	0.778
ROC-AUC	0.91

Source: Authors' calculations

Table 1 presents the performance results of the pooled sample model created using climate data from both the Šumadija and Vojvodina regions. The results imply that the logistic regression model demonstrates strong predictive performance in identifying drought events. The model achieves an accuracy of 0.87, meaning that approximately 87% of the observations in the test sample are correctly classified. Both precision and

recall equal 0.78. Additionally, the model strikes a good balance between correctly detecting drought events and avoiding misclassification with an F1-score of 0.78. Furthermore, the ROC–AUC value of 0.91 indicates that the model is highly effective at distinguishing drought from non-drought years.

In the second stage, XGBoost models were applied to forecast average annual yield and commodity prices for wheat, corn, and soybeans (tons/ha and RSD/kg respectively). Forecasting performance was evaluated using Mean Absolute Error (MAE), Root Mean Squared Error (RMSE) and Symmetric Mean Absolute Percentage Error (SMAPE), as shown in Table 2 and 3.

Table 2. XGBoost Log-Price Model Performance

Commodity	MAE	RMSE	SMAPE (%)
Wheat	0.197	0.232	6.41
Corn	0.196	0.257	6.47
Soybean	0.292	0.35	7.467

Note: MAE and RMSE are reported in logarithmic price units.

Source: Authors' calculations

Table 3. XGBoost Yield Model Performance

Commodity	MAE (t/ha)	RMSE (t/ha)	SMAPE (%)
Wheat	0.497	0.635	12.81
Corn	1.174	1.363	22.99
Soybean	0.57	0.691	23.23

Source: Authors' calculations

The XGBoost price model demonstrates strong predictive performance across all commodities, with SMAPE values below 8% for each crop. However, the yield prediction model shows higher forecasting errors. As agricultural yields are highly sensitive to climatic shocks and agronomic conditions, these SMAPE outcomes are expected and can be considered reasonable for the yield prediction model.

Together, the drought probability estimates derived from logistic regression and the projected commodity prices and yields generated through XGBoost constitute the key climatic and economic inputs required for region-specific, revenue-based crop insurance pricing.

Conclusions

This study demonstrates that the integration of temporal–spatial climatic data and machine learning techniques can significantly enhance net premium calculation for revenue-based crop insurance against drought risk. The main contribution of the research is threefold. First, the study provides a methodological contribution by combining logistic regression for probabilistic drought modelling with XGBoost algorithms for forecasting crop yields and commodity prices within an actuarial premium-calculation

framework. In the context of the Big Data revolution, this approach enables a dynamic, data-driven calculation of crop insurance premiums. By leveraging high-resolution indicators, such as the aridity index and consecutive dry days, the model captures the complex interactions between climate variability and drought risk, thus improving both predictive precision and regional specificity in premium determination.

Second, the research offers an empirical contribution by applying the proposed modelling framework to Serbia using long-term climatic and economic datasets. The results indicate that the selected climatic indicators provide a statistically coherent basis for estimating drought probabilities, while the machine learning models generate reliable forecasts of crop yields and market prices.

Third, the study provides a policy-relevant contribution by establishing a quantitative foundation for revenue-based crop insurance pricing in the Serbian agricultural sector. The proposed approach supports the development of more risk-sensitive and regionally differentiated insurance mechanisms that better reflect climatic exposure and market dynamics.

Although drought events are relatively infrequent in the analysed sample, the estimated logistic regression model demonstrates satisfactory predictive performance. Importantly, the primary objective of the logistic regression was not exact categorical classification, but the estimation of drought occurrence probabilities required for actuarial pricing, where probability calibration is more relevant than classification accuracy.

Empirical results show that the proposed model achieves high precision and recall in identifying drought events, consistent with the frequency and intensity patterns observed in the agricultural sector. Nevertheless, certain imbalances in class distribution, reflecting the rarity of extreme drought years, highlight the need for further methodological refinement. To address this issue, future research should incorporate class-imbalance mitigation techniques, such as Synthetic Minority Oversampling Technique (SMOTE) or One-Class Support Vector Machines (SVM).

Beyond technical improvements, actuarial modelling of agricultural insurance should also incorporate policy, behavioural, and marketing-related dimensions that influence farmers' insurance decisions. The effectiveness of insurance schemes depends not only on climatic risk assessment but also on farmers' risk perception, adoption behaviour, institutional settings, product communication, marketing strategies, and policy design. Incorporating these aspects would align agricultural insurance models more closely with real-world market dynamics and support the development of more effective and sustainable insurance solutions.

In this context, future research could benefit from integrating machine learning algorithms with system dynamics modelling. Such a hybrid modeling framework, implemented for example in VENSIM software, would enable the simulation of complex interactions among climatic, economic, and behavioural variables under alternative policy and climate scenarios.

In conclusion, this research contributes to the development of a resilient and data-driven crop insurance system for Serbia. By merging actuarial methods with machine learning, the proposed framework provides a foundation for evidence-based policy design, risk-informed pricing, and long-term sustainability in agricultural insurance markets.

Appendix

The following GitHub link provides the code for the models developed in this study, along with the corresponding results:

<https://github.com/bradickristina/ML-DRIVEN-CROP-INSURANCE.git>

Conflict of interests

The authors declare no conflict of interest.

References

1. Aerts, J. C. J. H., & Botzen, W. J. W. (2011). Climate change impacts on pricing long-term flood insurance: A comprehensive study for the Netherlands. *Global Environmental Change*, 21(3), 1045–1060. <https://doi.org/10.1016/j.gloenvcha.2011.04.005>
2. Barratt, J., Kath, J., Collins, B., Mushtaq, S., & An-Vo, D. A. (2025). Decile-based index drought insurance to help improve income stability for wheat producers in Australia. *Agricultural Water Management*, 318, 109726. <https://doi.org/10.1016/j.agwat.2025.109726>
3. Birghila, C., Pflug, G. C., & Hochrainer-Stigler, S. (2022). Risk-layering and optimal insurance uptake under ambiguity: With an application to farmers exposed to drought risk in Austria. *Risk Analysis*, 42(12), 2639-2655, <https://doi.org/10.1111/risa.13884>
4. Botzen, W. J. W. (2016). *Managing extreme climate change risks through insurance*. Cambridge University Press.
5. Botzen, W. J. W. (2016). Trends in weather related disasters – Consequences for insurers and society. *Weather and Climate Extremes*, 11, 70–79. <https://doi.org/10.1016/j.wace.2015.10.002>
6. Brunette, M., Holec, J., Sedliak, M., Tucek, J., & Hanewinkel, M. (2015). An actuarial model of forest insurance against multiple natural hazards in fir (*Abies Alba Mill.*) stands in Slovakia. *Forest Policy and Economics*, 55, 46–57. <https://doi.org/10.1016/j.forpol.2015.03.001>
7. Bucheli, J., Dalhaus, T., & Finger, R. (2021). The optimal drought index for designing weather index insurance. *European Review of Agricultural Economics*, 48(3), 573–597. <https://doi.org/10.1093/erae/jbaa014>
8. Bühlmann, H. (1985). Premium calculation from top down. *ASTIN Bulletin*, 15(2), 89–101. <https://doi.org/10.2143/AST.15.2.2015021>

9. Cabeza-Ramírez, L. J., Guerrero-Baena, M. D., Luque-Vílchez, M., & Sánchez-Cañizares, S. M. (2024). Assessing farmers' intention to adopt drought insurance. *International Journal of Disaster Risk Reduction*, 113, 104818. <https://doi.org/10.1016/j.ijdrr.2024.104818>
10. Chen, T., & Guestrin, C. (2016). XGBoost: A scalable tree boosting system. In *Proceedings of the 22nd ACM SIGKDD International Conference on Knowledge Discovery and Data Mining* (pp. 785–794).
11. Crane-Droesch, A. (2019). Climate change projected to increase cost of the federal crop insurance program. *Amber Waves*. USDA Economic Research Service.
12. de Ruig, L. T., Haer, T., de Moel, H., Brody, S. D., Botzen, W. J. W., Czajkowski, J., & Aerts, J. C. J. H. (2022). How the USA can benefit from risk-based premiums combined with flood protection. *Nature Climate Change*, 12(11), 995–998. <https://doi.org/10.1038/s41558-022-01501-7>
13. Deaton, A., & Laroque, G. (1992). On the behaviour of commodity prices. *Review of Economic Studies*, 59(1), 1–23. <https://doi.org/10.2307/2297923>
14. Dubbelboer, J., Nikolic, I., Jenkins, K., & Hall, J. (2017). An agent-based model of flood risk and insurance. *Journal of Artificial Societies and Social Simulation*, 20(1), 6. <https://www.jasss.org/20/1/6.html>
15. Eze, E., Girma, A., Zenebe, A. A., & Zenebe, G. (2020). Feasible crop insurance indexes for drought risk management in Northern Ethiopia. *International Journal of Disaster Risk Reduction*, 47, 101544. <https://doi.org/10.1016/j.ijdrr.2020.101544>
16. Friedman, J. H. (2001). Greedy function approximation: A gradient boosting machine. *Annals of Statistics*, 29(5), 1189–1232. <https://www.jstor.org/stable/2699986>
17. Führer, E., Horváth, L., Jagodics, A., Machon, A., & Szabados, I. (2011). Application of a new aridity index in Hungarian forestry practice. *Időjárás*, 115, 205–216.
18. Hohl, R., Jiang, Z., Tue Vu, M., Vijayaraghavan, S., & Liong, S. Y. (2021). Using a regional climate model to develop index-based drought insurance. *Agricultural Finance Review*, 81(1), 151–168. <https://doi.org/10.1108/AFR-02-2020-0020>
19. Hosmer, D. W., Lemeshow, S., & Sturdivant, R. X. (2013). *Applied logistic regression* (3rd ed.). Wiley.
20. Intergovernmental Panel on Climate Change (IPCC). (2023). *Climate Change 2023: Synthesis Report*. Cambridge University Press.
21. Islam, Md. M., Matsushita, S., Noguchi, R., & Ahamed, T. (2022). A damage-based crop insurance system for flash flooding. *Asia-Pacific Journal of Regional Science*, 6(1), 47–89. <https://doi.org/10.1007/s41685-021-00220-9>
22. Kapphan, I., Calanca, P., & Holzkämper, A. (2012). Climate change, weather insurance design and hedging effectiveness. *The Geneva Papers on Risk and Insurance*, 37(2), 286–317. <https://doi.org/10.1057/gpp.2012.8>

23. Koprivica, M., Kočović, J., & Cvijanović, D. (2024). A model for determining premium rates in index-based crop insurance. *Ekonomika poljoprivrede*, 71(2), 397–412. <https://doi.org/10.59267/ekoPolj2402397K>
24. Madaki, M. Y., Kaechele, H., & Bavorová, M. (2023). Agricultural insurance as a climate risk adaptation strategy in developing countries. *Climate Policy*, 23(6), 747–762. <https://doi.org/10.1080/14693062.2023.2220672>
25. Pindyck, R. S., & Rotemberg, J. J. (1990). The excess co-movement of commodity prices. *The Economic Journal*, 100(403), 1173–1189. <https://doi.org/10.2307/2233966>
26. Radosavljević, K., Bradić, K., & Đurđić, D. (2025). Sustainable agriculture in the digital age: Innovations in insurance. In J. Kočović et al. (Eds.), *Innovations in insurance – from traditional to modern market* (pp. 75–92). University of Belgrade.
27. Stojanović, Ž., Gligorijević, M., & Rakonjac-Antić, T. (2012). The role of the marketing mix in the improvement of agricultural insurance. *Ekonomika poljoprivrede*, 59(4), 769–780. <https://www.ea.bg.ac.rs/index.php/EA/article/view/545>
28. Tesselaar, M., Botzen, W. J. W., Haer, T., Hudson, P., Tiggeloven, T., & Aerts, J. C. J. H. (2020). Regional inequalities in flood insurance affordability and uptake under climate change. *Sustainability*, 12(20), 8734. <https://doi.org/10.3390/su12208734>
29. Vinnarasi, R., Dhanya, C. T., & Kumar, H. (2023). Tracing time-varying characteristics of meteorological drought through nonstationary joint deficit index. *Journal of Climate*, 36(12), 4203–4217. <https://doi.org/10.1175/JCLI-D-22-0437.1>
30. Wu, R., & Yang, Y. (2024). Drought disaster risk assessment and yield insurance pricing of maize. *Geomatics, Natural Hazards and Risk*, 15(1), 2420660. <https://doi.org/10.1080/19475705.2024.2420660>

PSYCHOLOGICAL AND SOCIAL DETERMINANTS OF RESIDENTS' SUPPORT FOR SUSTAINABLE RURAL TOURISM DEVELOPMENT: A SERIAL MEDIATION MODEL

Vladimir Ilić¹, Vladimir Džamić², Ana Ilić³, Kristina Ristić⁴, Sunčica Stanković⁵

*Corresponding author E-mail: suncicas372@gmail.com

ARTICLE INFO

Original Article

Received: 12 June 2026

Accepted: 15 August 2026

doi:10.59267/ekoPolj26038831

UDC

316.644:159.947.5]:338.48-44(1-22)

Keywords:

empowerment, place attachment, residents' attitudes, subjective norms, perceived behavioral control, Serbia

JEL: C30, C83, Q01, R58, D91

ABSTRACT

Based on the Theory of Planned Behavior and the Stimulus-Organism-Response model, the aim of this paper is to determine the role of the organism (subjective norms, perceived behavioral control, and attitudes towards supporting sustainable tourism development) as a mediator in the relationship between stimuli (perceived empowerment and place attachment) and the response (intention to support sustainable tourism development). The stratified sample included 243 respondents from rural areas of Southern and Eastern Serbia, who are employed or provide services within the tourism sector. Partial least squares structural equation modeling (PLS-SEM) was used to test the proposed model and research hypotheses. The obtained results confirmed the existence of positive and statistically significant mediating roles between the observed variables. This findings can contribute to a better understanding of the process through which psychological and social factors can shape residents' intentions to support the development of sustainable rural tourism.

-
- 1 Vladimir Ilić, Ph.D., Full Professor, Educons University, Faculty of Human Development, Bulevar despota Stefana 116, 11000 Belgrade, Serbia, E-mail: vladimirilic74@gmail.com, ORCID ID (<https://orcid.org/0009-0003-8643-4167>)
 - 2 Vladimir Džamić, Ph.D., Full Professor, Educons University, Faculty of Human Development, Bulevar despota Stefana 116, 11000 Belgrade, Serbia, E-mail: vladimir.dzamic@arh.edu.rs, ORCID ID (<https://orcid.org/0000-0001-8724-5593>)
 - 3 Ana Ilić, Ph.D., Assistant Professor, Educons University, Faculty of Human Development, Bulevar despota Stefana 116, Belgrade, Serbia, E-mail: ana.savic.ilic@gmail.com, ORCID ID (<https://orcid.org/0009-0003-4256-5392>)
 - 4 Kristina Ristić, Ph.D., Assistant Professor, Educons University, Faculty of Human Development, Bulevar despota Stefana 116, Belgrade, Serbia, E-mail: kristina.centar@gmail.com, ORCID ID (<https://orcid.org/0009-0007-5861-2922>)
 - 5 Sunčica Stanković, Ph.D., Full Professor, Educons University, Faculty of Human Development, Bulevar despota Stefana 116, Belgrade, Serbia, E-mail: suncicas372@gmail.com, ORCID ID (<https://orcid.org/0000-0001-8824-1973>)

Introduction

Rural tourism has a significant role in improving the modernization of agriculture and the development of rural areas, strengthening the connection between urban and rural areas, as well as in reducing poverty in underdeveloped regions. As an important segment of the tourism industry, it is based on the use of rural resources, including agricultural practices, landscapes, local traditions and specificities of the territory, which motivate tourists to visit rural areas, participate in different activities and gain new experiences. Thanks to the preserved natural environment and rich traditional heritage with pronounced local characteristics, rural areas can meet the needs of various tourists, especially the urban population seeking rest, relaxation and familiarization with cultural and historical contents, which is why they are becoming an increasingly important destination in the context of modern tourism (Wang et al., 2022). Rural tourism is an important segment of integrated sustainable development, both at the local and regional levels, as well as at the national level. Relevant literature suggests that the exchange of experiences and good practices leads to the conclusion that rural tourism in Serbia can contribute to increasing tourism activity and creating new jobs, reducing unemployment, diversifying the rural economy, as well as preserving and improving natural and cultural resources, while revitalizing rural areas (Borović et al., 2022; Pantić et al., 2026; Lakićević, 2020). Considering the significant potential of the Republic of Serbia for the development of various forms of rural tourism, Cvijanović and Ružić (2017) emphasize that tourism, as an important tertiary economic activity, together with agriculture as the main primary activity, can be seen as a locomotive that drives the development of rural areas. Lukić et al. (2020) indicate that the development of tourism in rural areas can contribute to broader local development by stimulating economic activity and valorizing the resources available to the local community.

The increased demand for tourist services in rural areas allows the residents to generate additional income through the sale of products and the provision of various services (Lazović et al., 2024; Nedeljković et al., 2022). Milićević et al. (2020) believe that in order to create effective strategies and policies aimed at increasing the competitiveness and sustainable development of tourist destinations, it is necessary to take into account the attitudes and perceptions of residents about tourism.

Despite the economic benefits, tourism development can pose a number of social and environmental challenges for the local community. This primarily concerns the rising cost of living, traffic congestion, overcrowding, and jobs characterized by low wages and poor working conditions (Telfer and Sharpley, 2015). In the case of Western Serbia, Panić et al. (2023) found that, in addition to positive economic and cultural effects, rural tourism also generates negative environmental consequences, with more than 60% of respondents reporting environmental degradation, such as increased pollution and habitat loss. Respondents highlighted the need for more responsible and environmentally sound tourism practices. These challenges, according to Yfantidou and Matarazzo (2017), are more pronounced in contexts with weaker institutional capacities, where the benefits of tourism often accrue to privileged groups, while local communities bear most of the social, cultural and environmental costs.

Such circumstances often lead to negative reactions of residents to the development of tourism. For example, resident protests in Bali due to water supply problems and the erosion of cultural identity (Suyadnya et al., 2025) or opposition to the commercialization of traditional religious and cultural practices in Vietnam (Quang et al., 2022). In response to these challenges, increasing attention is focused on the concept of sustainable tourism development, which seeks to balance economic benefits with environmental protection and socio-cultural development of local communities (Dias et al., 2024; Janković & Golubović, 2025). Nevertheless, the successful achievement of sustainable development goals requires the active involvement of local communities and the population in the processes of management, planning and promotion, although such initiatives of public institutions are often met with reservations by residents who often perceive them as an instrument for realizing the interests of tourists or local elites, rather than the wider community (Dias et al., 2024; Rastegar and Ruhanen, 2022). The sustainable development of tourism implies the adoption of a new social pattern that is in line with the principles of a sustainable way of life, where one of the biggest challenges for its realization can be seen precisely in this change of paradigm (Sharpley, 2000).

Tran et al. (2026) suggested that previous research points to several important gaps in the understanding of residents' support for sustainable tourism development. Most of the empirical studies were conducted in developed countries, while the contexts of developing countries are significantly less represented in the literature (Agarwal et al., 2024). Telfer and Sharpley (2015) point out that, given the specific characteristics of these environments, such as greater economic dependence on local resources, more sensitive ecosystems and less developed governance mechanisms, findings from developed countries cannot be fully generalized to developing countries.

In addition, a significant part of the research is based on Social Exchange Theory (SET) as the primary theoretical framework (Mihalic, 2016), introduced by Homans (1961). This framework assumes that residents' support depends on their assessment of whether the benefits of tourism outweigh the costs. However, the benefit-cost ratio cannot capture residents' attitudes and experiences in tourism destinations (Sharpley, 2014; Wang and Pfister, 2008; Deery et al., 2012). Empirical findings confirm that residents recognize the positive effects of tourism on their community, but still oppose its further development or exhibit behavior that indicates resistance (McKercher et al., 2015; Rosić, & Vilma Getman, 2025; Martín et al., 2018; Cardoso and Silva, 2018). In some cases, such support may stem more from economic necessity than from a truly positive assessment of the effects of tourism, especially in contexts where tourism is a key source of livelihood (Telfer and Sharpley, 2015). Furthermore, SET often fails to take into account psychological, cultural, and contextual factors that may influence residents' responses (Šegota et al., 2024), and the relevant literature increasingly advocates an approach that distinguishes between individual and collective levels of influence (Deery et al., 2012; Ćurčić et al., 2025; Sharpley, 2014). Recent research, particularly in the context of developing countries, emphasizes the importance of psychological and social factors and argues for theoretical frameworks that go beyond SET (Agarwal et al., 2024). Tran et al. (2026), for example, based their research on Theory of Planned Behavior (TPB) and the Stimulus-Organism-Response (S-O-R) model.

Evaluating costs and benefits through Social Exchange Theory is not sufficient to fully explain local community behavior. Therefore, in this research, using the methodology of the authors Tran et al. (2026), implements a hybrid framework linking the TPB (Ajzen, 1991) and the S-O-R model (Mehrabian & Russell, 1974). Such an integration can solve the problem of the inability of TPB to fully explain the origin of human attitudes (Nunkoo and Ramkissoon, 2010). Through the S-O-R paradigm, the process is mapped in more detail: external stimuli directly influence the internal psychological state of the individual, which then generates the ultimate behavioral response.

In the integrated model, the empowerment of the local population and their attachment to the place are seen as external variables that determine the attitudes of the locals towards the sustainable development of tourism. Although the literature confirms that both concepts influence the perception of tourism (Strzelecka et al., 2017), their inter-relationship and direct contribution to supporting sustainable tourism initiatives have not yet been thoroughly investigated (Aleshinloye et al., 2022). The model starts from the premise that these factors modify the basic components of the Theory of Planned Behavior (attitudes, subjective norms and perceived control of behavior), which ultimately directs residents' intention to support sustainable tourism.

The theoretical contribution of the research is reflected in a better understanding of the psychological mechanisms that influence residents' support for sustainable tourism development, while the results can provide useful guidelines to decision makers and destination management organizations for more effective inclusion of local residents in tourism planning and development processes.

Materials and methods

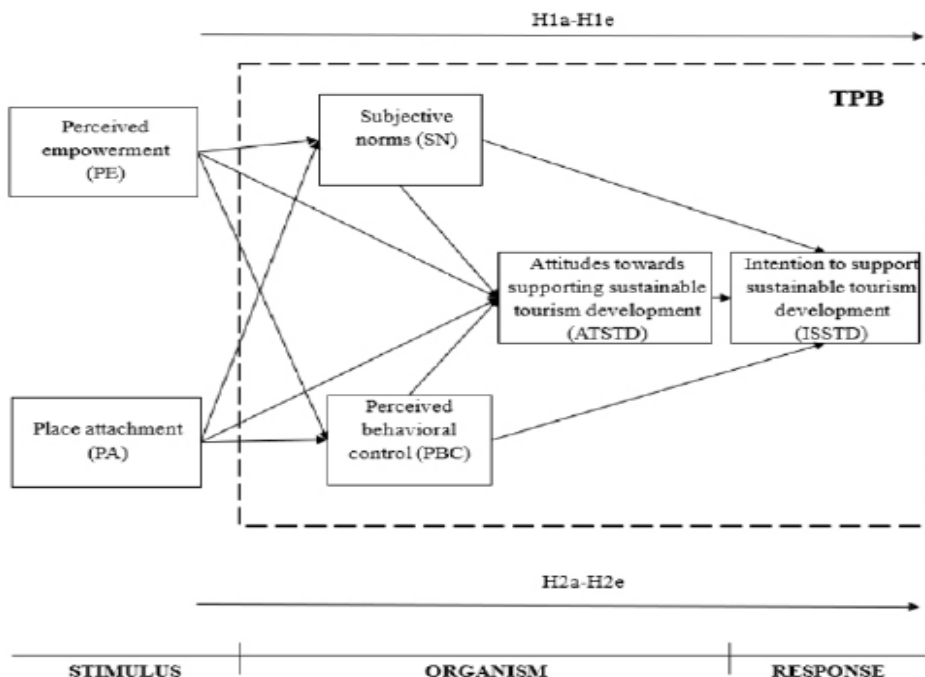
Based on the S-O-R model, external stimuli are defined as factors that influence an individual's internal psychological states and thus direct his or her reactions and behavior (Mehrabian and Russell, 1974). The key psychological stimuli, in this research, are perceived empowerment (PE) and place attachment (PA). Perceived empowerment (PE) represents the way in which residents experience their own, but also shared power, as well as the opportunities that arise from their participation in tourism activities at the local community level (Agazamani and Hunt, 2017; Boley & McGehee, 2014). In the research, it is conceptualized as a first-order construct. The concept of place attachment (PA) refers to the emotional attachment that individuals develop towards places (locations) that have special meaning and significance for them (Relph, 1976). This concept was also conceptualized in the research as a first-order construct.

Within the S-O-R model, the organism involves internal cognitive and emotional processes that mediate between external stimuli and the individual's final reactions (Mehrabian and Russell, 1974). In this research, the constructs of the Theory of Planned Behavior (TPB), i.e. attitudes towards supporting sustainable tourism development (ATSTD), subjective norms (SN) and perceived behavioral control (PBC) are considered as components of the organism. Subjective norms refer to residents' perception of social expectations and pressures that can encourage support for sustainable tourism development. Perceived behavioral control can be defined as individuals' assessment of their own abilities and possibilities to participate in and influence activities related to the development of sustainable tourism. Attitudes towards

supporting the sustainable development of tourism reflect the residents' overall positive or negative evaluation of involvement in activities that contribute to its improvement (Tran et al., 2026). The responses represent the final outcome of the process in which external stimuli, through the internal psychological states of the individual, influence his behavior (Mehrabian and Russell, 1974). In this research, the responses, were, similarly to Tran et al. (2026), operationalized through the residents' intention to support sustainable tourism development (ISSTD), which represents their willingness to actively support activities and initiatives aimed at sustainable tourism development.

Based on the methodology applied by Tran et al. (2026) in their study of urban tourism in Vietnam, this study examines the role of SN, PBC, and ATSTD as mediators in the relationships between PE and ISSTD and PA and ISSTD (Figure 1). The novelty of the paper is that the interrelationships between the observed variables are measured in the context of rural tourism in Serbia.

Figure 1. A conceptual model



Source: Authors, based on Tran et al. (2026)

Earlier research indicates a statistically significant relationship between psychological empowerment and residents' support for tourism development, as well as the significant role of subjective norms, attitudes towards sustainable tourism development and perceived behavioral control in residents' behavioral intentions to support sustainable tourism development (dos Santos et al., 2024; Gautam & Bhalla, 2024; Ribeiro et al., 2017; Shafieisabet & Haratifard, 2020; Strzelecka et al., 2023; Wong et al., 2022). Accordingly, the following hypotheses are defined:

H1a-e: Subjective norms (SN), attitudes towards sustainable tourism development (ATSTD) and perceived behavioral control (PBC) are significant mediators of the relationship between perceived empowerment (PE) and intention to support sustainable tourism development (ISSTD).

The results of earlier research indicate a positive association between place attachment and their intention to support sustainable tourism development, social norms, attitudes towards sustainable tourism development and perceived behavioral control (Soopramanien et al., 2023; Styliadis, 2018). Accordingly, the following hypotheses were defined:

H2a-e: Subjective norms (SN), attitudes towards sustainable tourism development (ATSTD) and perceived behavioral control (PBC) are significant mediators of the relationship between place attachment (PA) and intention to support sustainable tourism development (ISSTD).

For the purposes of the research, a questionnaire consisting of 4 parts was structured. The first part of the questionnaire consisted of open-ended questions, closed and multiple-choice questions, related to the demographic structure of the respondents (gender, age, level of education and career in tourism (restaurant/food store, tourist guide services, selling souvenirs/local products, transportation services and others). The second part of the questionnaire contained 10 items related to stimuli, of which 6 items related to PE, and 4 items to PA. The third part of the questionnaire was related to the organism and consisted of 9 items, whereby the constructs SN, ATSTD and PBC were measured with three items each. The fourth part of the questionnaire consisted of 3 items that related to the answer, that is, to the ISSTD construct. All views are taken from Tran et al. (2015). Each of the constructs was viewed as a first-order construct, as the arithmetic mean of the attitudes that made up each of the constructs. The research was conducted in the period March 2025 to November 2025. Questionnaires were distributed personally. Attitudes were measured using a Likert scale (1 - absolutely disagree, 5 - absolutely agree). A stratified sample included 243 respondents, from rural areas of Southern and Eastern Serbia, who are employed in tourism or provide tourism-related services.

Data were processed using IBM SPSS 23 and SmartPLS 4.0 software, by structural equation modeling using the partial least squares method (PLS-SEM). This technique is most recommended when the research focus is on predicting and investigating the dependent variables, for the maximum variance explained. Thus, PLS-SEM is the best prediction-oriented approach (Roldán and Sánchez-Franco, 2012). Also, it can simultaneously handle both measurement (external) and structural (internal) models. Furthermore, PLS-SEM is an appropriate approach for analyzing complex path models (Hair et al., 2016). PLS-SEM can also be used for small sample size and provide more accurate results.

Results and Discussion

Preliminary analysis

When dealing with survey studies, in cases where data are collected from a single source (Podsakoff et al., 2003), the issue of the presence of common method variance (CMV) can be a significant problem. To determine the presence of CMV among variables, a

one-factor test, proposed by Harman (1976), was conducted. The result showed that all attitudes in the model were categorized into 6 factors, with the first factor explaining 30.12% of the total variance, which is less than 50% (Hair et al., 2016). In addition, a collinearity assessment test was conducted in SmartPLS. It is a modern and more reliable approach, as suggested by Kock (2015) and recommended by various social science researchers (Zafar et al., 2020). All VIF values are less than the threshold value of 3, indicating that common method bias is not a problem in the model (Kock, 2015).

Measurement model

The results of evaluating the measurement model showed that the composite reliability (CR) and Cronbach's alpha (CA) values were above 0.70, i.e. critical value level, proposed by Cohen (1988). The standardized value of the loading factor of all constructs' attitudes is above 0.70, while the average extracted variance (AVE) of all constructs is above 0.50, which are adequate values. Validity and reliability results are shown in Table 1.

Table 1. Evaluation of measurement model evaluation

Constructs	Loadings	CA	CR	AVE
Perceived empowerment (PE)		0.711	0.922	0.663
PE1	0.814			
PE2	0.755			
PE3	0.823			
PE4	0.844			
PE5	0.887			
PE6	0.721			
Place attachment (PA)		0.799	0.855	0.598
PA1	0.706			
PA2	0.738			
PA3	0.863			
PA4	0.777			
Subjective norms (SN)		0.831	0.891	0.731
SN1	0.865			
SN2	0.810			
SN3	0.888			
Attitudes towards supporting sustainable tourism development (ATSTD)		0.766	0.835	0.627
ATSTD1	0.767			
ATSTD2	0.815			
ATSTD3	0.793			
Perceived behavioral control (PBC)		0.719	0.891	0.732
PBC1	0.890			
PBC2	0.854			
PBC3	0.822			
Intention to support sustainable tourism development (ISSTD)		0.803	0.853	0.659

Constructs	Loadings	CA	CR	AVE
ISSTD1	0.798			
ISSTD2	0.831			
ISSTD3	0.806			

Source: Authors

Discriminant validity means that each construct is divergent in relation to other constructs, which were used in the model (Sarstedt et al., 2017). Two methods were used to assess discriminant validity: 1) the Fornell-Larcker criterion, which suggests that the value of the square root of AVE must be greater than the correlation value between the proposed constructs (Fornell and Larcker, 1981) and 2) the HTMT ratio - Heterotrait-Monotrait Ratio, which indicates whether the defined constructs are sufficiently different from each other, that is, whether they describe different phenomena (Henseler et al., 2015). Values of the HTMT coefficient below 0.85 do not indicate a problem of discriminant validity, while values above 0.85 describe problems with discriminant validity (Sarstedt et al., 2017). Detailed results are shown in Table 2.

Table 2. Discriminant validity

Construct	Fornell-Larcker						HTMT					
	PE	PA	SN	ATSTD	PBC	ISSTD	PE	PA	SN	ATSTD	PBC	ISSTD
PE	.814											
PA	.285	.773					.499					
SN	.444	.387	.855				.660	.588				
ATSTD	.379	.331	.420	.792			.477	.555	.514			
PBC	.417	.291	.261	.304	.856		.695	.439	.483	.580		
ISSTD	.476	.318	.381	.374	.741	.812	.705	.688	.477	.566	.758	

Source: Authors

Structural model

The structural model was assessed in terms of its fit to the data, explanatory and predictive power, and testing of the hypotheses. The model fit is satisfactory, as confirmed by the SRMR value of 0.020, which is below the recommended threshold of 0.08. The explanatory power of the model was assessed based on the coefficient of determination (R^2), whose value for the endogenous variable ISSTD is 0.591, indicating a moderate to high explanatory power of the model. The predictive relevance of the model was assessed using the Stone-Geisser Q^2 , whose value of 0.237 confirms the existence of predictive relevance and indicates a medium level of predictive ability of the model (Hair et al., 2019).

According to the research results, shown in Table 1, SN ($\beta=0.316$; $p < 0.05$), ATSTD ($\beta=0.302$; $p < 0.05$) and PBC ($\beta=0.161$; $p < 0.05$) are significant mediators of the relationship between PE and ISSTD. In addition, it was also confirmed that SN ($\beta=0.168$; $p < 0.05$), ATSTD ($\beta=0.267$; $p < 0.05$) and PBC ($\beta=0.272$; $p < 0.05$) mediate the relationship between PA and ISSTD. In addition, it was confirmed that the mediation

path through SN and ATSTD ($\beta=0.094$; $p < 0.05$), as well as through PBC and ATSTD ($\beta=0.138$; $p < 0.05$) is positive and significant in the relationship between PE and ISSTD. Also, the serial indirect effect through SN and ATSTD ($\beta=0.162$; $p < 0.05$), as well as through PBC and ATSTD ($\beta=0.150$; $p < 0.05$) positively and significantly mediates the relationship between PA and ISSTD. The significance of the role of mediators, that is, of all indirect effects, is also confirmed by the fact that the bootstrap confidence intervals of each of the observed relationships did not include zero.

Table 3. Hypothesis testing results

H	Path	OS	SM	Std	T	P
H1a	PE→SN→ISSTD	.316	.313	.050	6.344	.0001
H1b	PE→ATSTD→ISSTD	.302	.302	.050	6.090	.0001
H1c	PE→PBC→ISSTD	.161	.158	.062	2.599	.009
H1d	PE→SN→ATSTD→ISSTD	.094	.094	.043	2.209	.027
H1e	PE→PBC→ATSTD→ISSTD	.138	.135	.070	1.970	.049
H2a	PA→SN→ISSTD	.168	.168	.054	3.126	.002
H2b	PA→ATSTD→ISSTD	.267	.264	.054	4.942	.0001
H2c	PA→PBC→ISSTD	.272	.272	.069	3.918	.0001
H2d	PA→SN→ATSTD→ISSTD	.162	.159	.045	3.612	.0001
H2e	PA→PBC→ATSTD→ISSTD	.150	.147	.062	2.399	.016

Source: Authors

Based on the obtained results, it can be concluded that the intentions of residents to support the sustainable development of tourism are strengthened, both through attitudes towards sustainable development, and through subjective norms and processes based on perceived behavioral control. Similar results were obtained by Tran et al. (2026), who also determined the significant role of attitudes and subjective norms, however, according to their findings, perceived behavioral control is significant only when it is a serial mediation, i.e. when, together with attitudes towards sustainable development, it mediates the relationship between perceived improvement or place attachment and intention to support sustainable tourism development. These results complement the existing literature dealing with sustainable development issues in both developed (Gautam, 2023; Gautam & Bhalla, 2024) and developing countries (Gautam, 2023; Phuc & Nguyen, 2023; Wani et al., 2024), contributing to a better understanding of the mechanism through which perceived empowerment and place attachment can lead to residents' intentions to support sustainable development.

Conclusions

The aim of this research was to examine how perceived empowerment and place attachment shape residents' intentions to support sustainable tourism development through subjective norms, perceived behavioral control, and attitudes towards supporting sustainable tourism development.

The results indicated the importance of all mediation paths, thus confirming the defined hypotheses of the research. The conducted research connects two theoretical

frameworks (TPB and S-O-R) whose application is not so common in research supporting the sustainable development of tourism, especially when it comes to rural tourism research. For this reason, the current research provides a more comprehensive explanation of the residents' intention formation process.

Given that the majority of previous studies were conducted in developed countries, the results of this research contribute to filling the gap in the literature by providing empirical evidence from Serbia, as a developing country. In this way, the applicability of the integrated TPB and S-O-R model is confirmed in different socioeconomic and institutional conditions, which improves the possibility of generalization of the existing theoretical assumptions. The obtained results show that the support of residents does not depend only on their feeling of empowerment or connection with the place, but also on whether a supportive environment for sustainable tourism development is formed through social norms and positive attitudes. It can help decision-makers to create policies that strengthen local residents' involvement, sense of community and positive attitudes towards sustainable tourism.

This research also has certain limitations. First, the research covered only Southern and Eastern Serbia, which is why the results cannot be fully generalized to other countries, and future research could apply the proposed model in other different cultural and geographical contexts. Second, the data were collected at one point in time, making it impossible to examine causal relationships, and future researchers could use a longitudinal design. Third, this research has shown that there are psychological mechanisms of transmission of effects, while future research could extend this model by adding new constructs, such as, for example, quality of life and trust in local institutions.

Acknowledgements

The authors wish to express their gratitude to Ph.D. Vesna Krstić for valuable support during the preparation of this work..

Conflict of interests

The authors declare no conflict of interest.

References

1. Agarwal, R., Mehrotra, A., Mishra, A., Rana, N. P., Nunkoo, R., & Cho, M. (2024). Four decades of sustainable tourism research: Trends and future research directions. *International Journal of Tourism Research*, 26(2), e2643.
2. Aghazamani, Y., & Hunt, C. A. (2017). Empowerment in tourism: A review of peer-reviewed literature. *Tourism Review International*, 21(4), 333-346.
3. Ajzen, I. (1991). The theory of planned behavior. *Organizational behavior and human decision processes*, 50(2), 179-211.

4. Aleshinloye, K. D., Woosnam, K. M., Tasci, A. D., & Ramkissoon, H. (2022). Antecedents and outcomes of resident empowerment through tourism. *Journal of Travel Research*, 61(3), 656-673.
5. Boley, B. B., & McGehee, N. G. (2014). Measuring empowerment: Developing and validating the resident empowerment through tourism scale (RETS). *Tourism Management*, 45, 85-94.
6. Borović, S., Stojanović, K., & Cvijanović, D. (2022). The future of rural tourism in the Republic of Serbia. *Economics of Agriculture*, 69(3), 925-938.
7. Cardoso, C., & Silva, M. (2018). Residents' perceptions and attitudes towards future tourism development: A challenge for tourism planners. *Worldwide Hospitality and Tourism Themes*, 10(6), 688-697.
8. Cohen, J. (1988). *Statistical Power Analysis for the Behavioral Sciences*. 2nd ed. New York: Lawrence Erlbaum Associates, Publishers.
9. Cvijanović, D., & Ružić, P. (2017). Rural Tourism, Faculty for Hotel and Tourism Management in Vrnjačka Banja, University in Kragujevac, Vrnjačka Banja [In Serbian: Цвијановић, Д., & Ружић, П. (2017), Ruralni turizam].
10. Deery, M., Jago, L., & Fredline, L. (2012). Rethinking social impacts of tourism research: A new research agenda. *Tourism management*, 33(1), 64-73.
11. Dias, Á., Viana, J., & Pereira, L. (2026). Barriers and policies affecting the implementation of sustainable tourism: the Portuguese experience. *Journal of Policy Research in Tourism, Leisure and Events*, 18(1), 184-202.
12. dos Santos, E. R. M., Pereira, L. N., Pinto, P., Boley, B. B., & Ribeiro, M. A. (2024). Imperialism, empowerment, and support for sustainable tourism: Can residents become empowered through an imperialistic tourism development model?. *Tourism Management Perspectives*, 53, 101270.
13. Fornell, C. & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurements error. *Journal of Marketing Research*, 18(1), 39-50.
14. Gautam, V. (2023). Why local residents support sustainable tourism development?. *Journal of Sustainable Tourism*, 31(3), 877-893.
15. Gautam, V., & Bhalla, S. (2024). Exploring the relationships among tourism involvement, residents' empowerment, quality of life and their support for sustainable tourism development. *Journal of Cleaner Production*, 434, 139770.
16. Hair, J. F. Jr., Hult, G. T. M., Ringle, C. M. & Sarstedt, M. (2016). *A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM)*. 2nd ed. New York, NY: SAGE Publications.
17. Harman, H. H. (1976). *Modern Factor Analysis*. Chicago: University of Chicago Press.

18. Henseler, J., Ringle, C. M. & Sarstedt, M. (2015). A new criterion for assessing discriminant validity in variance-based structural equation modeling. *Journal of the Academy of Marketing Science*, 43(1), 115-135.
19. Homans, G. C. (1961). *Social behavior and its elementary forms*. Harcourt: Brace and World.
20. Kock, N. (2015). Common method bias in PLS-SEM: a full collinearity assessment approach. *International Journal of e-Collaboration*, 11(4), 1-10.
21. Lakićević, M., Kostić, M., Pantović, D., & Žarevac-Bošković, M. (2022). Effects of climate change on sustainable tourism development in the Republic of Serbia - a case study of Vrnjačka Banja. *Ekonomika*, 68(1), 81-93.
22. Lazović, S., Milićević, S., Đorđević, N., & Kraguljac, V. (2024). Exploring rural tourism potential in rural areas of Vrnjačka Banja. *Менаџмент у хотелијерству и туризму*, 12(2), 59-73.
23. Lukić, D., Stanković, S., Petrović, M. D., Radovanović, M. M., & Vuković, D. (2020). How can small-scale events contribute to the tourism progress of an undeveloped border area? Lesson from Eastern Serbia. *GeoJournal of Tourism and Geosites*, 30(2spl), 905-912.
24. Martín, H. S., de los Salmones Sánchez, M. M. G., & Herrero, Á. (2018). Residents' attitudes and behavioural support for tourism in host communities. *Journal of Travel & Tourism Marketing*, 35(2), 231-243.
25. McKercher, B., Wang, D., & Park, E. (2015). Social impacts as a function of place change. *Annals of Tourism Research*, 50, 52-66.
26. Mehrabian, A., & Russell, J. A. (1974). *An approach to environmental psychology*. the MIT Press.
27. Mihalic, T. (2020). Conceptualising overtourism: A sustainability approach. *Annals of Tourism Research*, 84, 103025.
28. Milićević, S., Podovac, M., & Đorđević, N. (2020). Local residents' attitudes towards tourism events: A case study of the Carnival of Vrnjci, Serbia. *Economics of Agriculture*, 66(2), 75-91.
29. Nedeljković, M., Puška, A., & Krstić, S. (2022). Multicriteria approach to rural tourism development in Republic of Srpska. *Economics of Agriculture*, 69(1), 13-26.
30. Nunkoo, R., & Ramkissoon, H. (2010). Gendered theory of planned behaviour and residents' support for tourism. *Current issues in tourism*, 13(6), 525-540.
31. Panić, A., Vujko, A., & Knežević, M. (2024). Rural tourism impact on the life quality of the local community: a case study of Western Serbia. *Economic of Agriculture*, 71(3), 733-753.
32. Phuc, H. N., & Nguyen, H. M. (2023). The importance of collaboration and emotional solidarity in residents' support for sustainable urban tourism: case study Ho Chi Minh City. In *Theoretical advancement in social impacts assessment of tourism research* (pp. 56-75). Routledge.

33. Quang, T. D., Noseworthy, W. B., & Paulson, D. (2022). Rising tensions: heritage-tourism development and the commodification of “Authentic” culture among the Cham community of Vietnam. *Cogent Social Sciences*, 8(1), 2116161.
34. Rastegar, R., & Ruhanen, L. (2022). The injustices of rapid tourism growth: From recognition to restoration. *Annals of Tourism Research*, 97, 103504.
35. Relph, E. (1976). *Place and placelessness*. Pion.
36. Ribeiro, M. A., Pinto, P., Silva, J. A., & Woosnam, K. M. (2017). Residents’ attitudes and the adoption of pro-tourism behaviours: The case of developing island countries. *Tourism Management*, 61, 523-537.
37. Roldán, J. L. & Sánchez-Franco, M. J. (2012). Variance-Based structural equation modeling: Guidelines for using partial least squares in information systems research. In: Mora, M., Gelman, O., Steenkamp, A. & Raisinghani, M. (Eds.), *Research Methodologies, Innovations and Philosophies in Software Systems Engineering and Information Systems* (pp.193-221). IGI Global.
38. Sarstedt, M., Ringle, C. M. & Hair, J. F. (2017). Partial least squares structural equation modeling. In: C. Homburg et al. (Eds.), *Handbook of Market Research* (pp. 1-10). Springer International Publishing.
39. Šegota, T., Mihalič, T., & Perdue, R. R. (2024). Resident perceptions and responses to tourism: individual vs community level impacts. *Journal of Sustainable Tourism*, 32(2), 340-363.
40. Shafieisabet, N., & Haratifard, S. (2020). The empowerment of local tourism stakeholders and their perceived environmental effects for participation in sustainable development of tourism. *Journal of Hospitality and Tourism Management*, 45, 486-498.
41. Sharpley, R. (2000). Tourism and sustainable development: Exploring the theoretical divide. *Journal of Sustainable tourism*, 8(1), 1-19.
42. Sharpley, R. (2014). Host perceptions of tourism: A review of the research. *Tourism management*, 42, 37-49.
43. Soopramanien, D., Daryanto, A., & Song, Z. (2023). Urban residents’ environmental citizenship behaviour: The roles of place attachment, social norms and perceived environmental responsibility. *Cities*, 132, 104097.
44. Strzelecka, M., Boley, B. B., & Strzelecka, C. (2017). Empowerment and resident support for tourism in rural Central and Eastern Europe (CEE): The case of Pomerania, Poland. *Journal of Sustainable Tourism*, 25(4), 554-572.
45. Strzelecka, M., Prince, S., & Boley, B. B. (2023). Resident connection to nature and attitudes towards tourism: findings from three different rural nature tourism destinations in Poland. *Journal of Sustainable Tourism*, 31(3), 664-687.
46. Styliadis, D. (2018). Place attachment, perception of place and residents’ support for tourism development. *Tourism Planning & Development*, 15(2), 188-210.

47. Suyadnya, I. W., Cahyadi, R., Tirtayani, L. A., & Nuryani, A. F. (2025). Overtourism sensitivity and tourism development in Canggu, Bali. *Cogent Social Sciences*, 11(1), 2521364.
48. Telfer, D. J., & Sharpley, R. (2015). *Tourism and development in the developing world*. Routledge.
49. Tran, P. K. T., Ho-Mai, N. T., Tran, T. N., & Tran, V. T. (2026). How perceived empowerment and place attachment drive residents' support for sustainable tourism in central Vietnam: a serial mediation model. *International Journal of Tourism Cities*, 1-17.
50. Wang, G., Huang, L., Xu, C., He, K., Shen, K., & Liang, P. (2022). Analysis of the mediating role of place attachment in the link between tourists' authentic experiences of, involvement in, and loyalty to rural tourism. *Sustainability*, 14(19), 12795.
51. Wang, Y., & Pfister, R. E. (2008). Residents' attitudes toward tourism and perceived personal benefits in a rural community. *Journal of Travel Research*, 47(1), 84-93.
52. Wani, M. D., Dada, Z. A., & Shah, S. A. (2024). The impact of community empowerment on sustainable tourism development and the mediation effect of local support: a structural equation Modeling approach. *Community Development*, 55(1), 50-66.
53. Wong, A. K. F., Wu, H., & Kim, S. (2022). Residents' perceptions of tourism influence and intention to support tourism development: Application of the theory of planned behavior. *Journal of China Tourism Research*, 18(4), 710-734.
54. Yfantidou, G., & Matarazzo, M. (2017). The future of sustainable tourism in developing countries. *Sustainable development*, 25(6), 459-466.
55. Zafar, A. U., Qiu, J. & Shahzad, M. (2020). Do digital celebrities' relationships and social climate matter? Impulse buying in f-commerce. *Internet Research*, 30(6), 1731-1762.

FINANCIAL RISKS AND MANAGEMENT PRACTICES IN AGRICULTURE: EVIDENCE FROM RURAL TOURISM FARMERS IN SERBIA

Marijana Živković¹, Marija Ilievska Kostadinović², Ivana Savić³

*Corresponding author E-mail: mzivkovic@politehnika.edu.rs

ARTICLE INFO

Original Article

Received: 21 July 2026

Accepted: 15 August 2026

doi:10.59267/ekoPolj2603897Z

UDC 658.15:338.48-44(1-22)
(497.11)

Keywords:

should include 4-6 key words that summarize the contents of the paper /Times New Roman, Italic, 10/

JEL:(www.aeaweb.org/jel/jel_class_system.php) /Times New Roman, Italic, 10/

ABSTRACT

The aim of this paper is to investigate how farm owners engaged in rural tourism in Serbia perceive financial risks, adopt financial management practices, and evaluate the effectiveness of those practices in mitigating financial challenges. Data were collected through a structured online questionnaire administered between April and May 2026, using a random sampling approach. A total of 230 farm owners participated in the research. Data analysis was conducted using SPSS 26.0, incorporating descriptive statistics, reliability analysis, and inferential techniques. A one-way ANOVA was employed to examine differences across socio-demographic groups, with Tukey HSD post-hoc tests applied to identify specific contrasts. The results revealed that education is a significant determinant of financial management practices, with higher levels of formal education consistently linked to more advanced and effective approaches. Age demonstrated a non-linear effect, as middle-aged respondents perceived financial risks more strongly than both younger and older groups. In contrast, years of experience in rural tourism did not significantly influence perceptions of financial management practices, indicating that longevity in the sector alone does not necessarily enhance confidence in risk mitigation.

-
- 1 Marijana Živković, Ph.D., Professor, The Academy of Applied Studies Polytechnik, Katarine Ambrozić 3, Belgrade, Serbia, E-mail: mzivkovic@politehnika.edu.rs, ORCID ID (<https://orcid.org/0009-0009-8588-9569>)
 - 2 Marija Ilievska Kostadinović, Ph.D., Associate Professor, MB University, Business and Law Faculty, Belgrade, Serbia, E-mail: marija.ilievska.kostadinovic@ppf.edu.rs, ORCID ID (<https://orcid.org/0000-0001-7137-6177>)
 - 3 Ivana Savić, PhD student, University of Adriatic, Faculty of Management Herceg Novi, Meljine, Montenegro, E-mail: ivana.s7895@gmail.com, ORCID ID (<https://orcid.org/0009-0006-3458-0009>)

Introduction

Agricultural producers operate within environments characterized by diverse and interrelated sources of risk (Allahverdiyev, Rao, & Trujillo-Barrera, 2025; Liu, Ren, & Jin, 2025; Yang et al., 2022). These risks encompass production-related uncertainties such as droughts or excessive rainfall, market risks linked to price volatility, and institutional risks arising from policy shifts. The interaction of these risks often destabilizes farm operations and undermines long-term sustainability (Girma, Kuma, & Bedemo, 2023; Komarek, De Pinto, & Smith, 2020). Rural regions face additional constraints, as limited financial resources and insufficient human capital, which restrict opportunities for innovation and diversification into activities regarding rural tourism (Dejanović, Lukić Nikolić, & Ljubojević, 2024; Ostojić, Petrović, & Despotović, 2025; Vučić, 2024). Small and medium-sized agricultural enterprises frequently encounter financial challenges that impede growth and performance. Persistent barriers include restricted access to finance, low levels of financial inclusion, and disproportionately high transaction costs. Moreover, weak financial management practices often stemming from inadequate skills or financial illiteracy led to poor decision-making, reduced efficiency, and in some cases, business failure (Mangana, Ndyetabula, & Hokororo, 2023).

Among all these challenges, financial risk is particularly critical. Disruptions in production or markets can quickly translate into repayment difficulties, diminished access to credit, and broader financial instability (Duong et al., 2019). In agriculture, financial risk encompasses uncertainties in meeting obligations due to fluctuating interest rates, lenders' willingness to extend capital, cash flow volatility, and changes in collateral value (Wolf & Karszes, 2023). Effective financial risk management is therefore indispensable for sustaining operations, enabling investment, and fostering resilience (Musah, Gakpetor, & Portia, 2018). Strengthening financial literacy and expanding access to formal credit channels not only stabilize farm income but also promote balanced financial management (Dašić, 2025; Komarek, De Pinto, & Smith, 2020), while simultaneously supporting rural tourism development (Ostojić, Sekulić, & Mićović, 2025).

High levels of perceived risk such as uncertain demand, volatile prices, or rising input costs can discourage innovation and reduce investment in marketing activities, thereby limiting opportunity recognition (Komarek, De Pinto, & Smith, 2020). In such contexts, the potential benefits of marketing strategies, including branding, promotion, or collaboration with retailers, are overshadowed by concerns about financial exposure (Wolf & Karszes, 2023). Consequently, farmers who perceive financial risks as overwhelming often prioritize risk avoidance over opportunity exploitation, making them less inclined to adopt marketing as a pathway for growth and competitiveness (Gottlieb & Hansson, 2024; Hasan et al., 2024).

Agritourism has increasingly been recognized as a pathway to sustainable rural development (Turtureanu et al., 2025), with the potential to encourage farmers to adopt organic practices (Baby & Kim, 2024). However, financial barriers remain a

major obstacle to this transition. In developing countries, financial considerations play a decisive role in shaping agricultural diversification. The availability of capital, alongside resources such as labor and materials, is a fundamental prerequisite for farmers seeking to expand or adapt their activities (Paunić et al., 2025). Institutional and financial challenges are therefore central to the regulation and development of the rural tourism sector (Mihailović et al., 2025). Moreover, empirical studies consistently demonstrate that effective planning and management of financial resources enhance farm performance (Vanhuysse, Bailey, & Tranter, 2021). Limited access to capital and the high costs associated with converting to organic methods often deter farmers from pursuing such strategies. Combined with knowledge gaps and weak institutional support, these financial constraints significantly hinder diversification into organic farming and limit the economic potential of agritourism (Grillini et al., 2025).

The aim of this paper is to investigate how farm owners engaged in rural tourism perceive financial risks, adopt financial management practices, and evaluate the effectiveness of those practices in mitigating financial challenges. By analyzing the relationships between socio-demographic characteristics, farming experience, and attitudes toward risk management, this paper seeks to provide a comprehensive understanding of the determinants shaping financial resilience in rural tourism enterprises. This research is particularly significant as it addresses a critical gap in the literature on rural tourism and agricultural entrepreneurship, where financial risk management remains underexplored. Rural tourism enterprises are highly vulnerable to external shocks such as seasonal demand fluctuations, rising input costs, and policy changes. Understanding how farm owners perceive and respond to these risks offers valuable insights into the sustainability of rural tourism as a diversification strategy for agricultural households (Yusriadi, Cahaya, & Masriadi, 2024).

Theoretical framework and hypotheses development

Financial literacy is widely recognized as a critical dimension of human capital, reflecting an individual's capacity to acquire and apply financial knowledge for effective decision-making (Twumasi et al., 2026). It enables individuals to plan budgets over time, assess risks and returns, manage debt, and accumulate assets, thereby contributing to long-term economic stability (Dwangu & Mahlangu, 2021; Božić & Knežević, 2025; Rosić & Vilma Getman, 2025; Klapper & Lusardi, 2020). Within the tourism sector, financial literacy plays a pivotal role by facilitating access to financial services, strengthening asset accumulation, and fostering sustainable business engagement. Empirical evidence highlights its importance, showing that individuals with stronger financial skills are better equipped to navigate competitive markets such as tourism (Koomson et al., 2022). For farmers and entrepreneurs, investing in financial literacy as part of human capital development not only enhances productivity but also expands opportunities for resilient market participation.

Diversification of agricultural activities into tourism has increasingly been acknowledged as a sustainable strategy for strengthening farm finances (Ndhlovu & Dube, 2024),

particularly in developing economies such as Serbia. Through agritourism initiatives such as offering accommodation services or selling products directly to visitors, farms can generate supplementary income streams, stabilize earnings amid market volatility, and enhance long-term financial resilience (Dejanović & Lukić Nikolić, 2024; Janković & Golubović, 2025). Evidence from both developed and developing contexts suggests that farmers often perceive diversification not only as a means of improving household income but also as a pathway to greater financial stability and reduced dependence on traditional production systems (Paunić et al., 2025).

Strengthening financial literacy and management capacity is therefore essential for improving resilience and ensuring sustainable performance in agriculture (Mangana, Ndyetabula, & Hokororo, 2023). Adequate financial resources allow farmers to meet material requirements, reinforce economic security, expand purchasing power, and ultimately enhance overall well-being (Lin & Lai, 2025). Given that tourism represents a significant source of income and stability, improving the financial literacy of farmers is of tremendous importance (Dašić, Kostadinović, & Ilievska Kostadinović, 2024).

Financial risk in farming arises from uncertainties related to interest rates, lender support, cash flow adequacy, and collateral value. Modern dairy production, for instance, is highly capital-intensive, requiring sound investment in productive assets to ensure long-term viability. Borrowed funds or external equity introduce risks tied to debt servicing, asset valuation, and liquidity pressures, which may be further exacerbated by rising interest rates, household cash demands, income disruptions, and limited reserves. Effective management of these risks relies on tools such as savings, credit lines, financial reserves, and well-structured farm business models (Wolf & Karszes, 2023).

Ultimately, financial risk management constitutes one of the most critical decisions farmers make, as it directly influences farm viability and the stability of the broader food system. Anticipating potential outcomes and developing strategies proactively rather than reacting after adverse events ensures income stability and safeguards agricultural resilience (Michels et al., 2025). In this context, risk management has become a strategic priority for agricultural enterprises seeking to navigate increasingly complex financial systems, evolving technologies, volatile markets, and climate-related uncertainties (Kesanta, Makuya, & Makona, 2025).

Previous research indicates that farmers' perceptions of financial risk are shaped by demographic and experiential factors. Age often plays a decisive role, as older farm owners - having lived through crop failures, market volatility, and policy shifts tend to adopt more cautious approaches. In contrast, younger farmers, particularly those familiar with contemporary education and technology, are generally more open to experimentation and innovation (Agriculture Institute, 2025). From these differences arises the first hypothesis of this paper:

Hypothesis 1: There is a statistically significant difference in perceived financial risk across age groups of farm owners.

Education also influences financial management and decision-making. Farmers with higher levels of education are typically better equipped to evaluate risks objectively, which reduces excessive risk aversion. At the same time, their awareness of potential consequences fosters more calculated and deliberate risk-taking. Studies consistently show that education is negatively associated with risk aversion, suggesting that more educated farmers adopt more advanced financial management perspectives (Agriculture Institute, 2025). From this evidence emerges the second hypothesis:

Hypothesis 2: *Education level has a significant effect on financial management perspectives, with higher education associated with more advanced management perspectives.*

Experience in rural tourism further shapes financial risk management practices. Farm owners with long-term involvement in agritourism often refine their operations over time, adopting structured business plans, insurance coverage, and diversified activities to safeguard against financial uncertainty. Sustained experience enables them to integrate strategic planning, marketing, and liability protection more effectively than less experienced counterparts (Stearns, Ghimire, & Lentz, 2025). From this observation follows the third hypothesis of the paper:

Hypothesis 3: *Farm owners with more than 10 years of experience in rural tourism perceive their management practices as more effective in mitigating financial risks compared to less experienced owners.*

Materials and methods

Data collection. Data were gathered through a structured online questionnaire administered during April and May 2026. The survey was disseminated using a random sampling approach and made accessible online, thereby enabling broad participation among farm owners across Serbia.

Questionnaire. The questionnaire was structured into two main sections. The first section collected data such as: gender, age, education, and farming experience. The second section assessed respondents' attitudes across three domains using a five-point Likert scale (1 = strongly disagree, 5 = strongly agree): Financial Risks (4 items) - measuring perceived exposure to seasonal demand fluctuations, infrastructure investment risks, rising input costs, and external threats such as policy changes or extreme weather; Financial Management Practices (4 items) - evaluating the extent to which farmers engage in budgeting, diversification, maintaining reserves, and collaboration with other businesses; and Perceived Effectiveness of Financial Management (4 items) - assessing how effective farmers believe their practices are in reducing risks, improving resilience, strengthening financial positions, and stabilizing income. This structure allowed for both descriptive profiling of farm owners and statistical measurement of their financial risks, financial management practices, and perceived effectiveness of those practices. A pilot study conducted with 40 respondents confirmed the reliability and validity of the proposed scales, with Cronbach's Alpha coefficients exceeding 0.80, indicating strong internal consistency.

Sample. The final sample comprised 230 farm owners from Serbia who voluntarily completed the questionnaire. The random sampling approach and online administration ensured accessibility and broad participation, capturing a representative cross-section of farm owners engaged in rural tourism.

Data Analysis. Data were processed using the Statistical Package for the Social Sciences (SPSS), version 26.0. To test the proposed hypotheses, both descriptive and inferential statistical techniques were employed. Descriptive statistics summarized socio-demographic characteristics and provided an overview of responses across the constructs of financial risks, financial management practices, and perceived effectiveness of financial management. Reliability analysis was conducted using Cronbach's Alpha to ensure internal consistency of the Likert-scale items. As shown in Table 1, all scales demonstrated high reliability, with coefficients well above the recommended threshold of 0.70 (DeVellis, 2003).

Table 1. Cronbach's Alpha coefficients

Scale	N	Cronbach's Alpha
Financial Risks (FR)	4	0.926
Financial Management Practices (FMP)	4	0.916
Perceived Effectiveness of Financial Management (PEFM)	4	0.925

Source: Authors' calculations

For inferential analysis, one-way ANOVA was applied to examine differences in perceptions of financial risks, financial management practices, and perceived effectiveness of those practices across socio-demographic groups (e.g., age, education, and farming experience). Where statistically significant differences were identified, Tukey's HSD post-hoc tests were conducted to determine which specific groups differed from one another.

Research results

Table 2 presents the basic information about the sample. The sample consisted of 230 farm owners engaged in rural tourism. The majority of respondents were male (55.65%). In terms of age, the largest proportion of participants were in the 41–50 years old (31.30%), indicating that middle-aged farm owners were most strongly represented. With respect to education, the highest percentages were observed among those with a high school (37.39%) or college background (36.52%), suggesting that most participants had attained at least secondary or post-secondary education. Finally, regarding engagement in farming, the majority of respondents reported having more than 10 years of experience (39.57%).

Table 2. Key information about respondents

	Answers	N	%
Gender	Male	128	55.65
	Female	102	44.35
Age	Up to 20	11	4.78
	From 21 to 30	45	19.57
	From 31 to 40	58	25.22
	From 41 to 50	72	31.30
	Above 50	44	19.13
Education	Primary School	18	7.83
	High School	86	37.39
	College	84	36.52
	University	42	18.26
How long have you been engaged in farming?	Less than 5 years	50	21.74
	From 5 to 10 years	89	38.70
	Above 10 years	91	39.57

Source: Authors' calculations

Table 3 presents the responses to the statements in the measurement scale "Financial Risks". The results indicate that respondents generally perceive financial risks as high across all statements. The highest mean values were observed for rising costs of inputs ($M = 4.33$) and external factors such as policy changes or extreme weather conditions ($M = 4.33$), suggesting that these are considered the most pressing financial threats. In terms of percentages, nearly half of the respondents selected the highest category (5 – strongly agree) for both rising input costs (48.70%) and external factors (48.70%), underscoring the widespread concern about these issues. Seasonal fluctuations in tourist demand ($M = 4.03$) and infrastructure investments ($M = 4.08$) were also perceived as significant risks, with the majority of respondents agreeing or strongly agreeing (over 75% combined in categories 4 and 5).

Table 3. Results regarding the scale "Financial Risks"

Statements	Answer	N	%	M	SD
Seasonal fluctuations in tourist demand significantly affect the financial stability of the farm.	1	4	1.74	4.03	0.896
	2	9	3.91		
	3	37	16.09		
	4	105	45.65		
	5	75	32.61		
Investments in infrastructure carry high financial risk due to uncertain returns.	1	2	0.87	4.08	0.837
	2	8	3.48		
	3	36	15.65		
	4	108	46.96		
	5	76	33.04		
Rising costs of inputs (e.g., food, energy, maintenance) threaten the profitability of the farm.	1	2	0.87	4.33	0.801
	2	6	2.61		
	3	18	7.83		
	4	92	40.00		
	5	112	48.70		

Statements	Answer	N	%	M	SD
External factors such as policy changes or extreme weather conditions increase financial risk.	1	2	0.87	4.33	0.805
	2	6	2.61		
	3	19	8.26		
	4	91	39.57		
	5	112	48.70		

Source: Authors' calculations

Table 4 provides insights into respondents' perceptions of their financial management practices. The results show that respondents generally report strong engagement in financial management practices aimed at mitigating financial risks. The highest mean values were observed for maintaining financial reserves or savings ($M = 4.31$) and collaborating with other farms or local businesses ($M = 4.27$), indicating that these practices are perceived as particularly important. In terms of percentages, nearly half of the respondents strongly agreed with maintaining financial reserves (45.65%) and collaborating with others (43.48%), underscoring the widespread adoption of these practices. Preparing financial plans and budgets ($M = 4.17$) and diversifying income sources ($M = 4.22$) also received high levels of agreement, with more than 80% of respondents selecting the top two categories (4 and 5).

Table 4. Results regarding the scale "Financial Management Practices"

Statements	Answer	N	%	M	SD
I regularly prepare financial plans and budgets to manage farm operations.	1	3	1.30	4.17	0.864
	2	8	3.48		
	3	27	11.74		
	4	100	43.48		
	5	92	40.00		
I diversify income sources (e.g., agriculture, tourism, crafts) to reduce financial risk.	1	2	0.87	4.22	0.798
	2	8	3.48		
	3	17	7.39		
	4	113	49.13		
	5	90	39.13		
I maintain financial reserves or savings to cover unexpected expenses.	1	2	0.87	4.31	0.790
	2	7	3.04		
	3	14	6.09		
	4	102	44.35		
	5	105	45.65		
I collaborate with other farms or local businesses to share financial risks.	1	2	0.87	4.27	0.813
	2	9	3.91		
	3	14	6.09		
	4	105	45.65		
	5	100	43.48		

Source: Authors' calculations

Table 5 presents respondents' answers regarding perceived effectiveness of financial management practices. The results suggest that respondents generally perceive their financial management practices as effective in mitigating financial risks. The highest

mean values were observed for marketing and promotional activities ($M = 4.38$) and collaboration with local stakeholders ($M = 4.36$), indicating that these practices are considered particularly impactful. In terms of percentages, more than half of the respondents strongly agreed that collaboration strengthens their financial position (51.74%) and that marketing activities help stabilize farm income (50.87%). Preparing financial plans and budgets ($M = 4.17$) and diversification ($M = 4.17$) were also rated positively, with over 80% of respondents agreeing or strongly agreeing (categories 4 and 5).

Table 5. Results regarding the scale “Perceived Effectiveness”

Statements	Answer	N	%	M	SD
My current financial management practices adequately protect me from financial risks.	1	3	1.30	4.17	0.879
	2	9	3.91		
	3	27	11.74		
	4	97	42.17		
	5	94	40.87		
Diversification has improved the financial resilience of the farm.	1	2	0.87	4.17	0.826
	2	10	4.35		
	3	20	8.70		
	4	113	49.13		
	5	85	36.96		
Collaboration with local stakeholders strengthens my financial position.	1	3	1.30	4.36	0.833
	2	7	3.04		
	3	14	6.09		
	4	87	37.83		
	5	119	51.74		
Marketing and promotional activities help stabilize the farm’s income.	1	2	0.87	4.38	0.793
	2	9	3.91		
	3	6	2.61		
	4	96	41.74		
	5	117	50.87		

Source: Authors’ calculations

Hypotheses testing and discussion of research findings

A one-way ANOVA (Table 6) was conducted to examine the effect of age on financial risk (hypothesis 1). The analysis revealed a statistically significant difference in perceived financial risk across age groups, $F(4,225) = 3.62, p = 0.007$. This means that age of the respondents influences how they perceive financial risk.

Table 6. One way ANOVA results for Hypothesis 1

Source	Sum of Squares (SS)	df	Mean Square (MS)	F	Sig.
Between Groups	7.909	4	1.977	3.62	0.007
Within Groups	122.891	225	0.546		
Total	130.799	229			

Source: Authors’ calculations

The Tukey HSD results (Table 7) reveal that significant differences in perceptions were found between certain age groups. Specifically, respondents up to 20 years reported significantly lower values compared to those aged 41–50 years ($p < 0.05$), indicating that younger farm owners perceive financial risks less strongly than middle-aged owners. Similarly, respondents aged 31–40 years differed significantly from those aged 41–50 years ($p < 0.05$), with the middle-aged group again reporting higher values. No other pairwise comparisons reached statistical significance, as indicated by non-significant p -values across the remaining age categories.

These findings suggest that middle-aged farm owners (41–50 years) consistently perceive financial risks more strongly than both younger (up to 20 years) and slightly younger middle-aged groups (31–40 years).

Table 7. Tukey HSD: Multiple comparisons for Hypothesis 1

(I) Age	(J) Age	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1 (Up to 20)	2	-0.569	0.249	0.153	-1.25	0.11
	3	-0.384	0.243	0.512	-1.05	0.28
	4	-.747*	0.239	0.017	-1.41	-0.09
	5	-0.477	0.249	0.312	-1.16	0.21
2 (From 21 to 30)	1	0.569	0.249	0.153	-0.11	1.25
	3	0.185	0.147	0.717	-0.22	0.59
	4	-0.178	0.14	0.709	-0.56	0.21
	5	0.091	0.157	0.977	-0.34	0.52
3 (From 31 to 40)	1	0.384	0.243	0.512	-0.28	1.05
	2	-0.185	0.147	0.717	-0.59	0.22
	4	-0.363*	0.13	0.046	-0.72	0
	5	-0.093	0.148	0.97	-0.5	0.31
4 (From 41 to 50)	1	0.747*	0.239	0.017	0.09	1.41
	2	0.178	0.14	0.709	-0.21	0.56
	3	0.363*	0.13	0.046	0	0.72
	5	0.27	0.141	0.316	-0.12	0.66
5 (Above 50)	1	0.477	0.249	0.312	-0.21	1.16
	2	-0.091	0.157	0.977	-0.52	0.34
	3	0.093	0.148	0.97	-0.31	0.5
	4	-0.27	0.141	0.316	-0.66	0.12

* The mean difference is significant at the 0.05 level.

Source: Authors' calculations

The results of homogeneous subsets (Table 8) indicate a split: younger/older groups perceive less risk, while middle-aged groups perceive more.

Table 8. Tukey HSD: Means for groups in homogeneous subsets (Hypothesis 1)

Age	N	Subset for alpha = 0.05	
		1	2
1 (Up to 20)	11	3.66	
3 (From 31 to 40)	58	4.04	4.04
5 (Above 50)	44	4.14	4.14
2 (From 21 to 30)	45		4.23
4 (From 41 to 50)	72		4.41
Sig.		0.095	0.32

Source: Authors' calculations

Furthermore, another one-way ANOVA (Table 9) was conducted to examine the effect of education level on financial management practices (hypothesis 2). The analysis revealed a statistically significant difference among the groups, $F(3, 226) = 46.65$, $p < 0.001$, indicating that education level accounts for a considerable proportion of the variance in financial management practices.

Table 9. One way ANOVA results for Hypothesis 2

	Sum of Squares (SS)	df	Mean Square (MS)	F	Sig.
Between Groups	46.655	3	15.552	46.654	0
Within Groups	75.335	226	0.333		
Total	121.99	229			

Source: Authors' calculations

The Tukey HSD analysis (Table 10) reveals strong and consistent differences across education levels. Respondents with primary school education reported significantly lower values compared to all other groups ($p < 0.001$), indicating that limited formal education is associated with weaker perceptions of management practices. In contrast, those with university (faculty) education scored significantly higher than all other groups, underscoring the positive influence of advanced education on financial risk awareness and management practices. Differences between secondary school and college were not statistically significant, suggesting that these two groups share similar perceptions. However, both groups reported significantly lower values than university graduates, highlighting a clear stepwise progression in perceptions as education level increases.

Overall, the findings emphasize that education is a critical determinant of how farm owners perceive and evaluate financial risks and management practices.

Table 10. Tukey HSD: Multiple comparisons for Hypothesis 2

(I) Education		Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1 (Primary school)	2	-1.464*	0.150	0.000	-1.85	-1.08
	3	-1.579*	0.150	0.000	-1.97	-1.19
	4	-1.871*	0.163	0.000	-2.29	-1.45
2 (Secondary school)	1	1.464*	0.150	0.000	1.08	1.85
	3	-0.116	0.089	0.559	-0.35	0.11
	4	-0.408*	0.109	0.001	-0.69	-0.13
3 (College)	1	1.579*	0.150	0.000	1.19	1.97
	2	0.116	0.089	0.559	-0.11	0.35
	4	-0.292*	0.109	0.040	-0.57	-0.01
4 (Faculty)	1	1.871*	0.163	0.000	1.45	2.29
	2	0.408*	0.109	0.001	0.13	0.69
	3	0.292*	0.109	0.040	0.01	0.57

Source: Authors' calculations

The analysis presented in Table 11 revealed three homogeneous subsets. Education level 1 ($M = 2.78$) formed its own subset, reflecting significantly lower financial management practices compared to all other groups. Education levels 2 ($M = 4.24$) and 3 ($M = 4.36$) clustered together, indicating no significant difference between them. Education level 4 ($M = 4.65$) formed a separate subset, reflecting the highest perceptions of management practices.

Table 11. Tukey HSD: Means for groups in homogeneous subsets (Hypothesis 2)

Education	N	Subset for alpha = 0.05		
		1	2	3
1 (Primary school)	18	2.78		
2 (Secondary school)	86		4.24	
3 (College)	84		4.36	4.36
4 (Faculty)	42			4.65
Sig.		1	0.813	0.119

Source: Authors' calculations

Finally, a one-way ANOVA was conducted to examine whether farm owners' years of experience in rural tourism influenced their perceptions of financial management practices effectiveness in mitigating financial risks (hypothesis 3).

The results (Table 12) indicated that there was no significant effect of experience level on perceived financial management effectiveness, $F(2, 227) = 0.16$, $p = 0.848$. The between-groups variance ($MS = 0.094$) was negligible compared to the within-groups

variance ($MS = 0.571$), suggesting that differences in experience did not account for meaningful variation in financial management practices effectiveness scores.

Table 12. One way ANOVA results for Hypothesis 3

	Sum of Squares (SS)	df	Mean Square (MS)	F	Sig.
Between Groups	0.188	2	0.094	0.164	0.848
Within Groups	129.724	227	0.571		
Total	129.912	229			

Source: Authors' calculations

Across the conducted statistical analyses, Hypotheses 1 and 2 were supported, while Hypothesis 3 was rejected. Results from the one-way ANOVA revealed significant differences across socio-demographic groups, and subsequent Tukey HSD post-hoc tests clarified the specific group contrasts. Education emerged as a particularly strong determinant of financial management practices, with higher levels of formal education consistently associated with more advanced and effective management approaches. Age demonstrated a non-linear influence: middle-aged respondents perceived financial risks more acutely than both younger and older groups. In contrast, years of experience in farming did not significantly affect perceptions of management practices, suggesting that longevity in the sector alone does not necessarily translate into greater confidence in financial risk mitigation. Taken together, these findings highlight that education and life stage are more influential than experience in shaping how farm owners conceptualize and evaluate financial management practices in the context of risk.

The implications of these findings are multifaceted. The findings underscore the need for targeted training and capacity-building programs, as formal education and life-stage factors appear more decisive than experience alone in shaping effective financial management practices. These insights can inform the design of support initiatives by rural tourism associations and policymakers. Finally, the findings highlight the necessity of integrating financial risk management into broader rural development policies, ensuring that farm owners are equipped not only with practical skills but also with strategic approaches to sustain their enterprises in the face of uncertainty.

Conclusion

The findings presented in this paper highlight the complex interplay between age and education in shaping financial management practices and perceptions of financial risk among farm owners engaged in rural tourism. Education emerged as the most consistent and influential factor, with higher levels of formal education associated with more advanced and effective financial management practices. Age demonstrated a non-linear effect, with middle-aged groups perceiving financial risks more strongly than both younger and older groups, suggesting that life-stage responsibilities may heighten sensitivity to financial uncertainty. In contrast, years of experience in rural tourism did not significantly influence perceptions of financial management practices, indicating

that longevity in the field alone does not necessarily translate into greater confidence in financial risk mitigation. Taken together, these results underscore the importance of formal education and additional training of farmers to financial risk mitigation and financial literacy.

Overall, the findings highlight that farm owners view external, uncontrollable factors and increasing operational costs as the most critical financial risks, while also acknowledging the substantial impact of tourism seasonality and infrastructure investments. Furthermore, farm owners place considerable emphasis on proactive financial planning, diversification, savings, and collaboration, reflecting a comprehensive approach to managing financial risks in rural tourism.

This research has certain limitations. First, reliance on an online questionnaire may have excluded farm owners with limited internet access, potentially biasing the sample toward more digitally connected respondents. Second, the research was conducted within a single national context (Serbia), which restricts the generalizability of findings to other regions with different agricultural, economic, or policy environments.

Future research should therefore consider employing mixed method approaches to capture richer insights into farmers' perceptions, while also expanding to cross-country comparative studies to examine how cultural, institutional, and market differences shape management perspectives. Additionally, longitudinal research could provide valuable evidence on how perceptions of financial risks and financial management practices evolve over time, particularly in response to external shocks such as policy changes or climate events.

Conflict of interests

The authors declare no conflict of interest.

References

1. Agriculture Institute (2025). *Understanding Farmers' Perception of Risk in Agriculture*. <https://agriculture.institute/farm-cost-mgt/farmers-perception-risk-agriculture/>
2. Allahverdiyev, E., Rao, X., & Trujillo-Barrera, A. (2025). Farm liquidity and business risk from the risk balancing perspective: evidence from selected U.S. states. *Journal of Economics and Finance*, 49, 710–732. <https://doi.org/10.1007/s12197-025-09722-0>
3. Baby, J., & Kim, D.-Y. (2024). Sustainable Agritourism for Farm Profitability: Comprehensive Evaluation of Visitors' Intrinsic Motivation, Environmental Behavior, and Satisfaction. *Land*, 13(9), 1466. <https://doi.org/10.3390/land13091466>

4. Božić, K., & Knežević, V. (2025). Activity-based costing as a function of information support for modern management . *Oditor*, 11(2), 127-148. <https://doi.org/10.59864/Oditor62502KB>
5. Dašić, B. (2025). Analysis of public finance management reform within the comprehensive public administration reform. *Management horizons*, 5(1), 55–71. <https://hm.edu.rs/index.php/hm/article/view/6>
6. Dašić, D., Kostadinović, G., & Ilievska Kostadinović, M. (2024). Cultural tourism and its impact on the economic development of local communities. *Management horizons*, 4(1), 9–20. <https://hm.edu.rs/index.php/hm/article/view/11>
7. Dejanović, A., & Lukić Nikolić, J. (2024). The role of agricultural cooperatives in the development and promotion of rural tourism: A case study of Azanja, Serbia. *Marketing*, 55(4), 269–281. <https://doi.org/10.5937/mkng2404269D>
8. Dejanović, A., Lukić Nikolić, J., & Ljubojević, Lj. (2024). Assessing and managing territorial capital for rural tourism development: Findings from field research in Azanja (Republic of Serbia). *Economic of Agriculture*, 71(4), 1401–1420. <https://doi.org/10.59267/ekoPolj24041401D>
9. DeVellis, R. F. (2003). *Scale development: Theory and applications*. Thousand Oaks, California: Sage.
10. Duong, T. T., Brewer, T., Luck, J., & Zander, K. (2019). A Global Review of Farmers’ Perceptions of Agricultural Risks and Risk Management Strategies. *Agriculture*, 9(1), 10. <https://doi.org/10.3390/agriculture9010010>
11. Dwangu, A. M., & Mahlangu, V. P. (2021). Accountability in the financial management practices of school principals. *International Journal of Educational Management*, 35(7), 1504–1524. <https://doi.org/10.1108/IJEM-06-2021-0243>
12. Girma, Y., Kuma, B., & Bedemo, A. (2023). Risk Aversion and Perception of Farmers about Endogenous Risks: An Empirical Study for Maize Producers in Awi Zone, Amhara Region of Ethiopia. *Journal of Risk and Financial Management*, 16(2), 87. <https://doi.org/10.3390/jrfm16020087>
13. Gottlieb, U., & Hansson, H. (2024). Farmers’ Financial Literacy-Scale Development and Linkages to Accounting Practices and Financial Outcomes. *Agribusiness: An International Journal*, 1–16. <https://doi.org/10.1002/agr.21986>
14. Grillini, G., Streifeneder, T., Stotten, R., Schermer, M., & Fischer, C. (2025). How tourists change farms: The impact of agritourism on organic farming adoption and local community interaction in the Tyrol-Trentino mountain region. *Journal of Rural Studies*, 114, 103531. <https://doi.org/10.1016/j.jrurstud.2024.103531>
15. Hasan, M., Jannah, M., Supatminingsih, T., Ahmad, M. I. S., Sangkala, M., Najib, M., & Elpisah. (2024). Understanding the role of financial literacy, entrepreneurial literacy, and digital economic literacy on entrepreneurial creativity and MSMEs success: a knowledge-based view perspective. *Cogent Business & Management*, 11(1), 2433708. <https://doi.org/10.1080/23311975.2024.2433708>

16. Janković, G., & Golubović, M. (2025). Circular economy as the basis of today's sustainable development. *Održivi razvoj*, 7(1), 31-62. <https://doi.org/10.5937/OdrRaz2501031J>
17. Kesanta, M. N., Makuya, V., & Makona, A. (2025). Risk management practices and financial sustainability: Evidence from savings and credit cooperative societies in Tanzania. *Cogent Business & Management*, 12(1). <https://doi.org/10.1080/23311975.2025.2563034>
18. Klapper, L., & Lusardi, A. (2020). Financial literacy and financial resilience: Evidence from around the world. *Financial Management*, 49, 589–614. <https://doi.org/10.1111/fima.12283>
19. Komarek, A. M., De Pinto, A., & Smith, V. H. (2020). A review of types of risks in agriculture: What we know and what we need to know. *Agricultural Systems*, 178, 102738. <https://doi.org/10.1016/j.agsy.2019.102738>
20. Koomson, I., Ansong, D., Okumu, M., & Achulo, S. (2022). Effect of Financial Literacy on Poverty Reduction Across Kenya, Tanzania, and Uganda. *Global Social Welfare*, 10(1), 93–103. <https://doi.org/10.1007/s40609-022-00259-2>
21. Lin, X., & Lai, Q. (2025). How does rural tourism affect farmers' subjective well-being? The mediating role of farmers' livelihoods. *Acta Psychologica*, 261, 105807. <https://doi.org/10.1016/j.actpsy.2025.105807>
22. Liu, B., Ren, B., & Jin, F. (2025). Does climate risk affect the ease of access to credit for farmers? Evidence from CHFS. *International Review of Economics & Finance*, 97, 103813. <https://doi.org/10.1016/j.iref.2024.103813>
23. Mangana, K. M., Ndyetabula, D. W., & Hokororo, S. J. (2023). Financial management practices and performance of agricultural small and medium enterprises in Tanzania. *Social Sciences & Humanities Open*, 7(1), 100494. <https://doi.org/10.1016/j.ssaho.2023.100494>
24. Michels, M., Wever, H., Ölkens, T., Rieling, J. A., Barenbräuker, R., & Mußhoff, O. (2025). Classifying agricultural risk management strategies: A cluster analysis approach. *Canadian Journal of Agricultural Economics/Revue canadienne d'agroeconomie*, 73, 292–308. <https://doi.org/10.1111/cjag.70006>
25. Mihailović, B. M., Radosavljević, K., Paraušić, V., & Pantović, D. (2025). Institutional and financial conditions for the development of rural tourism in the Republic of Serbia: A case study. *Economic of Agriculture*, 72(3), 885–904. <https://doi.org/10.59267/ekoPolj2503885M>
26. Mirković, S., Ranisavljević, M., Jovanović, V., & Mirković, L. (2025). The impact of diversification strategy on corporate financial performance. *Akcionarstvo*, 31(1), 85-96. <https://doi.org/10.65772/ak202517>

27. Musah, A., Gakpetor, E. D., & Pomaa, P. (2018). Financial management practices, firm growth and profitability of small and medium scale enterprises (SMEs). *Information management and business review*, 10(3), 25–37. <https://ojs.amhinternational.com/index.php/imbr/article/view/2461/1696>
28. Ndhlovu, E., & Dube, K. (2024). Agritourism and sustainability: A global bibliometric analysis of the state of research and dominant issues. *Journal of Outdoor Recreation and Tourism*, 46, 100746. <https://doi.org/10.1016/j.jort.2024.100746>
29. Ostojić, B., Petrović, V., & Despotović, D. (2025). Consumer perceptions of geographical indications, branding, and intellectual property in the agricultural sector. *Economic of Agriculture*, 72(4), 1359–1374. <https://doi.org/10.59267/ekoPolj250413590>
30. Ostojić, B., Sekulić, D., & Mićović, A. (2025). Green marketing as a factor of sustainable rural tourism in the Đurđevica Tara national park. *Economic of Agriculture*, 72(2), 645–663. <https://doi.org/10.59267/ekoPolj25026450>
31. Paunić, M., Tešanović, D., Vujasinović, V., Lazarević, J., Gagić Jaraković, S., Ćirić, M., Vulić, G., & Aleksić, S. (2025). Farmers' Attitudes Towards the Diversification of Agricultural Sustainable Production in Tourism in Vojvodina Province (Republic of Serbia). *Agriculture*, 15(17), 1895. <https://doi.org/10.3390/agriculture15171895>
32. Rosić, M., & Vilma Getman, R. (2025). Menadžerski aspekti timova i grupa. *Finansijski Savetnik*, 30(1), 95-105. <http://fa-journal.com/index.php/fa/article/view/5>
33. Stearns, S., Ghimire, S., & Lentz, E. (2025). *Best Practices in Agritourism: Business Planning and Risk Management for Farmers*. University of Connecticut. <https://doi.org/10.61899/ucext.v2.098.2025>
34. Turtureanu, A.-G., Crețu, C.-M., Pripoaie, R., Marinescu, E. Ș., Sîrbu, C.-G., & Talaghir, L.-G. (2025). Sustainable Development Through Agritourism and Rural Tourism: Research Trends and Future Perspectives in the Pandemic and Post-Pandemic Period. *Sustainability*, 17(9), 3998. <https://doi.org/10.3390/su17093998>
35. Twumasi, M. A., Lai, B., Huang, Z., Wu, H., & Jiang, W. (2026). Financial literacy and tourism market participation among rural households in Ghana: A human capital perspective. *Tourism Management Perspectives*, 62, 101475. <https://doi.org/10.1016/j.tmp.2026.101475>
36. Vanhuyse, F., Bailey, A., & Tranter, R. (2021). Management practices and the financial performance of farms. *Agricultural Finance Review*, 81(3), 415–429. <https://doi.org/10.1108/AFR-08-2020-0126>

37. Vučić, V. (2024). Challenges of sustainable rural development of regions of the republic of Serbia. *Management horizons*, 4(1), 123–152. <https://hm.edu.rs/index.php/hm/article/view/19>
38. Wolf, C. A., & Karszes, J. (2023). Financial risk and resiliency on US dairy farms: Measures, thresholds, and management implications. *Journal of Dairy Science*, 106(5), 3301–3311. <https://doi.org/10.3168/jds.2022-22711>
39. Yang, J., Tang, D., Kong, H., & Boamah, V. (2022). Research on financial risk management and control of agricultural products supply chain - A case study of Jiangsu Province of China. *Frontiers. Sec. Environmental Economics and Management*, 10, 1008716. <https://doi.org/10.3389/fenvs.2022.1008716>
40. Yusriadi, Y., Cahaya, A., & Masriadi, M. (2024). Tourism and farmers' economic transformation: lessons from North Toraja. *Frontiers in Sustainable Food Systems*, 8, 1487452. <https://doi.org/10.3389/fsufs.2024.1487452>

ADDING VALUE TO PLUM AS A POSSIBILITY OF ECONOMICS SUSTAINABILITY OF ITS PRODUCTION

Zorica Sredojević¹, Sandra Jagodić Rusić², Jasmina Poštin³

*Corresponding author E-mail: zokas@agrif.bg.ac.rs

ARTICLE INFO

Original Article

Received: 24 July 2026

Accepted: 14 August 2026

doi:10.59267/ekoPolj2603915S

UDC 330.342.146:634.22

Keywords:

fresh and dried plum, plum brandy, adding value to plum, economic sustainability of production of plum

JEL: D13; Q12; Q22

ABSTRACT

The subject of this research is plum production and the possibility of improving its economic value. The aim is to examine the economic justification of investing in dryers and distilleries. Three variants were analyzed: production and sale of fresh plum; dried plum; and plum brandy. From 100 kg of fresh plum, 25 kg of dried plum are obtained (ratio 1:4) with an average humidity of 26%, and from 100 kg of fresh plum, about 16.5 l of brandy (ratio 1:6) with an alcohol strength of about 40-45%, and in both variants, the economic value of plum is about 6 times higher. For every 100 euro invested, 36 euro of accumulation is achieved for fresh plum, 187 euro for dried plum and 171 euro for plum brandy. The cost-effectiveness coefficient for the variants ranges from 2.11 to 2.59, and the payback period is from half a year to two years. Adding value to plum through drying and producing plum brandy achieves good economic results, long-term stability and economic sustainability of its production.

Introduction

In terms of its useful value and economic importance, plum (*Prunus domestica* L.) occupies a significant place in fruit production, both in Serbia and in the world (Mišić, 2006; Milatović, 2023). Of the total plum production in the world, about 2/3 is made up of Chinese-Japanese plum. The largest areas under plum in Serbia are located in the region of Shumadiya and Western Serbia, with a share of 67% (Gazdić et al., 2024). In

-
- 1 Zorica Sredojević, PhD, Full Professor, University of Belgrade - Faculty of Agriculture, Nemanjina 6, 11080 Belgrade - Zemun, Serbia, Phone: +38111441 3297, E-mail: zokas@agrif.bg.ac.rs, ORCID ID (<https://orcid.org/0000-0001-7224-1573>)
 - 2 Sandra Jagodić Rusić, Ph.D., Assistant Professor, MB University, Faculty of Business and Law, Teodora Drajzera br. 27, 11040 Beograd, Serbia, Phone: +381113391641, E-mail: aleksandra@rusic.rs, ORCID ID (<https://orcid.org/0009-0005-3876-7615>)
 - 3 Jasmina Poštin, Ph.D., Assistant Professor, University Union Nikola Tesla, Faculty of Management FAM, Address: Njegoševa 1a, 21205 Sremski Karlovci, Serbia, Phone: +381692576288, E-mail: jasminapostin@gmail.com, ORCID ID (<https://orcid.org/0000-0003-3707-7522>)

Serbia, European plum are almost exclusively grown commercially. (Milatović, 2019). The Stanley variety dominates the plantations, followed by the Čačanska rodna and Čačanska lepotica, and to a lesser extent the table varieties Čačanska rana and Čačanska sabrava are also present. In agricultural practice, Serbia has a high prevalence of old indigenous plum varieties, which give low and variable yields (Urošević, 2015). Due to the great interest in the production of brandy, the indigenous plum variety Crvena Ranka is increasingly being cultivated (Cvetković & Glišić, 2020; Milatović, 2023). In well-maintained plum plantations, with proper application of agricultural and support techniques, yields range between 20 and 30 t/ha (Mišić, 2006; Keserović et al., 2016). On the holdings where there are driers and distilleries, the remains of plum pruning are also significant. The weight of the remains of pruned mass in plum is from 2,895 to 4,780 kg/ha (Mika et al., 2015). The plum fruit is mainly used for fresh consumption, to obtain dried plum, brandy, juices, jams and jellies (Mahato et al., 2015; Milatović, 2023). Plum fruits are known for their nutritional and health values (Ertekina et al., 2006; Paraušić et al., 2025). Since ancient times, plum has been used for various health problems (Milošević et al., 2008; Matković, 2015).

Plum plantations are suitable for growing on soils of various configurations and positions, and plum fruits are good raw materials for processing (Blagojević & Božić, 2012; Mahato et al., 2015). Before planting plum, special attention should be paid to the choice of varieties cultivation method, cultivation form and production purpose (Milovanović et al. 2018). When establishing new plantings, more space should be given to new and more resistant plum varieties (Keserović et al., 2014). Pruning residues from fruit and viticulture production can be used as high-quality organic fertilizer (Bakhsh et al., 2022). Mechanical harvesting of plum allows for a significant reduction in harvesting costs, and therefore overall costs. The share of quality fruit within the mechanically harvested yield is around 80% (Mika et al., 2015). Harvest losses can be reduced by 5-9% if plum are harvested at the appropriate fruit maturity (Shahzad et al., 2013).

Processed fruit has advantages in strengthening the export capacities of the Serbian economy (Milošević et al., 2008). Every energy-saving process for drying plum has been accepted in the industry. Applying pretreatment to fresh plum is suitable for reducing the drying time of plum, while maintaining high quality and saving energy (Hedayatizadeh & Chaji, 2016; Seočanac et al., 2026). Plum processing depends on the process of drying, canning, preparation of jams, jellies, drinks, wine and brandy (Somogay, 2005). About 75% of the world's total prune supply is produced in California and the Pacific Northwest (Bhutani & Joshi, 1995; Gazdić et al., 2024). Plum brandy is one of the traditional Serbian products often produced in rural households (Ognjanov et al., 2007; Vakula, 2020). Since 2007, our plum brandy has been protected as a Serbian brand with a geographical origin in the EU under the name „Serbian Slivovitz“ (Milatović, 2023). In Serbia, about 66% of the total plum produced are processed into brandy, 7.20% are used for table use, 3.40% are used for the production of dried plum, while slightly more than 20% are processed into jam, compote, jam, juices and other products (Ognjanov et

al., 2007). The largest amount of plum in BiH is sold fresh (94.98%), dried plum in very small quantities, only 3.01%, while a smaller part of plum is processed into brandy, so-called plum brandy 2.01% (Spahić-Vukojević & Direk, 2021). When choosing a variety of plum for the production of brandy, one should take into account the characteristics of the fruit that affect the quality and yield of the plum wine (Popović et al., 2008). Modern technology imposes the need to apply an engineering approach in the production of brandy (Somsen & Capelle, 2002). In Serbia, for practical reasons, soft brandies are expressed in liters, with a certain ethanol content (most often between 25 and 30 vole %), which is obtained by processing 100 kg of raw material (Popović et al., 2008). In countries with developed fruit growing, producer associations monitor the state of fruit production in the country and in the surrounding area, as well as in more important competitor countries, and based on this data, they plan the production structure and assortment in fruit growing in their own country (Sredojević, 2011). The Serbian plum trade is characterized by a low degree of marketability and competitiveness on the international market (Radosavljević, 2015). For successful product placement, it is important to know the desires and attitudes of consumers (Vávra et al., 2006).

Investing in the raising and exploitation of plantations is a complex and responsible business. Mistakes made during planting cannot be corrected during their exploitation (Sredojević, 1998; Sredojević et al., 2024). Production in orchards is largely dependent on natural conditions and is conditioned by numerous risks, such as: founding, breeding, production, market, financial and others (Sredojević & Mojsijev, 2013; Sredojević et al., 2024). In family-owned businesses, social responsibility represents a commitment to improving the well-being of the community through voluntary business practices (Kotler & Lee, 2009; Bogdanović & Hadžić, 2019). In line with technical, technological, organizational and economic changes in family farm operations, new conditions are being created for the production and processing of plum (Sredojević et al., 2024). The subject of this research is the analysis of plum production and the possibility of improving its economic value. The aim of the research is to analyze the state, conditions and economic justification of investing in plum production and processing in order to ensure the sustainability of its production.

Materials and Methods

For the analysis of areas and yields of plum production in the world and in Serbia, statistical data bases were used, namely: Food and Agriculture Organization (FAO) and the Republic Institute for Statistics of Serbia (SORS). The key source of data for the needs of this research is a survey conducted over three consecutive years with representative plum producers, owners of dryers and distilleries in the area of Shumadiya and Western Serbia. According to the collected data, using the norms of production and technological operations and published results in scientific and professional papers, investment models were compiled for the establishment and exploitation of plum plantations, as well as for the capacities for its processing. By applying statistical and calculative methods, economic indicators were determined, of which the most important are: average net

profit, accumulation rate and return on investment period (Andrić et al., 2005; Sredojević et al., 2025). The average net profit (PND) is determined as the quotient of the sum of the net profit per individual year with the number of years of the analyzed period (in this case, six years). This value is compared with the marginal net profit (GND), whose value is most often taken as zero euro, and the higher the average net profit is than the marginal, the more economically efficient the production is for the producer, and vice versa. Accumulation rate (SA) represents the quotient between the average net profit (PND) and the total investments in the investment (UU), and considering that it is a rate as a relative number, in the end this amount is multiplied by 100%. This rate is compared with the threshold value of the accumulative rate (GSA) and based on the difference, an investment assessment is made. The limiting rate of accumulateness was taken as 20%. The higher the calculated planned accumulation rate is than the limit, the more favorable it is and vice versa. In addition to this, the accumulative rate provides an answer to the question: - How much is financially gained for each euro of invested capital? The return on investment period (RPP) represents the quotient between the total investment (UU) and the average net profit (PND) and is expressed in years. For evaluation, this period is compared with the planned six-year period of use of the investment.

Three variants of the economic effects of plum were analyzed in the paper: Variant I – investing in raising and exploiting 1 ha of plantations and selling plum fresh; Variant II - investing in raising and exploiting 1 ha of plum plantations, investing in a dryer and selling prunes with an average moisture content of 26%; Variant III – investment in the establishment and exploitation of 1 ha of plum plantations, investment in a distillery and sale of plum brandy, i.e. plum wine with a strength of around 40-45% alcohol. Variants II and III relate to adding value to plum in order to make their production economically sustainable. According to the defined criteria for each of the mentioned indicators, ratings were determined, based on which a fairly reliable picture of the efficiency and economic justification of investing in all three varieties of plum production and processing was given.

Results and Discussion

The area under plum plantations in the world, looking at the continents, is mostly located in Asia, 78.62%, followed by Europe, 16.05%, then America, 3.08%, and Africa, 2.12%, and the smallest share is in Oceania, 0.13%. In total plum production in the world, the leading place belongs to Asia, with a share of 65.86%, followed by Europe, 22.24%, America, 8.15%, Africa, 3.58%, and Oceania, 0.17% (FAO, 2025). According to yields per unit area, the leading place belongs to America with an average yield over a ten-year period of 12.00 t/ha, followed by Africa with an average yield of 7.61 t/ha, Europe 6.32 t/ha, Oceania 6.18 t/ha and Asia with 3.78 t/ha (FAO, 2025). The highest yields per unit area are achieved in America (12.00 t/ha), followed by Africa (7.61 t/ha), Europe (6.32 t/ha) and Oceania (6.18 t/ha) whose yields are higher than the world average. Finally, Asia (3.78 t/ha) follows, whose yield is below the world average. During the analyzed period 2014-2023, the highest average plum production in the world was achieved in

China with 6,599,066.00 tons, then in Romania with 621,562.00 tons, and in third place is Serbia with 460,025.00 tons (FAO, 2025). During the same period, Serbia, with an average yield per unit area of 5.82 t/ha, is far behind the leading countries, among which Chile is the leader with an average yield for the analyzed period of 22.86 t/ha (Table 1).

Table 1. Average volume of production, structure and average yield of plum in certain leading countries and in the world during the period 2014-2023

Country /World	Volume and structure of production		Average yield (t/ha)
	t	Share (%)	
China	6,599,066.00	55.39	3.42
Romania	621,562.00	5.22	9.36
Serbia	460,025.00	3.86	5.82
Chile	370,764.00	3.11	22.86
USA	331,873.00	2.79	14.65
Turkey	306,533.00	2.57	13.82
Iran	305,981.00	2.57	16.86
Italy	194,710.00	1.63	15.71
Ukraine	181,886.00	1.53	10.13
France	178,600.00	1.50	11.61
Other countries	2,363,111.00	19.83	-
World:	11,914,111.00	100.00	-

Source: Author's calculation based on FAO data <https://www.fao.org/faostat/>

Plum are grown throughout Serbia, with the following districts being the most prominent: Kolubara, Toplica and Šumadiya. The leading municipalities in terms of plum plantation areas are: Valjevo, Prokuplje, Kragujevac, Užice and Blace. In terms of plantations, Topola is in first place, followed by Leskovac, Prokuplje, Kragujevac and Šabac. According to statistical data, the amounts for areas, production and average yield of plum in Serbia in the period 2014-2023 are given in Table 2.

Table 2. Average amounts and indices for areas, volume of production and average yield of plum in Serbia during the period 2014-2023.

Year	Area		Production volume		Average yield	
	ha	Index (2014=100)	t	Index (2014=100)	t/ha	Index (2014=100)
2014	75,626.00	100.00	421,529.00	100.00	5.6	100.00
2015	74,172.00	98.10	354,890.00	84.19	4.8	85.71
2016	73,319.00	96.95	471,442.00	111.84	6.4	114.28
2017	72,024.00	95.24	330,582.00	78.42	4.6	82.14
2018	72,224.00	95.52	430,199.00	102.06	6.0	107.14
2019	72,316.00	95.62	558,930.00	132.60	7.7	137.50
2020	73,010.00	96.54	582,547.00	138.20	8.0	142.85
2021	72,569.00	95.96	412,778.00	97.92	5.7	101.79
2022	72,323.00	95.63	448,593.00	106.42	6.8	121.43
2023	74,418.00	98.40	362,713.00	86.05	4.9	87.50

Source: Author's calculation based on SORS data, Statistical yearbooks, 2014–2023, <https://www.stat.gov.rs/>

During the analyzed period 2014-2023, the average area under plum plantations decreased slightly, with annual oscillations of 2 to 5% compared to the base year 2014. The volume of production varied by year, with a decrease of up to 22% in 2017 and an increase of up to 39% in 2020 compared to the base year 2014. The average yield had a similar tendency, with a decrease of up to 19% in 2017 and an increase of up to 43% in 2020 compared to 2014. Plum production in the orchard takes place with several work operations during the year, such as: regular pruning, protection from diseases and pests, fertilization, soil cultivation, irrigation, harvesting, etc. The technological map of work operations with the appropriate number of working days of workers and mechanization, as well as the amount and amount of materials used in the production of plum is given in table 3.

Table 3. Technological map of plum production per 1 ha

Work operations	Unit of measure	Amount
Number of working days of the employee		
Pruning	working days	15.00
Feeding	“	0.30
Surface treatment (6x)	“	1.80
Digging around the tree (6x)	“	24.00
Protection (5x)	“	1.50
Green pruning	“	7.00
Harvest	“	15.00
Basic fertilization	“	0.40
Basic processing	“	0.50
Other works	“	2.00
Number of working days for machines		
Feeding	working days	0.20
Surface treatment (6x)	“	1.80
Protection (5x)	“	1.00
Harvest	“	2.00
Basic fertilization	“	0.30
Basic processing	“	0.50
Other works	“	2.00
Type and amount of material used		
Nitrogen fertilizers	kg	400.00
Complex fertilizers	kg	800.00
Packaging (crates)	pieces	500.00
Protective equipment	kg, L	2.00
Manure	t	15.00

Source: Author's specification based on operations of practice

Operations from spring work to plum harvesting alternate throughout the year, and their proper execution directly affects the yield and quality of the fruit. Based on the natural and value amounts of inputs and outputs during the establishment and exploitation of plum plantations, parameters for economic analysis are given (Tab. 4).

Table 4. Plum production and processing parameters

Parameters for economic analysis	Amount
Plum plantation area	1 ha
Average plum yield per 1 ha	28 t
Plum planting period	4 years
Period of exploitation of plum plantations	20 years
Length of period for economic analysis	6 years
Investments in raising plum plantations on the holding	9,700.00 €
Investment investments in a dryer on a family holding	3,200.00 €
Investment investments in a distillery on a family holding	2,600.00 €
Required quantities of fresh plum for 1kg of prunes	4 kg
Required quantities of fresh plum for 1 liter of plum brandy	6 kg
Price of 1 kg of fresh plum	0.30 €
Price of 1 kg of prunes	7.50 €
Price of 1 l of plum brandy	9.20 €

Source: Author's calculation based data of practice

Based on the fact that the average yield of plum in 2025 on the farms analyzed was 28 t/ha and according to the average price of €0.30/kg, the income from the sale of fresh plum in the same year was determined. Then, taking into account the potential risks, the income projection was made for the next five years as well. Also, in accordance with the plum production technology, the costs in 2025 were determined and based on them; the amounts for the next five years were projected. By subtracting the amount of total costs from the total income, the gross profits and net profits from fresh plum were determined for the analyzed six years, in the period of full fertility of the plum plantations (Table 5).

Table 5. Revenues and costs of production and sales of fresh plum - Variant I

Indicator \ Year	2025	2026	2027	2028	2029	2030
Total sales revenue	8,460.00	8,280.00	8,400.00	8,460.00	8,370.00	8,430.00
Total costs	3,807.00	4,240.00	3,780.00	4,230.00	3,770.00	4,220.00
Material costs	1,350.00	1,370.00	1,290.00	1,330.00	1,200.00	1,530.00
Labor costs of workers	960.00	980.00	920.00	980.00	870.00	920.00
Machinery operating costs	777.00	880.00	890.00	850.00	790.00	840.00
Marketing costs	450.00	570.00	530.00	550.00	480.00	510.00
Other expenses	270.00	440.00	430.00	520.00	430.00	420.00
Gross profit	4,653.00	4,040.00	4,620.00	4,230.00	4,600.00	4,210.00
Income tax	930.00	808.00	924.00	846.00	920.00	842.00
Net profit	3,723.00	3,232.00	3,696.00	3,384.00	3,680.00	3,368.00

Source: Author's calculation based data of practice

According to the calculation in table 5, the average net profit from the production and sale of fresh plum is about €3,500/ha. Instead of selling raw plum at often low and unstable prices, drying enables the placement of the final product with significant economic results. The process of drying plum includes several key steps that ensure longevity and quality of the fruit: harvesting and sorting, drying in dryers and final cooling and finishing - calibration and packaging. Plastic bags of 250 to 500 g, as well as cardboard boxes of 1 kg and 12.5 kg are most often used for packing prunes. Among the producers there is a dryer with a capacity of 350 kg of prunes per day. For a yield of 28 t/ha of fresh plum, and with the application of input output norms during drying of plum, the income from the sale of prunes and the total costs of drying and selling prunes with an average humidity of 26% in 2025 were calculated. Then, the amounts of income and expenses for the next five years were projected and the gross profits and net profits were calculated by individual years for the six-year period (Table 6).

Table 6. Revenues and costs of production and sales of prunes - Variant II

Indicator \ Year	2025	2026	2027	2028	2029	2030
Total sales revenue	52,880.00	51,750.00	52,500.00	52,880.00	52,320.00	52,690.00
Total costs	25,390.00	25,880.00	25,500.00	25,920.00	25,150.00	25,300.00
Raw material costs	12,700.00	13,160.00	12,900.00	13,100.00	12,900.00	12,750.00
Labor costs of workers	5,100.00	5,180.00	5,100.00	5,300.00	4,900.00	5,050.00
Machinery operating costs	2,700.00	2,600.00	2,500.00	2,530.00	2,490.00	2,650.00
Energy costs	2,450.00	2,460.00	2,400.00	2,360.00	2,390.00	2,530.00
Packaging costs	770.00	830.00	890.00	870.00	790.00	690.00
Current maintenance costs	630.00	710.00	730.00	750.00	630.00	670.00
Marketing costs	550.00	510.00	520.00	540.00	560.00	530.00
Other expenses	490.00	430.00	460.00	470.00	490.00	430.00
Gross profit	27,490.00	25,870.00	27,000.00	26,960.00	27,170.00	27,390.00
Income tax	5,500.00	5,170.00	5,400.00	5,390.00	5,430.00	5,480.00
Net profit	21,990.00	20,700.00	21,600.00	21,570.00	21,740.00	21,910.00

Source: Author's calculation based data of practice

According to the calculation in table 6, the average net profit from dried plum is about €21,580/ha, which is about six times better than if the plum were sold fresh. The volume of production and the time of arrival of plum should be coordinated with the capacity of the dryer. Operational plans are often drawn up in which the yield per unit area, time and number of days of plum arrival, and even varieties are planned, as well as the capacities of potential plantings from which the required quantity for drying can be provided (Matković, 2015).

In addition to prunes, plum brandy, so-called plum, is a significant product with added value. The production technology of plum wine includes four key steps: harvesting of ripe plum fruits, alcoholic fermentation (boiling), double distillation (roasting) and aging in wooden barrels. With the application of norms in the technology of production of plum wine, for a yield of 20 t/ha of fresh plum, sales revenue, costs of production and sale of brandy with a strength of around 40-45% alcohol, in 2025, were calculated.

Next, the projected amounts of income and expenses for the next five years, as well as gross and net profits by individual years for the six-year period (Table 7).

Table 7. Revenues and costs of production and sales of plum brandy - Variant III

Indicator \ Year	2025	2026	2027	2028	2029	2030
Total sales revenue	43,240.00	42,320.00	42,940.00	43,240.00	42,780.00	43,080.00
Total costs	17,300.00	16,500.00	16,320.00	16,430.00	17,110.00	16,370.00
Raw material costs	8,900.00	8,600.00	8,450.00	8,900.00	9,200.00	9,100.00
Labor costs of workers	2,780.00	2,800.00	2,750.00	2,800.00	2,750.00	2,700.00
Energy costs	1,600.00	1,500.00	1,650.00	1,550.00	1,550.00	1,350.00
Packaging costs	1,300.00	1,250.00	1,350.00	1,150.00	1,330.00	1,050.00
Current maintenance costs	830.00	880.00	890.00	830.00	870.00	910.00
Marketing costs	940.00	840.00	730.00	750.00	790.00	650.00
Other expenses	950.00	930.00	500.00	450.00	620.00	610.00
Gross profit	25,940.00	25,820.00	26,620.00	26,810.00	25,670.00	26,710.00
Income tax	5,188.00	5,164.00	5,324.00	5,362.00	5,134.00	5,342.00
Net profit	20,752.00	20,656.00	21,296.00	21,448.00	20,534.00	21,368.00

Source: Author's calculation based data of practice

According to the calculation in table 7, the average net profit from plum brandy is about 21,000 €/ha, i.e. 0.75 €/kg, which is about six times better than selling plum fresh, while the approximate amount from dried plum is 0.77 euro/kg. By selling fresh plum in bulk, you can quickly make a profit, there is no need to store and protect the product from potential risks.

On the other hand, the production of brandy yields a higher profit per product unit, but it is necessary to store the product until it is sold. The economic indicators of plum production and processing depend on numerous factors, the most important of which are: the amount of total investments in raising plantations, in raising or building a dryer, in purchasing a distillery; the length of the planting period; amount and schedule of net annual benefits; conditions and method of financing plantations; the length of the plantation exploitation period, use of the dryer and distillery, etc (Sredojević et al., 2024).

Given that the analysis period is shorter, 6 years, static methods were applied to the projected amounts of income and costs to assess the economic justification of investments for individual variants. Although the analysis assumes that the plum plantation is in the period of full fruiting, when determining economic indicators, previously made investments in planting the plantation, in the construction of the dryer and the purchase of the distillery were also taken into account. The amounts of the selected indicators were calculated based on the data from the previous tables, and the final amount is given in Table 8.

Table 8. Indicators of economic justification of plum production and processing

Indicators of economic justification production and processing of plum	Amount and fulfillment of criteria by variants		
	Variant I	Variant II	Variant III
UU - total investments (€)	9,700.00	12,900.00	12,300.00
GNI – average gross profit (€)	4,392.00	26,980.00	26,261.00
PND – average net profit (€)	3,514.00	21,585.00	21,009.00
KE – coefficient of economy	2.11	2.16	2.59
SA – accumulation rate (%)	36.23	167.32	170.80
PVU - investment payback period (years)	2.21	0.60	0.47

Source: Authors' calculation

The calculated economic indicators show that investing in all three analyzed variants, under the assumed organizational and economic conditions, is expedient, i.e. economically justified. For every 100 euro of invested funds, about 36 euro of accumulation are achieved by selling fresh plum, 187 euro by selling dried plum and 171 euro by selling plum brandy. Plum production and processing is economical, with the cost-effectiveness coefficient for fresh plum being 2.11, for dried plum 2.16 and for plum brandy 2.59. From the average amounts of net profit, investments in variant I, i.e. in raising plum plantations can be recovered in a period slightly longer than two years, for variant II, in the second half of the first year and for variant III, in the first half of the year of using the investment.

By comparing the economic indicators of all three investment options, it can be concluded that the results for variants II and III are far more favorable than variant I. This means that instead of selling fresh plum, processing plum significantly increases their added value, about 6 times. In this case, the results are somewhat more favorable with the production and sale of brandy compared to the sale of prunes, but in the long term, the choice between these two options depends on the market price of the final products, supply, demand, competition, etc. Thus, the production and sale of prunes or plum brandy provides producers with long-term economic stability and sustainability of plum production, and thus the economic and social security of family members on the holding.

The production and processing of plum on family holdings stimulates the development of other economic activities at the local level. A large number of producers produce plum on small areas, which are irrational, and the often smaller volume of production causes market uncertainty in meeting demand. Therefore, it is convenient for the owners of dryers and distilleries, in addition to producing from their own areas, to purchase fresh plum from smaller producers in the area. With the increase in the areas under plantations and the production and processing of plum, increases employment. Through continuous education of producers, and thus better efficiency in the production and processing of plum, better profitability and economic sustainability of plum production are achieved.

Conclusions

According to the average yield per unit area in the period 2014-2023 in the world, Chile is the leader, with an average yield of 22.86 t/ha. Serbia, with an average yield of 5.82 t/ha, is far behind the leading countries. Adding value to fresh plum through processing is an opportunity for its better profitability and economic sustainability of its production. Investments in a plum dryer and a distillery represent good opportunities for adding value to plum. From an economic perspective, plum brandy is a significant plum product with high added value.

Three variants of the economic effects of plum were analyzed in the paper: Variant I – investing in raising and exploiting 1 ha of plantations and selling plum fresh; Variant II - investing in raising and exploiting 1 ha of plum plantations, investing in a dryer and selling dried plum with an average moisture content of 26%; Variant III – investment in the establishment and exploitation of 1 ha of plum plantations, investment in a distillery and sale of plum brandy, i.e. plum wine with a strength of around 40-45% alcohol. Variants II and III relate to adding value to plum in order to make their production economically sustainable. According to economic indicators, investing in all three analyzed variants is, under assumed organizational and economic conditions, expedient, that is, economically justified. For every 100 euro invested in the production and sale of fresh plum, about 36 euro of accumulation are achieved, with the sale of dried plum 187 euro and the sale of plum brandy 171 euro. The cost-effectiveness coefficient for fresh plum is 2.11, for dried plum 2.16 and for plum brandy 2.59, which means that the production and processing of plum is economical. From the average amounts of net profit, the investments made in variant I, i.e. in raising plum plantations, can be recovered in a period of slightly longer than two years, for variant II, in the second half of the first year and for variant III, in the first half of the year of exploitation of the investment.

A comparative analysis of the economic indicators of all three investment options has shown that the results for variants II and III are far more favorable than for variant I. Instead of selling fresh plum, by drying them, their value increases by about 6 times, while the results are slightly more favorable with the production and sale of plum brandy. For long-term effects, the choice between these two options depends on the market price of the final products, supply, demand, competition, etc.

The production and sale of prunes or plum brandy provides producers with long-term economic stability and sustainability of plum production, and thus the economic and social security of family members on the farm, and encourages the development of other economic activities at the local level. Owners of dryers and distilleries, in addition to production on their own land, purchase fresh plum from smaller producers in the area, which encourages employment, better profitability of business on family farms, and the economic sustainability of plum production in Serbia.

Acknowledgements

This paper is a research result within the “Treaty on the transfer of funds for financing the scientific research work of teaching staff at accredited higher education institutions in 2026 between the Ministry of Science, technological development and innovation of the Republic of Serbia and the Faculty of Agriculture, University of Belgrade” No. 451-03-34/2026-03/200116.

Conflict of interests

The authors declare no conflict of interest.

References

1. Andrić, J., Vasiljević, Z., & Sredojević, Z. (2005). *Investicije - osnove planiranja i analize*. Univerzitet u Beogradu – Poljoprivredni fakultet. [in English: Andrić, J., Vasiljević, Z., & Sredojević, Z. (2005). *Investments - basics of planning and analysis*. University of Belgrade - Faculty of Agriculture]
2. Bakhsh, A.M., Abbas, M., M., Nasir, M., Aziz, M., M., Aslam, K., & Aziz, A. (2022): Comparative Analysis of Different Plum Cultivars on Basis of their Yield and Quality Attributes, *J. Agric. Res.* 2022, 60(2), Vol. 60(2):139-144
3. Bhutani, V.P., & Joshi, V.K. (1995). Plum. In: *Handbook of Fruit Science and Technology: Production, Composition, Storage and Processing* (D.K. Salunkhe and S.S. Kadam, eds.), Marcel Dekker, New York. p. 206
4. Blagojević, R., & Božić, V. (2012). *Tehnologija proizvodnje šljive*. Kancelarija za program podrške u privatnom sektoru za podršku sektoru voćarstva i bobičastog voća u Južnoj Srbiji, Niš. [in English: Blagojević, R., & Božić, V. (2012). *Plum production technology*. Office for the support program in the private sector to support the fruit and berry growing sector in South Serbia, Niš]
5. Bogdanović, S., & Hadžić, M. (2019). Strategic multicriteria decision-making process in agriculture. *Economics of Agriculture*, 66(1), 89-106.
6. Cvetković, M., & Glišić, I. (2020). *Šljiva – tehnologija gajenja*. Univerzitet u Banjoj Luci, Poljoprivredni fakultet, Banja Luka. [in English: Cvetković, M., Glišić, I. (2020): *Plum - cultivation technology*. University of Banja Luka, Faculty of Agriculture, Banja Luka]
7. Ertekina, C., Gozlekci, S., Kabasa, O., Sonmez, S., & Akinci, I. (2006). Some physical, pomological and nutritional properties of two plum (*Prunus domestica* L.) cultivars. *J. Food Eng.* 75: 508-514.
8. Food and Agriculture Organization of the United Nations, FAOSTAT. Retrieved from <https://www.fao.org/faostat/en/#data> (accessed 7 May 2025)
9. Gazdić, D., Nađ, D., & Sredojević, Z. (2024). Economic Aspects of Plum Production in the Republic of Serbia and Worldwide. *Contemporary Agriculture*, Vol. 73, No. 1-2, pp. 34-42

10. Hedayatizadeh, M., & Chaji, H. (2016). A review on plum drying. *Renewable and Sustainable Energy Reviews*, 56, 362–367
11. Keserović, Z., Magazin, N., Kurjakov, A., Dorić, M., & Gošić, J. (2014). *Voćarstvo*. Popis poljoprivrede 2012, Poljoprivreda u Republici Srbiji, Republički zavod za statistiku Srbije, Beograd. [in English: Keserović, Z., Magazin, N., Kurjakov, A., Dorić, M., & Gošić, J. (2014): *Fruit growing*. Census of agriculture 2012, Agriculture in the Republic of Serbia, Republic Institute of Statistics of Serbia, Belgrade]
12. Keserović, Z., Magazin, N., Milić, B., & Dorić, M. (2016). *Voćarstvo i vinogradarstvo*. Poljoprivredni fakultet, Novi Sad. [in English: Keserović, Z., Magazin, N., Milić, B., & Dorić, M. (2016): *Fruit growing and viticulture*. Faculty of Agriculture, Novi Sad]
13. Kotler, P., & Lee, N. (2009). *Društveno odgovorno poslovanje - Suvremena teorija i najbolja praksa*. M.E.P. CINSULT d.o.o., Zagreb, 15. [in English: Kotler, P., & Lee, N. (2009): *Corporate Social Responsibility - Contemporary Theory and Best Practice*. M.E.P. CINSULT d.o.o., Zagreb, 15]
14. Mahato, S.K., Sarad, G. & Binoy, C. (2015). Performance of Some Plum Cultivars Growing in the Himalayan Tract of Darjeeling. *Int. J. Agric.Sci.* 7(10):703-706.
15. Matković, M. (2015). Possibilities of plum cultivation in the republic of Serbia. *Economics of Agriculture*, Vol. 62, No. 4, pp. 1045-1060.
16. Mika, A., Buler, Z, Rabcewicz, J., Białkowski, P., & Konopacka, D. (2015). Suitability of Plum and Prune Cultivars, Grown in a High Density Planting System, for Mechanical Harvesting With A Canopy Contact, Straddle Harvester. *Journal of Horticultural Research*, Vol. 23(2): 69-81
17. Milatović, D. (2019). *Šljiva*. Naučno voćarsko društvo Srbije, Čačak. [in English: Milatović, D. (2019): *Plum*. Scientific Fruit Society of Serbia, Čačak]
18. Milatović, D. (2023). *Koštice voćke*. Naučno voćarsko društvo Srbije, Čačak. [in English: Milatović, D. (2023): *Stone fruits*. Scientific Fruit Society of Serbia, Čačak]
19. Milošević, T., Zornić, B., & Glišić, I. (2008). A comparison of low-density plum plantings for differences in establishment and management costs, and in returns over the first three growing seasons - a mini-review. *Journal of Horticultural Science and Biotechnology*, 83: 539-542.
20. Milovanović, Ž, Todorović, M., & Stojanović, M. (2018). Odabir sorti šljive za sadnju posredstvom AHP metode. *Ekonomski pregled* Vol. 20, 1, 79-90. [in English: Milovanović, Ž, Todorović, M., & Stojanović, M. (2018): Selection of plum varieties for planting using the AHP method. *Economic Review* Vol. 20, 1, 79-90]
21. Mišić, P. D. (2006). *Šljiva*. Drugo izdanje, Partenon, Beograd. [in English: Mišić, P. D. (2006): *Plum*. The second version, Parthenon, Belgrade]

22. Ognjanov, V., Ogašanić, D., Milatović, D., Paunović, G., Milinković, V., & Radićević, S. (2007). Perspektivne sorte i podloge koštićavih vrsta voćaka. *Zbornik radova sa savetovanja o perspektivnim sortama i podlogama voćaka*, Čačak, strp. 15-33. [in English: Ognjanov, V., Ogašanić, D., Milatović, D., Paunović, G., Milinković, V., Radićević, S. (2007): Perspective varieties and rootstocks of stone fruit tree species. *Proceedings of the consultation on promising varieties and rootstocks of fruit trees*, Čačak, p. 15-33]
23. Paraušić, V., Pantović, D., Mihailović, B., & Radosavljević, K. (2025). Digital literacy of farmers in the context of rural tourism services provision in Serbia. *Hotel and Tourism Management*, 13(1). <https://doi.org/10.5937/menhottur2500002P>
24. Popović, B., Nikićević, N., Gavrilović-Damnjanović, J., Mitrović, O., Srećković, M., & Ogašanić, D. (2008a). Uticaj sorte šljive na prinos rakije šljivovice. *Voćarstvo*, 42, 163-164, str. 111-118 [in English: Popović, B., Nikićević, N., Gavrilović-Damnjanović, J., Mitrović, O., Srećković, M., & Ogašanić, D. (2008a): Influence of plum variety on the yield of plum brandy. *Journal of Pomology*, 42, 163-164, str. 111-118]
25. Popović, B., Nikićević, N., Gavrilović-Damnjanović, J., Mitrović, O., Petrović, A., & Ogašanić, D. (2008b). Tehnološka svojstva raznih sorata šljive kao sirovine za proizvodnju rakije šljivovice. *Arhiv za poljoprivredne nauke*, 67 (238):73-82. [in English: Popović, B., Nikićević, N., Gavrilović-Damnjanović, J., Mitrović, O., Petrović, A., & Ogašanić, D. (2008b): Technological properties of various plum cultivars as raw materials for the production of šljivovica brandy. *Archives of Agricultural Sciences*, 67 (238):73-82]
26. Radosavljević, K. (2015). The competitiveness of agricultural products: Case study of plum production and sale. *Ekonomika preduzeća/Economics of Enterprise*, Vol. 63, No. 7-8, pp. 449-460.
27. Seočanac, M., Veljović, S., Kostić, M., & Hrobňová, K. (2025). From “Experiencers” to “Souvenir buyers”: Segmenting Serbian tourists based on motivations for purchasing local liqueurs while travelling. *Hotel and Tourism Management*, 13(1). <https://doi.org/10.5937/menhottur2500007S>
28. Shahzad, M., Ali, A., Hayee Qureshi, A., Jehan, N., Ullah, I. & Khan, M. (2013). Assessment of Post-Harvest Losses of Plum in Swat. *J. Agric. Res. Pakistan*, Vol. 26 No. 3, pp. 185-104
29. Somogay, L. P. (2005). *Plums and Prunes Processing of Fruits Science and Technology*. 2nd ed., CRC Press, Boca Raton, FL, Vol. 21, pp. 513–530.
30. Somsen, D., Capelle, A. (2002). Introduction to production yield analysis – a new tool for improvement of row material yield. *Trends in food science and technology*, Vol.13, Issue 13, pp. 136-145.
31. Spahić-Vukojević, S., & Direk, M. (2021). An Economic Analysis of Plums Production: The Case of Gradacac. Bosnia And Herzegovina, *Selcuk Journal of Agriculture and Food Sciences*, Vol. 35, No 3, 202-209

32. Sredojević, Z. (1998): *Procena vrednosti višegodišnjih zasada*. Društvo agrarnih ekonomista Jugoslavije i Ekonomski institut, Beograd. [in English: Sredojević, Z. (1998). *Assessment of the value of perennial plantations*. Association of Agrarian Economists of Yugoslavia and Institute of Economics, Belgrade].
33. Sredojević, Z. (2011). Ekonomska evaluacija proizvodnje trešnje i višnje u Srbiji. *Zbornik radova III savetovanja Inovacije u voćarstvu „Unapređenje proizvodnje trešnje i višnje”*, Beograd. [in English: Sredojević, Z. (2011): Economic evaluation of cherry and sour cherry production in Serbia. *Proceedings of the III Innovations in Fruit Growing Consultation “Improving cherry and sour cherry production”*, Belgrade]
34. Sredojević, Z., & Mojsijev, D. (2013). Farm.Soft S.20.10-Agromix-software for recording agricultural farm business operations: an example of good practice in Serbia. *Thematic proceedings-Internatuional Scientific Conference Sustainable agriculture and rural development in terms of the Republic of Serbia strategic goals realization within the Danube region—achieving regional competitiveness*, Dec., 5-7, 2013., Topola, Institute of Agricultural Economics, Belgrade, Balkan Scientific Association of Agrarian Economists (B.E.N.A) et al., pp.798-815
35. Sredojević, Z., Elenov, R., & Gajić, B. (2025). Investment in biological systems sustainability of water and locations in rural areas of the Republic of Serbia. *Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development*, Vol. 25, No 4, pp. 927-938
36. Sredojević, Z., Gazdić, D., Gajić, B., & Čule, N. (2024). Economic sustainability of production of plum and cherry on family holdings in the Republic of Serbia. *Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development*, Vol. 24, No 1, pp. 949-956
37. Sredojević, Z., Kljajić, N., & Gajić, B. (2019). Brownfield investments as possibility of revitalization and sustainability of locations. *Economics of Agriculture*, Year 66, No.2, pp. 589–599
38. Statistical Office of the Republic of Serbia (SORS). *Statistical Yearbook of the Republic of Serbia*, 2014-2023. Republic of Serbia, Belgrade. Available at: <https://www.stat.gov.rs/> (accessed 26 February 2026.).
39. Tomić, D., Milić, D., & Radojević, V. (2006). Perspectives of plum production in Republic of Serbia. *Economics of Agriculture*, Vol. 53, No. 3, pp. 737-746
40. Urošević, I. (2015). Uticaj sojeva selekcionisanog kvasca i hraniva u fermentaciji na hemijski sastav i senzorne karakteristike voćnih rakija. *Doktorska disertacija*, Univerzitet u Beogradu, Poljoprivredni fakultet, Beograd. [in English: Urošević, I. (2015): The influence of selected yeast strains and nutrients in fermentation on the chemical composition and sensory characteristics of fruit brandies. *Doctoral dissertation*, University of Belgrade, Faculty of Agriculture, Belgrade]

41. Vakula, A. (2020). Fizičke, hemijske i biološke osobine osušenog koštičavog voća proizvedenog različitim tehnikama sušenja. *Doktorska disertacija*, Tehnološki fakultet, Novi Sad. [*in English*: Vakula, A. (2020). Physical, chemical and biological properties of dried stone fruits produced by different drying techniques. *Doctoral dissertation*, Faculty of Technology, Novi Sad]
42. Vávra, R., Blažek, J., Mazánek, J., & Bartoníček, L. (2006). The economics of modern plum orchards in the Czech Republic, *Hort. Sci.* (Prague), 33, (2): 47–56.

TOWARDS SUSTAINABLE GROWTH: ASSESSING THE NEXUS BETWEEN AGRICULTURAL OUTPUT AND CIRCULAR ECONOMY INDICATORS

Boris Radovanov¹, Aleksandra Marcikić Horvat², Otilija Sedlak³

*Corresponding author E-mail: aleksandra.marcikic.horvat@ef.uns.ac.rs

ARTICLE INFO

Original Article

Received: 23 July 2026

Accepted: 14 September 2026

doi:10.59267/ekoPolj2603931R

UDC 338.432:330.354

Keywords:

agricultural value added, circular economy, European Union, panel data analysis, renewable energy, sustainable development.

JEL: C23, Q10, Q56, Q57.

ABSTRACT

This paper examines the relationship between agricultural output and circular economy indicators in 36 European countries over the period 2015–2024. Using an unbalanced panel of 360 observations, a panel regression model with fixed effects was estimated following a series of diagnostic tests that confirmed the robustness and reliability of the estimates. Agriculture, forestry and fishing value added per worker was modelled as a function of five circular economy indicators, alongside GDP per capita, rural population share and agricultural employment. All estimated coefficients were significant at the 1% level. The recycling rate of municipal waste and the share of renewable energy positively affect agricultural value added, while the generation of municipal waste, raw material consumption, rural population and agricultural employment exert negative effects. The findings confirm that circular economy practices and agricultural productivity are complementary rather than conflicting areas, whose long-term synergy depends on coordinated economic policy support.

-
- 1 Boris Radovanov, PhD, Associate Professor, University of Novi Sad, Faculty of Economics in Subotica, Segedinski put 9-11, 24000 Subotica, Serbia, Phone: +381 24 628 022, E-mail: boris.radovanov@ef.uns.ac.rs, ORCID ID (<https://orcid.org/0000-0002-4728-7286>)
 - 2 Aleksandra Marcikić Horvat, PhD, Associate Professor, University of Novi Sad, Faculty of Economics in Subotica, Segedinski put 9-11, 24000 Subotica, Serbia, Phone: +381 24 628 027, E-mail: aleksandra.marcikic.horvat@ef.uns.ac.rs, ORCID ID (<https://orcid.org/0000-0002-4199-4238>)
 - 3 Otilija Sedlak, PhD, Full Professor, University of Novi Sad, Faculty of Economics in Subotica, Segedinski put 9-11, 24000 Subotica, Serbia, Phone: +381 24 628 000, E-mail: otilija.sedlak@ef.uns.ac.rs, ORCID ID (<https://orcid.org/0000-0002-7430-7027>)

Introduction

Agriculture remains one of the most resource-intensive sectors of the European economy, and its long-term productivity is inseparably connected to how efficiently natural resources, waste and energy are managed across the food and land-use value chain. Over the last decade, the European Union has placed the transition toward a circular economy at the centre of its environmental and economic agenda, seeking to decouple growth from resource depletion through targets related to recycling, waste reduction, renewable energy and material efficiency (Castillo-Díaz et al., 2024). Agriculture, forestry and fishing occupy a distinctive position within this transition: they are simultaneously significant generators of environmental pressure, through greenhouse gas emissions, raw material use and land-related waste, and potential beneficiaries of circularity, since practices such as composting, biomass valorisation, renewable-energy adoption and closed-loop nutrient cycles can lower input costs and raise resource productivity (Erdiaw-Kwasie et al., 2025; Giacomello et al., 2025).

Despite growing academic and policy interest in the circular economy, empirical evidence on how specific circular economy indicators relate to agricultural output remains fragmented, often confined to individual countries, a single circularity dimension, or comparatively short observation periods (Novaković D. et al., 2025; Novaković T. et al., 2025a). Most cross-country panel studies of the circular economy-growth nexus in the EU treat GDP or aggregate resource productivity as the outcome variable, while comparatively few isolate the agricultural sector, and fewer still extend the analysis beyond the EU-27 to EEA and EU candidate countries, whose agricultural structures, resource endowments and stages of circular economy adoption differ substantially from those of longstanding member states (Dimitrijević et al., 2025; Đokić et al., 2022b).

This gap is particularly relevant for Southeast Europe and the Western Balkans, where accession negotiations require gradual alignment with EU environmental and agricultural policy, and where the pace of this alignment has direct consequences for agricultural competitiveness and rural livelihoods (Đokić et al., 2022a). Understanding whether, and how, circular economy performance translates into higher agricultural value added is therefore relevant not only for academic reasons but also for policy design in both EU member states and candidate economies.

Against this background, the aim of this paper is to examine the relationship between agricultural output, measured as agriculture, forestry and fishing value added per worker, and a set of circular economy indicators (generation of municipal waste, recycling rate of municipal waste, greenhouse gas emissions from production activities, share of renewable energy and raw material consumption), while controlling for GDP per capita, rural population share and agricultural employment. The analysis covers 36 European countries – all 27 EU member states, three EEA countries and six EU candidate countries – over the 2015–2024 period, using panel regression methodology.

The remainder of the paper is organized as follows. The next section reviews the relevant literature on the circular economy-agriculture nexus. This is followed by a

description of the data and methodology used in the empirical analysis. The subsequent section presents and discusses the estimation results, after which the final section offers conclusions and policy implications.

Literature review

The relationship between circular economy practices and agricultural performance has attracted increasing scholarly attention as part of broader research into the circular economy transition in the European Union. At the policy level, the alignment between the EU Common Agricultural Policy and circular economy principles has been shown to encourage more efficient use of inputs and by-products, although the practical uptake of circular practices differs considerably across member states depending on farm structure, access to funding and institutional support (Castillo-Díaz et al., 2024). These structural differences help explain why studies that rely on aggregate, EU-wide circular economy indicators often need to be complemented with more detailed sector-level analysis, such as the one presented in this paper.

Regarding the waste and recycling dimension of the circular economy, prior research indicates that higher municipal waste generation is generally associated with adverse environmental outcomes, including soil, water and air pollution stemming from inadequate treatment or disposal, all of which undermine agricultural productivity (Giacomello et al., 2025). Conversely, higher recycling rates, particularly through the conversion of organic waste into compost and organic fertilizers, have been found to substitute for costly chemical inputs, restore soil health and reduce greenhouse gas emissions, thereby supporting agricultural employment and value added (Erdiaw-Kwasie et al., 2025).

The relationship between greenhouse gas emissions and agricultural performance is more ambiguous in the literature. Some studies report a dynamic, occasionally positive short-run association between emissions and agricultural productivity, explained by temporarily favourable effects on plant growth that are eventually outweighed by longer-term damage to the environmental systems on which agriculture depends (Mulusew & Hong, 2024). Similar interlinkages between energy-driven economic growth and environmental degradation have been documented for EU agriculture more broadly, confirming that the emissions-productivity relationship is strongly context- and time-dependent (Zafeiriou et al., 2023).

The role of renewable energy in agriculture has received growing attention, with evidence from both EU and non-EU country groups suggesting that a higher share of renewable energy reduces input costs, increases efficiency and strengthens the climate resilience of farms, ultimately boosting agricultural economic output (Soni & RL, 2024). Raw material consumption, on the other hand, shows conflicting effects depending on the channel through which it operates: rising raw material costs increase intermediate consumption and can reduce value added, whereas adequate access to essential agricultural raw materials can raise physical yields and, through that channel, increase economic value added (Ali et al., 2025).

Beyond circular economy indicators, macroeconomic and structural determinants remain central to explaining agricultural value added. As economies grow and diversify, labour tends to shift away from agriculture, while capital investment and technology adoption increase value added per remaining worker (George, 2020). A similar mechanism has been identified for rural population decline, where capital deepening and mechanization tend to raise agricultural productivity even as the rural labour force shrinks (Shen et al., 2023).

Several recent studies specifically address the intersection of circular economy indicators and agricultural or agri-food performance in Serbia and the broader Western Balkan region. Dynamic panel evidence for the Serbian agri-food sector confirms a statistically significant link between resource efficiency and circular economy indicators (Novaković D. et al., 2025), while stochastic frontier analyses of crop and dairy production in the European Union and Serbia show that eco-efficiency gains are closely tied to circular economy adoption at the farm level, including input reduction and waste valorisation (Novaković T. et al., 2025a; Novaković T. et al., 2025b). This is further supported by an efficiency-based assessment of circular economy performance across European countries and Serbia using Data Envelopment Analysis, which finds that Serbia lags behind the EU average in circular economy efficiency and highlights the need for targeted improvements in resource productivity and waste management (Radovanov et al., 2023a). These findings reinforce the relevance of extending the analysis of circular economy-agriculture linkages to candidate countries, whose agricultural sectors are undergoing parallel processes of modernization and EU alignment.

From a comparative regional perspective, studies contrasting the agricultural sectors of the European Union and the Western Balkans consistently find a productivity and competitiveness gap, driven by lower technical efficiency, weaker value-added generation and less intensive use of production factors in the Western Balkan countries (Đokić et al., 2022a; Đokić et al., 2022b). Similarly, evidence on the competitiveness of the Southeast European agricultural sector highlights that raising productivity through modern technology and greater processing of agricultural products, rather than relying on low input prices, is essential for closing this gap (Dimitrijević et al., 2025).

The policy dimension of this nexus is equally important. Analyses of the Common Agricultural Policy emphasize that agricultural labour productivity and greenhouse gas emissions represent central milestones in its evolution, requiring member states to balance productivity growth with climate objectives (Constantin et al., 2021). For the Western Balkans, the alignment of national agricultural policies with the CAP and the European Green Deal is considered essential for sustainable agricultural development and climate change mitigation (Županić et al., 2021), while the efficient and sustainable use of agricultural inputs has been identified as a precondition for reconciling productivity growth with environmental protection in both innovative economies and the Republic of Serbia (Dimitrijević et al., 2024). Recent evidence on competitiveness and cereal self-sufficiency in the Western Balkan countries

further shows that economic development and agricultural value added per worker positively influence comparative advantage, linking sectoral productivity to broader macroeconomic conditions (Kovljenić et al., 2024). At the same time, persistent competitiveness gaps between old and new EU member states point to the need for productive and sustainable agricultural systems across the enlarged Union (Jarosz-Angowska et al., 2022).

Methodologically, panel data models with fixed or random effects, selected on the basis of the Hausman specification test, are widely used in agricultural and financial economics to account for the grouped, cross-country and cross-time nature of the data and to improve the robustness of the estimated coefficients (Radovanov et al., 2023b; Sotiroski et al., 2023; Wooldridge, 1999). This methodological approach is also well established in the regional economic literature, as illustrated by a recent panel regression analysis of profitability determinants among wholesale companies in Serbia, which likewise relies on fixed- and random-effects estimation to capture firm-level heterogeneity over time (Dakić et al., 2025).

Taken together, the reviewed literature confirms that individual circular economy indicators can exert markedly different, and at times opposing, effects on agricultural output, and that these relationships are shaped by country-specific structural and institutional conditions. However, comprehensive panel evidence that jointly considers multiple circular economy dimensions, alongside macroeconomic and structural controls, across the full spectrum of EU, EEA and EU candidate countries remains scarce. This paper aims to address this gap by providing an integrated empirical assessment of the circular economy-agriculture nexus across 36 European countries over the 2015–2024 period.

Data and methodology

Given the specificity of the topic, the availability of data sources as well as the possibilities of comparability of European countries, the creation of an adequate data sample implies an important step in the quantitative analysis procedure. In this regard, the comparison of EU, EEA and candidate countries through panel analysis is ideal because it enables the monitoring of economic and social indicators over time and space. This method precisely maps the path of convergence, helping researchers to assess the effects of gradual integrations and assess the “step-by-step” enlargement policies before full membership. For this reason, the sample consists of all 27 member states of the European Union, 3 member states of the European Economic Area (Iceland, Norway and Switzerland) and 6 EU candidate countries (Albania, Bosnia and Herzegovina, Montenegro, North Macedonia, Serbia and Turkey) in the period from 2015 to 2024. Overall there are 360 panel data in the sample. The annual values of the indicators collected in the sample are directed towards the analysis of the effects of the state and development of agriculture, as well as circular economy and sustainable development. Therefore, the following indicators were used:

Agricultural indicators

AVA - Agriculture, forestry, and fishing, value added per worker (constant 2015 US\$) (World Bank Open Data)

RP - Rural population (%) (World Bank Open Data)

EMP - Employment in agriculture (%) (World Bank Open Data)

Macroeconomic indicator

GDP - GDP per capita (World Bank Open Data)

Circular economy indicators

GMW- Generation of municipal waste per capita (Eurostat)

RR - Recycling rate of municipal waste (Eurostat)

GGE - Greenhouse gases emissions from production activities (Eurostat)

SRE - Share of renewable energy (Eurostat)

RMC - Raw material consumption (Eurostat)

In order to conduct an adequate analysis based on the collected data, panel data models (Fixed or Random Effects) are used instead of Pooled ordinary least squares because Pooled OLS ignores the grouped nature of the data. By treating all observations independently, Pooled OLS risks severe omitted variable bias and incorrect standard errors if unobserved individual traits correlate with your variables. Also, the model wants to enhance the robustness of the estimated values (Wooldridge, 1999). The initial functional structure of the studied model is presented as follows:

$$AVA_{it} = \alpha + \beta_1 GMW_{it} + \beta_2 RR_{it} + \beta_3 GGE_{it} + \beta_4 SRE_{it} + \beta_5 RMC_{it} + \beta_6 GDP_{it} + \beta_7 RP_{it} + \beta_8 EMP_{it} + \varepsilon_{it}$$

AVA is dependent variable, i is a symbol that represents the cross-section data (i -th country), t represents the time (yearly data), α is an intercept coefficient, β_j indicates a regression coefficient for each of the independent variable and ε represents the error term of the model.

In order to properly implement the panel regression model methodology, it is necessary to test the existence of fixed or random effects in this model. Such model position refers to the application of a specification test based on the differences between the fixed effects and random effects estimators, known as the Hausman test. If the null hypothesis is true, the fixed effect estimator is not efficient under the random effect specification because it counts only on the within variation in the data series (Radovanov et al, 2023b).

Results and discussion

Before presenting the results of the econometric analysis, the results of the descriptive statistics are presented in order to overview the main characteristics of the included variables (Table 1).

Table 1. Descriptive statistics and stationarity test

Variable	Mean	Median	Standard deviation	ADF test	Skewness	Kurtosis	Jarque-Bera test
AVA	33063.747	25554.446	26218.265	11.626	1.554	2.702	146.244
GMW	512.011	489.000	132.932	17.586	0.543	-0.250	176.180
RR	33.941	36.000	18.256	10.001	-0.240	-0.890	230.457
GGE	7785.045	7476.494	3051.798	20.337	1.280	1.529	130.780
SRE	27.579	22.879	16.412	18.056	1.490	2.102	145.326
RMC	19.405	17.533	7.871	15.212	1.367	1.667	138.749
GDP	32413.970	22397.764	25427.055	10.112	1.243	0.938	156.406
RP	27.636	29.708	12.965	14.060	-0.161	-1.040	246.397
EMP	6.600	3.950	7.088	22.511	2.450	6.764	572.546

Source: Authors' estimations

Table 1 presents descriptive statistics of given variables in case of 36 selected European countries during the 2015-2024 period. The values from Table 1 are applied to estimate agricultural output, selected circular economy indicators as well as macroeconomic indicators overall. Before proceeding with the panel regression estimation, it is necessary to examine the dynamic characteristics of the variables that will be used in the model. In this regard, non-stationary variables can produce spurious relationships and biased coefficient estimates (Novaković et al, 2025). Consequently, Augmented Dickey-Fuller test (ADF test) is applied to determine whether the series were stationary over the observed period. The results of the ADF test indicate the existence of stationarity at the level of the mentioned variable time series, which means that the null hypothesis is rejected according to the ADF test. It is important to notice that in this situation it is not necessary to transform the original variables because their mean and variance remain stable over time, indicating that the variables return to equilibrium after short-term fluctuations. In addition to the aforementioned, Table 1 also contains the test results of the normal distribution of the included variables. The results indicate that the individual variables are not normally distributed, which should not be a concern because through the application of the panel ordinary least squares methodology, they become resistant to deviations, especially in the case of the application of the fixed effects models.

Table 2. Correlation matrix

	AVA	GMW	RR	GGE	SRE	RMC	GDP	RP	EMP
AVA	1								
GMW	-0.4794	1							
RR	0.4367	0.4368	1						
GGE	0.4182	0.3726	0.0403	1					
SRE	0.4670	0.1191	-0.0450	0.2604	1				
RMC	-0.3840	0.2138	-0.0157	0.5157	0.6784	1			
GDP	0.6274	0.7224	0.5741	0.4078	0.1521	0.3531	1		
RP	-0.6835	-0.5475	-0.3406	-0.3009	-0.1112	-0.1238	-0.5824	1	
EMP	-0.5137	-0.5086	-0.5973	-0.0845	0.0511	-0.0523	-0.5119	0.4484	1

Source: Authors' estimations

Table 2 contains the results of comparing the relationships between the included variables. Therefore, the presented correlation matrix is included to transparently summarize variable relationships, check for multicollinearity among predictors (independent variables), and validate that your data meets the assumptions required for further modeling process. Since there are no strong correlations between independent variables, the results indicate that there is no significant concern regarding multicollinearity.

Table 3. Estimation results of the panel regression model

Variable	Coefficient	t-Statistic	VIF test
C	43491.9500	8.2118***	-
GMW	-36.7482	-4.6089***	2.3674
RR	145.0638	2.7195***	5.6014
GGE	1.6717	5.8030***	0.9804
SRE	753.5714	12.7152***	1.0566
RMC	-469.3270	-3.2306***	3.8821
GDP	0.2400	4.8139***	4.1008
RP	-817.3400	-11.6823***	5.0772
EMP	-972.2642	-7.2892***	6.1177
R-squared	0.7597		
F-statistic	138.6828***		
Hausman test	22.8116***		
Breusch-Pagan-Godfrey F test	1.7492		
Durbin-Watson statistic	1.7709		

Source: Authors' estimations

Note: *** indicates significance at the level of 1%

The results shown in Table 3 are the outcome of the modeling process by inserting one variable at a time. The final model represents the best possible choice, and therefore the best representation of the impact on agricultural output at the macroeconomic level. The consistency of the presented model with the available data is best determined by the high value of the coefficient of determination (R-squared), which in this case is at the level of almost 76%. In addition, a high F-statistic value indicates a statistically significant joint effect of all estimated parameters in the model at the significance level of 1%. Based on the prior remarks associated to the outcomes from the correlation matrix, the variance inflation (VIF) test was implemented and the results approve that there is no statistically significant multicollinearity between the independent variables (VIF test values below 10). These results indicate the stability of the estimated coefficients so that the relationships between the introduced variables remain statistically reliable without any negative effects of multicollinearity. Further verification of the robustness of the model specification was accomplished by using the Hausman test. The χ^2 test result points to the rejection of the null hypothesis and states that in this case it is necessary to use the model specification with fixed effects. To additionally improve model fit, the Breusch-Pagan-Godfrey test was conducted in order to detect potential heteroscedasticity of the model residuals. Only models that fulfilled the null hypothesis that there is homoscedasticity among the residuals of the estimated model can be considered as appropriate ones. The result indicates that in the selected model there are no problems with residuals caused by the occurrence of independent variables. Finally, Durbin-Watson statistic is implemented to detect serial correlation in the residuals of the regression model. By using the generally accepted rule of thumb, the results in the range of 1.5 to 2.5 are generally considered normal with a little to no autocorrelation.

All previous tests allow a certain degree of confidence in the results of the regression model, and therefore its reliability in application. First of all, it should be emphasized that all the estimated coefficients in this regression panel model are statistically significant with a significance level of 1%. Generation of municipal waste per capita has a negative effect on the value of agricultural output per worker. High municipal waste generation often means increased landfilling. Improper waste management and the burning of municipal or industrial waste can lead to soil and water contamination and air pollution, which suppresses agricultural yields and degrades the underlying agricultural value added (Giacomello et al. 2025). On the other hand, recycling rate of municipal waste has positive impact on agriculture, forestry, and fishing, value added per worker. By transforming organic municipal waste into compost and organic fertilizers, regions can substitute costly chemical inputs, restore soil health, and lower greenhouse gas emissions, ultimately driving economic growth in the agricultural sector (Erdiaw-Kwasie et al. 2025). Against all expectations, greenhouse gases emissions from production activities have a positive relationship with agriculture, forestry, and fishing, value added per worker. This statement can be justified to some extent with the fact that increased emissions temporarily stimulate some plant growth, but these emissions damage the environmental systems that agriculture relies on, acting

as a negative feedback loop (Mulusew and Hong. 2024). This study shows that an increased share of renewable energy generally positively impacts agricultural value added. By transitioning to clean energy sources, farms reduce input costs, increase efficiency, and gain climate resilience, which subsequently boosts the economic output of the agricultural sector (Soni and RL. 2024). Raw material consumption demonstrates significant negative impact on agriculture value added. In the scientific literature, there are conflicting views on the connection between these indicators. Apparently, everything depends on how this influence takes place. When the cost of raw materials increases, it raises the intermediate consumption, which directly reduces the overall value added to the agricultural output. From another perspective, adequate consumption of essential agricultural raw materials increases physical yields. This boosts overall production, which mainly leads to an increase in economic value added (Ali et al. 2025). As confirmed in most scientific studies, GDP growth significantly affects agriculture value added per worker. As a nation's GDP and non-agricultural economy grow, they pull labor out of farming. This reduction in agricultural employment, combined with increased capital investment and better technology, directly drives up value added per remaining agricultural worker (George, 2020). In accordance with the previous facts, the coefficient explaining the relationship between agricultural employment and agricultural value added per worker presents a significant negative value. Finally, rural population shows a negative association with agricultural value added per worker. This finding are consistent with the fact that s rural populations shrink and non-farm sectors increase, agricultural productivity often increases through capital deepening (better machinery) and fewer workers dividing the same output (Shen et al. 2023).

Conclusions

This study investigated the relationship between circular economy indicators and agricultural output per worker in case of 36 European countries, among which all 27 EU countries, 3 EEA member countries and 6 candidate countries were analyzed over the period of 2015–2024. The empirical analysis leads to several major conclusion remarks.

Stating numerous circular economy indicators and establishing their statistically significant connection with agricultural outputs indicates the necessity of understanding environmentally responsible production and improving resource efficiency in order to achieve long-term economic goals. In this regard, the inclusion of individual indicators of the circular economy enables an adequate insight into the state, but also the possibilities for further development, first of all of the circular economy, and then, consequently, the efficiency of agricultural production.

The obtained results confirm that the circular economy and agricultural production are complementary areas rather than pursuing the same defined goal. Nevertheless, synergy is possible if time, sector characteristics, but also financial and institutional support are harmonized. Acceptance and implementation of circular economy practices can have a short-term effect on the reduction of output through the growth of investment costs.

However, this approach is introduced due to superior long-term performance and better competitiveness in the market.

The results of this analysis allow decision-makers to gain insight into possible changes in approach when creating economic policy and implementing the circular economy in all spheres of socially responsible work. In order to adequately connect this, policy makers should define certain targeted instruments, through green financial programs, innovation initiatives and knowledge exchange, all with the aim of accepting a circular and resource-efficient economy in agriculture.

Future research should target the microeconomic level through the analysis of profitability and efficiency of agricultural enterprises in the implementation of circular economy principles. Furthermore, the application of more advanced econometric methods can enable a better understanding of the heterogeneity between the entities within the sample, and thus a better understanding of the relationship between the circular economy indicators and agricultural value added.

Acknowledgements

Supported by the Provincial Secretariat for Higher Education and Scientific Research, Autonomous Province of Vojvodina, Republic of Serbia, Grant No. 003819373 2025 09418 003 000 000 001 04 002; 003897281 2025 09418 004 000 000 001 01 001; 002342107 2026 09418002 000 000 001 04 002 and 003897064 2025 09418 003 000 000 001 04 004.

Conflict of interests

The authors declare no conflict of interest.

References

1. Ali, A., Xiangyu, G., & Radulescu, M. (2025). Investigating the Impact of Agricultural Value Added and Agricultural Components (Rice Production, Inorganic Fertilizers and Livestock Production) on the Ecological footprint in emerging economies in Asia. *Cogent Food & Agriculture*, 11(1). <https://doi.org/10.1080/23311932.2025.2522334>
2. Castillo-Díaz, F.J., Belmonte-Ureña, L.J., Álvarez-Rodríguez, J.F., & Camacho-Ferre, F. (2024). Role of Sustainability and Circular Economy in Europe's Common Agricultural Policy. In: Valls Martínez, M.d.C., Santos-Jaén, J.M. (eds) *Environmentally Sustainable Production*. Springer, Cham. https://doi.org/10.1007/978-3-031-52656-5_4
3. Constantin, M., Radulescu, I. D., Andrei, J. V., Chivu, L., Erokhin, V., & Gao, T. (2021). A Perspective on Agricultural Labor Productivity and Greenhouse Gas Emissions in Context of the Common Agricultural Policy Exigencies. *Economics of Agriculture*, 68(1), 53–67. <https://doi.org/10.5937/ekoPolj2101053C>

4. Dakić, S., Nuševa, D., Vučenović, S., Hladika, M., Petreska, L., & Jovanović, D. (2025). Panel Analysis of Wholesale Profitability in the Republic of Serbia. *Anali Ekonomskog Fakulteta u Subotici*, 61(54). <https://doi.org/10.5937/10.5937/AnEkSub2500010D>
5. Dimitrijević, M. S., Bošković, N., Veselinović, P., & Leković, M. (2024). Agricultural Inputs Use for Sustainable Development: The Innovative Countries and the Republic of Serbia. *Economics of Agriculture*, 71(3), 853–870. <https://doi.org/10.59267/ekoPolj2403853D>
6. Dimitrijević, M., Mrdalj, V., & Leković, M. (2025). Competitiveness of the Agricultural Sector of Southeast Europe: The Western Balkans vs. European Union. *Economics of Agriculture*, 72(1), 255–269.
7. Đokić, D., Matkovski, B., Jeremić, M., & Đurić, I. (2022a). Land Productivity and Agri-Environmental Indicators: A Case Study of Western Balkans. *Land*, 11(12), 2216. <https://doi.org/10.3390/land11122216>
8. Đokić, D., Novaković, T., Tekić, D., Matkovski, B., Zekić, S., & Milić, D. (2022b). Technical Efficiency of Agriculture in the European Union and Western Balkans: SFA Method. *Agriculture*, 12(12), 1992. <https://doi.org/10.3390/agriculture12121992>
9. Erdiaw-Kwasie, M., Abunyewah M., Owusu-Ansah K., Baah, C., Alam, K., Basson, M. (2025). Circular Economy and Agricultural Employment: A Panel Analysis of EU Advanced and Emerging Economies. *Environment, Development and Sustainability* (2025)27, 10469–10496. <https://doi.org/10.1007/s10668-023-04318-2>
10. George, T. (2020). A New Look at Agricultural Development and the Non-Agriculture Economy in Low-Income Countries. *Global Food Security*, 26(2020), 100449. <https://doi.org/10.1016/j.gfs.2020.100449>.
11. Giacomello, G., Leonardi, N., Assandri, D., Pampuro, N. (2025). Agricultural and Municipal Biowaste Within the Circular Economy Framework: A Bibliometric Analysis. *Agriculture*, 15, 546. <https://doi.org/10.3390/agriculture15050546>
12. Jarosz-Angowska, A., Nowak, A., Kołodziej, E., & Klikocka, H. (2022). Effect of European Integration on the Competitiveness of the Agricultural Sector in New Member States (EU-13) on the Internal EU Market. *Sustainability*, 14(20), 13124. <https://doi.org/10.3390/su142013124>
13. Kovljenić, M., Matkovski, B., & Đokić, D. (2024). Competitiveness and Cereal Self-Sufficiency in Western Balkan Countries. *Agriculture*, 14(9), 1480. <https://doi.org/10.3390/agriculture14091480>
14. Mulusew, A., Hong, M. (2024). A Dynamic Linkage Between Greenhouse Gas (GHG) Emissions and Agricultural Productivity: Evidence from Ethiopia. *Humanities Social Sciences Communications*, 11, 52. <https://doi.org/10.1057/s41599-023-02437-9>

15. Novaković, D., Novaković, T., Milić, D., Tomaš Simin, M., Nikolić, S., Knežević, M., Radišić, M., Radišić, M., & Pevac, D. (2025). Circular Economy and Resource Efficiency in the Serbian Agri-Food Sector: Evidence from Dynamic Panel Analysis. *Economies*, 13(12), 346. <https://doi.org/10.3390/economies13120346>
16. Novaković, T., Milić, D., Novaković, D., Tomaš Simin, M., & Zekić, V. (2025a). Eco-Efficiency of Crop Production in the European Union and Serbia. *Agriculture*, 15(20), 2158. <https://doi.org/10.3390/agriculture15202158>
17. Novaković, T., Novaković, D., Milić, D., Tomaš Simin, M., Radišić, M., Radišić, M., Nikolić, S., & Mihajlović, M. (2025b). Assessment of Technical and Eco-Efficiency of Dairy Farms in the Republic of Serbia: Towards the Implementation of a Circular Economy. *Agriculture*, 15(8), 899. <https://doi.org/10.3390/agriculture15080899>
18. Radovanov, B., Marcikić-Horvat, A., Stojić, D., Sedlak, O., & Bobera, D. (2023a). Assessing Circular Economy Performance of European Countries and Serbia using Data Envelopment Analysis. *The European Journal of Applied Economics*, 20(2), 1–11.
19. Radovanov, B., Milenković, N., Kalaš, B., & Marcikić Horvat, A. (2023b). Do the Same Determinants Affect Banks' Profitability and Liquidity? Evidence from West Balkan Countries Using a Panel Data Regression Analysis. *Mathematics* 2023, 11, 4072. <https://doi.org/10.3390/math11194072>
20. Shen, D., Liang, H., Shi, W. (2023). Rural Population Aging, Capital Deepening, and Agricultural Labor Productivity. *Sustainability*, 15, 8331. <https://doi.org/10.3390/su15108331>
21. Soni, S., RL, M. (2024). The Dynamic Nexus between Agricultural Productivity and Renewable Energy Consumption in BRICS: The Role of Financial Inclusion and Foreign Direct Investment. *International Journal of Energy Sector Management*, 18(6), 1885–1904. doi: <https://doi.org/10.1108/IJESM-08-2023-0028>
22. Sotiroski, K., Kovács, P, Marcikić Horvat, A., Sedlak, O, Lakić, V., Radovanov, B. (2023). Assessing sustainable economic development efficiency: a DEA approach, Strategic Management, International Journal of Strategic Management and Decision Support Systems in Strategic Management, University of Novi Sad, Faculty of Economics in Subotica, DOI: <https://doi.org/10.5937/StraMan2300039S> , ISSN 1821-3448, ISSN 2334-6191 online
23. Wooldridge, J.M. *Econometric Analysis of Cross Section and Panel Data*; MIT Press: Cambridge, UK, 1999.
24. Zafeiriou, E., Galatsidas, S., Arabatzis, G., Tsiantikoudis, S., & Batzios, A. (2023). Environmental Degradation by Energy-Economic Growth Interlinkages in EU Agriculture. *Energies*, 16(9), 3900. <https://doi.org/10.3390/en16093900>
25. Županić, F. Ž., Radić, D., & Podbregar, I. (2021). Climate Change and Agriculture Management: Western Balkan Region Analysis. *Energy, Sustainability and Society*, 11(1), 51. <https://doi.org/10.1186/s13705-021-00327-z>

THE ROLE OF MODERN INNOVATIONS IN THE TRANSFORMATION OF SERBIAN AGRICULTURE TOWARDS SUSTAINABILITY

Anita Klikovac¹, Marijana Milunović², Ana Anufrijević³, Jovan Rudež⁴

*Corresponding author E-mail: anitaklikovac@yahoo.com

ARTICLE INFO

Review Article

Received: 25 July 2025

Accepted: 30 September 2025

doi:10.59267/ekoPolj2603945K

UDC 001.895:338.43.02]:502.1
31.1(497.11)

Keywords:

*Innovations, agriculture,
digitization, sustainable
development*

JEL: Q16, Q01, O33

ABSTRACT

The agricultural sector and food production are increasingly striving to find answers to complex challenges, among which climate change stands out in particular. The paper states the role of innovation in the agricultural sector, as well as the analysis of challenges in the sustainable development of the agricultural sector. From conventional to digital agriculture, the paper analyzes all aspects in order to find the best solutions towards creating a sustainable transformation of Serbian agriculture. Strategic investment in innovation is a link between traditional production and modern, ecologically responsible agriculture that will meet the needs of current and future generations.

Introduction

The concept of sustainable agriculture implies the development of this sector based on balancing the economic, social and ecological aspects of sustainability. At the end of the 1980s, the Food and Agriculture Organization (FAO) defined this approach as a development model that allows for the preservation of natural resources such as soil,

-
- 1 Anita Klikovac, PhD student at the Faculty of Security, Ministry of Internal Affairs, Department for Emergency Situations, Belgrade, Serbia, Phone:+381666602467, E-mail: anitaklikovac@yahoo.com, ORCID ID (<https://orcid.org/0009-0003-8616-7564>)
 - 2 Marijana Milunović, Full professor, Union – Nikola Tesla University, Faculty of Economics and Finance, Cara Dušana 62–64 Belgrade, Serbia, Phone:+381629646280, E-mail: mmilunovic@unionnikolatesla.edu.rs, ORCID ID (<https://orcid.org/0000-0003-3791-5098>)
 - 3 Ana Anufrijević, Full professor, Union – Nikola Tesla University, Faculty of Economics and Finance, Cara Dušana 62–64 Belgrade, Serbia, Phone:+38162262072, E-mail: aanufrijevic@unionnikolatesla.edu.rs, ORCID ID (<https://orcid.org/0000-0001-5476-440X>)
 - 4 Jovan Rudež, Assistant professor, University Business Academy in Novi Sad, Faculty of Economics and Engineering Management, Cvečarska 2 Novi Sad, Srbija, Phone:+381600503133, E-mail: jovan.rudez@gmail.com, ORCID ID (<https://orcid.org/0000-0003-4910-4946>)

water, and the genetic potential of plants and animals, while being environmentally acceptable, economically profitable, technically feasible, and socially sustainable (FAO, 1989, p. 5).

In the modern context, the agricultural sector and food production are increasingly striving to find answers to complex challenges, among which climate change stands out. The modern approach implies respect for the principles of sustainability and a focus on achieving the goals defined by the 2030 Agenda for Sustainable Development adopted by the United Nations (UN, 2015). This agenda includes 17 main goals and 169 sub-goals, which together cover the three basic dimensions of sustainable development: economic progress, social justice and environmental protection. The signatories of the Agenda have undertaken to direct their resources in a responsible manner in order to achieve the set goals by 2030.

In addition, in the light of increasingly intense global changes and increasingly complex challenges, innovation, investment in science, research and development, as well as investment in education, are becoming key factors for building sustainable and competitive agriculture — both at the level of individual enterprises and within national economies around the world.

The development of agriculture and rural areas in Serbia is directed towards sustainable solutions and greater use of innovations, which is one of the strategic priorities of the Government of the Republic of Serbia. Within the “Strategy of agriculture and rural development for the period 2014-2024”, one of the key segments (Area 7) refers to technological progress and modernization of agricultural production and processing (Official Gazette of RS, no. 85/14).

In addition, in 2021, the “Strategy of scientific and technological development of the Republic of Serbia for the period 2021-2025 - The power of knowledge” was adopted (Official Gazette of the RS, No. 10/21), with the intention of accelerating the economic progress of the country and improving the quality of life of citizens through the development of knowledge, science, technology and innovation, as well as to improve Serbia’s integration into the European research area.

This chapter aims to analyze the innovative capacities of Serbian agriculture, with a focus on the extent to which investments in research, development and application of innovations in this sector contribute to the achievement of the sustainable development goals of the United Nations until 2030 (UN Serbia, 2018).

The role of innovation in the agricultural sector

In modern conditions, no sector of the economy can expect success if it does not implement continuous innovation and improve its operations. For this reason, companies strive to optimize costs and increase profitability. Nevertheless, the achievement of economic profit should not be carried out at the expense of environmental degradation and endangering human health, which is in line with current regulations and numerous

scientific analyses.

The innovations that are introduced must be in accordance with the principles of sustainable development, which means that they should include economic, environmental and social aspects. Innovation activity means activities aimed at the development of new products, technologies, processes and services or significant changes to existing ones, all with the aim of meeting the needs of the market.

Innovation is defined as the successful commercial application of new or significantly improved products, services or processes - which may include improvements in technical features, components, materials, software, user experience and other functional elements. In addition, innovations can also include new marketing or organizational approaches in the way of doing business and managing relations with the environment (Official Gazette of RS, No. 55/2013).

An innovation is defined as a new idea, procedure or object that an individual or group perceives as something they have not used or known before. The process of spreading innovations, i.e. diffusion, is a form of social change and involves communication between people with the aim of transmitting new solutions. During this process, participants actively exchange information for better mutual understanding. The peculiarity of diffusion is reflected in the fact that it is aimed precisely at new ideas (Rogers, 2003). Diffusion theory, developed by rural sociologists, plays a significant role in explaining how changes occur in society, especially with regard to the adoption of innovations in rural and agrarian communities. It tries to predict the reactions of individuals and social groups to innovations, taking into account their personal characteristics, social connections, time and the very nature of the innovation. This theory is particularly relevant in the case of switching to organic farming. Although it was created during the period of intensive agricultural development during the so-called "green revolution", diffusion theory is also applied in new contexts such as organic agriculture, which focuses on ecological sustainability and environmental protection (Padel, 2001).

It is important to make a clear distinction between inventiveness and innovation. Invention refers to scientific or technical discoveries and is always related to the creative process, while innovation refers to the application of new or existing ideas in a new way (Grujić et al., 2015, p. 210). A significant part of modern technologies belongs to sustainable technologies, because they contribute to the improvement of various product properties (Grujić et al., 2015, p. 211). Although the agricultural sector has a certain potential for improvements through innovation, this area still does not receive enough attention. This is especially pronounced in regions with an older agricultural population, which is often skeptical of changes and slower to accept new solutions.

In today's time of continuous global changes, it is necessary to constantly adapt and follow modern trends, along with the continuous introduction of innovations. In the agricultural sector, where resources are often limited, it is crucial to make optimal use of available ingredients and apply innovation in order to achieve the best possible business

results. The agricultural and food sector has undergone numerous transformations over the course of two centuries. In response to environmental challenges and pollution problems caused by conventional agriculture, organic and other sustainable agricultural production has developed. Agriculture is specific due to its dependence on various external factors, resources, knowledge and innovations, as well as the way of transferring new technologies. The application of innovations in this sector is not a simple process and it is not enough to provide financial resources and experts, because experiences from many countries, both developed and developing, have shown that this in itself is not a guarantee of successful modernization of agriculture and rural development (Tomaš Simin & Janković, 2014).

Innovations in agriculture are not limited to agricultural holdings, but should encompass the entire value chain, including government policies aimed at agribusiness development (Vanclay et al., 2013). The connection between research, innovation and increasing productivity is gaining more and more importance, so in this context the role of the state is extremely important.

Recent research shows that nanotechnology has significant potential for a positive impact on the agri-food sector. It can reduce the negative effects of agricultural practices on the environment and human health, while increasing food security and productivity, while promoting social and economic balance.

The concept of sustainability in this context implies production systems that aim to increase yields without harming the environment and with appropriate cultivation of agricultural land. Considering challenges such as global population growth and climate change, the application of nanotechnologies and nanomaterials in agriculture can significantly contribute to sustainability.

The efficiency of the use of fertilizers and pesticides can be improved through the use of nanocarriers and compounds, which allows for a reduction in quantity without loss of productivity. Nanotechnologies also contribute to reducing waste, improving production and reusing waste through recycling. Nanosensor technology is driving the development of precision agriculture, enabling more efficient management of resources such as water and energy (Fraceto, 2016).

Contemporary challenges and sustainable development of the agricultural sector

In modern society, no economic sector can successfully advance without the constant introduction of innovations, application of new approaches and improvement of business activities. At the same time, economic benefits must not be achieved at the expense of the environment and human health. The innovations that are implemented must be harmonized with the modern requirements of sustainable development, that is, they must satisfy economic, ecological and social criteria. In this process, legal regulations and accompanying institutional mechanisms play a key supporting role.

In the agricultural sector, it is crucial to efficiently use available resources, especially

natural ones, as well as properly apply innovations. In order to protect the environment, but also to increase yields and productivity, different agricultural systems have been developed over time. Nevertheless, even at the beginning of the 21st century, there is still a dilemma as to which type of agriculture should be focused on.

Low productivity in the agriculture of less developed countries represents a significant challenge, mainly due to the insufficient application of modern resources and the presence of other negative factors. Therefore, these countries need technological innovations that will be adapted to the specifics of each region, and that will encourage the modernization of agriculture, while preserving traditional values. It is important to emphasize that today's agricultural system can be considered sustainable and successful in the long term only if it simultaneously improves human health, protects the environment, ensures sufficient food production and ensures an acceptable income for farmers.

Sustainable agricultural development in modern conditions

Sustainable development is defined as development that meets the needs of the present generation without jeopardizing the ability of future generations to meet their needs (World Commission on Environment and Development, 1988). The concepts of sustainable development and rurality, as well as their combination — sustainable rural development and sustainable agriculture, are often discussed in the literature. Although they appear similar, each of these concepts includes different ideas related to agriculture, rural development, nature and landscape conservation, as well as the role of key actors such as farmers, rural populations and the state (Tovey, 2008).

Sustainable agriculture mainly focuses on farmers and ecological conditions at the farm level, while sustainable rural development covers a wider regional framework and includes a wider range of actors because, in addition to agriculture, it also includes other aspects of rural development (Murdoch et al., 2003). In doing so, priority is given to long-term sustainability instead of short-term profit, and sustainability is also viewed in the context of the social acceptability of the agricultural sector.

In essence, sustainability is a means to improve the social, economic and environmental acceptability of the sector. Sustainable agriculture is tasked with solving numerous technical challenges, while simultaneously providing socio-economic and environmental aspects (Hermans et al., 2010).

Sustainable agriculture represents one of the key segments within sustainable development and is considered a modern approach to the development of this sector. Given the close connection between agriculture and the environment, sustainable development in agriculture must be a continuous process in order to preserve natural resources for future generations.

Emphasizing the importance of agricultural activity and the importance of sustainable rural development, especially in countries with a less developed economy where

many rural residents depend on agriculture as a source of income and employment, it becomes clear that this topic has a high priority in planning future development. Sustainable development requires the proper management and protection of natural resources, as well as appropriate management of technological innovation and adequate administrative structures, in order to enable the continuous satisfaction of people's needs now and in the future.

This approach implies the preservation of key elements such as soil, water and biodiversity, with the application of technologies that do not threaten the environment, and at the same time are economically and socially acceptable (Bastan et al., 2018).

It is necessary to adopt the concept of sustainable agriculture, which is adapted to the specific conditions of each country, as a fundamental resource for future development. This approach enables efficient and rational use of natural and other resources in accordance with the environment, while ensuring food safety for both current and future generations. However, the application of the concept of sustainable development represents a complex task in modern conditions, because it includes a series of measures that should maintain economic and social stability, based on environmental protection, which can contribute to a significant improvement in the quality of life of the population (Simiton, 2015). The sustainability of agricultural systems has become a central topic in debates about human survival. In an age of climate change, market globalization and rapid technological progress, an accurate assessment of the sustainability of food production systems becomes crucial.

One of the important questions is the extent to which intensive agricultural systems affect the environment and how ecologically sustainable they are (Tait & Morris, 2000). Managing the relationship between plants and the environment, especially in the context of global climate change, represents one of the most important challenges of modern sustainable development in agriculture.

Sustainable agriculture has a special importance in modern society because it provides solutions for needs that conventional agriculture has not been able to fully satisfy. It is a comprehensive concept that includes advances in agricultural production management and the improvement of agricultural technologies. Its importance is growing, especially considering that the intensive development of conventional agriculture after the Second World War was not able to respond to all the challenges of the modern era.

Today, an ideal agricultural system is considered to be sustainable only if it simultaneously improves human health, benefits both producers and consumers, protects the environment, and provides sufficient food for the growing world population (Singh et al., 2011). Agricultural practice today offers new development models, which is confirmed by the rapid growth of the agricultural bio-economy with an increasing emphasis on ecological values.

In many countries, an intense wave of innovation in the agri-food sector is visible, which results in the expansion of the offer of products and services, the development

of new perennial crops, the production of biomass, healthy food and ecological non-food products from agricultural raw materials. These innovations contribute to the development of the so-called "new agriculture" which is oriented towards sustainability and responsibility in social, economic and environmental terms (Jordan et al., 2008).

Modern agriculture rapidly increases productivity, but at the same time leads to excessive consumption of resources and energy, as well as to the degradation of the agricultural environment. Inadequate management of agricultural development damages the environment and significantly threatens the sustainability of agricultural development. In this context, the circular economy has emerged as an effective model based on the principles of sustainable development, which enables the coordinated development of the economy and the environment through efficient waste management. This model, known as the recycling economy, is based on the concept of ecological agriculture without pollution and represents a path towards progressive and sustainable development (Jun & Xiang, 2011).

Conventional agriculture

Conventional agriculture is still the most widespread model of agricultural production in the world, primarily because of its high economic profitability, especially when it comes to large-scale production. This system allows the use of chemical agents, but within the legally regulated norms. In professional literature, conventional agriculture is often characterized as a model that requires large capital investments, a high degree of mechanization and profitability, with a wide application of mineral fertilizers, pesticides and herbicides, and intensive ways of growing plants and animals (Comer et al., 1999).

However, certain practices characteristic of this type of production - such as the use of agrochemicals - have negative consequences for human health and the environment. The use of pesticides has led to various environmental and health problems, which has encouraged the development of alternative models of agriculture that limit the use of chemicals without causing a significant drop in yields. Although the yield in organic farming is usually lower compared to conventional production, it depends on the type of crops, regional conditions and technologies used. Despite this, conventional production systems generally yield higher profits.

From the point of view of environmental protection, the advantages of organic production - such as reduced use of chemicals, preservation of soil and water fertility, as well as improvement of biodiversity - are significantly more pronounced than in conventional systems. However, due to better economic profitability, conventional agriculture is still dominant. Despite its ecological disadvantages, it is possible to improve its sustainability and reduce the negative impact on the environment through the gradual inclusion of certain organic practices within conventional production (Pimentel et al., 2005).

According to research by Te Pas and Risa (2014), in developed countries, organic

agriculture generally brings lower yields and lower profitability compared to conventional agriculture. In middle-developed countries, organic production has a slightly better position, while in the least developed countries this type of production is often more profitable - thanks to lower labor costs and the availability of cheaper manure.

In theory and practice, it is often emphasized that organic agriculture is more environmentally friendly, while conventional is more economically profitable. However, one should not strive for exclusivity. It is necessary to strive for a balance between economic and ecological interests, while respecting the social context. This implies the application of innovative approaches within conventional production, with controlled and limited use of chemical and synthetic agents in crop and livestock production.

Modern agriculture as a driver of sustainable development and green transformation

Sustainable development implies a balanced approach that includes economic, ecological and social aspects of development, whereby institutional support is of key importance for the successful implementation of this concept. The idea of sustainable development and ecologically oriented economy appeared in the second half of the 20th century, and the end of that century and the beginning of the 21st were marked by the intensification of global initiatives, forums and research aimed at this issue.

The concept of green economy is closely related to sustainable development. Its advocates believe that the modern economic system, although it has contributed to the improvement of living standards, has numerous shortcomings, among which stand out environmental problems such as climate change, loss of biodiversity, overexploitation of natural resources, as well as pronounced social inequalities, poverty, shortages of food, water and energy.

The green economy is proposed as an alternative to the existing model, with the aim of enabling a long-term increase in social well-being, without jeopardizing the natural environment and resources needed by future generations. Special importance to this concept was given at the United Nations Conference on Sustainable Development, held in 2012 in Rio de Janeiro (Rio + 20), where key documents such as the Rio Declaration and Agenda 21 were adopted, which further confirmed the green economy as an important path to a sustainable future.

Sustainable agriculture can be viewed from several angles, depending on the professional field. From an agronomist's point of view, it implies the long-term preservation of food production. Environmentalists see it as a method that makes it possible to meet food needs without harming natural resources. The economic aspect of sustainable agriculture is reflected in the rational and long-term efficient use of resources. For sociologists and anthropologists, this form of agriculture has a wider meaning - it preserves cultural heritage and respects the social dimensions of the development of rural areas (Vujičić & Ristić, 2006).

The progress of sustainable agriculture and the countryside can be ensured through the interconnection and cooperation of the primary (agriculture), secondary (manufacturing) and tertiary sectors (services), in various forms. In that process, in addition to the key role of the state, local initiatives that contribute to the development and strengthening of rural communities are extremely important (Vujičić et al., 2012).

Integration of the bioeconomy into the circular development of the agricultural sector

The bioeconomy is based on the use of renewable biological resources in order to produce food, biological products that are not intended for food, as well as green energy. Its application includes various sectors such as agriculture, forestry, fishing, food industry, pulp and paper industry, parts of the chemical industry, biotechnology and energy (Ronzon et al., 2017). According to OECD (2006), the bioeconomy implies the use of biological products and processes with the aim of achieving benefits both for individuals and for society as a whole.

When we talk about the development of the bioeconomy, it is important to point out that the key sources of biomass for energy production are precisely agriculture, forestry and certain types of biological waste. The most important forms of biofuels include liquid fuels such as biodiesel and bio-oil, but also solid biofuels such as pellets and torrefied biomass. Biomass originating from agriculture includes the production of liquid fuels, bio-oil from wood pulp and pellets. At the global level, the available biomass base for energy production from biological sources represents a significant alternative to fossil fuels, which contributes to the sustainable development of the agricultural sector (Mathews, 2009).

In addition to the green economy, one of the key concepts closely related to the bioeconomy is the concept of circular economy. This model implies the introduction of business practices aimed at increasing efficiency in the use of resources, with a special emphasis on proper waste management. According to some authors, circular economy is considered a narrower term in relation to green economy and bioeconomy (Birner, 2018). Nevertheless, all three concepts represent compatible directions of development that are in accordance with the principles of sustainable agriculture and the entire economic system.

In the modern context, the circular economy is attracting more and more attention at the global level as a potential solution for overcoming the existing model of production and consumption, which is based on constant economic growth and intensive use of natural resources. The basic idea of the circular approach is to establish closed production cycles that enable reuse of raw materials and energy savings, unlike the traditional linear model, where raw materials become waste after one use (Ghisellini et al., 2016; Urbinati et al., 2017). This approach seeks to establish a balance between economic development, environmental protection and social responsibility.

Digitization of agriculture: Precision agriculture in the function of increasing efficiency

Today, modern information and communication technologies (ICT) play a key role in the economy and society, including in agriculture (Ristić, Vujičić & Dimitrijević, 2020). Innovation in this sector is no longer limited to new plant varieties and animal breeds, but also includes technologies such as satellite imagery, sensors and drones.

Agriculture has always benefited from technical and technological progress. The industrial revolution brought mechanization, the use of artificial fertilizers and chemicals, while the modern age introduced genetic engineering and automation. Today, the digital era provides great opportunities for integrating ICT solutions into the model of precision agriculture. The success of precision agriculture is measured not only by economic but also by ecological and social benefits. It is particularly important for increasing the profitability of farmers and saving financial and other resources (Zhang et al., 2002). Also, precision agriculture contributes to the development of smart villages.

Although precision agriculture represents an innovative approach, it is still significantly less represented in practice compared to conventional agriculture. Its purpose is, among other things, to increase the efficiency of resource use. This approach involves the use of various technologies, such as sensors, information systems, advanced machines and management software, with the aim of optimizing production (Gebbers & Adamchuk, 2010). It is believed that the application of precision agriculture in the world will increase significantly, but this requires a modern information infrastructure, including broadband Internet and other supporting technologies.

Precision agriculture involves intensive data collection directly in the field, often in parallel with the operation of machines. Analysis of this data is key to understanding yield variability. Wireless sensor networks are a new technology that enables the collection and processing of data from sensors distributed in the field in real time (Camilli et al., 2007). By using these networks, precision agriculture can increase efficiency, productivity and profitability while reducing negative environmental impacts.

For the application of numerous technologies in agriculture, the goal is to make products safer and to reduce negative impacts on the environment, which is in line with the principles of sustainable development. Precision agriculture is emerging as a key part of a broader strategy to achieve this goal. This approach uses remote sensing technologies and is an effective tool for achieving sustainability. Precision agriculture brings numerous benefits, including increased profitability, productivity, quality of crops and final products, improvement of farm living conditions, food security, environmental protection, development of rural economy and better management of resources through more rational use of inputs (Liaghat & Balasundram, 2010). However, the development of precision agriculture is slowed down by various challenges, such as the high cost of equipment, the complexity of working with modern devices that require specialized training, problems in servicing and maintaining equipment, as well as strict requirements in terms of standards for sensor networks.

Conclusion

Modern innovations are the key driving force behind the transformation of Serbian agriculture towards a sustainable and competitive production system. Faced with challenges such as climate change, land degradation, workforce reduction and the need to conserve natural resources, Serbian agriculture increasingly has to rely on technological advances in order to preserve productivity and at the same time reduce negative impacts on the environment.

The application of precision agriculture, information technologies, smart sensors, automated irrigation systems and satellite crop monitoring enables more efficient management of resources such as water, fertilizers and energy. This not only improves the quality and quantity of production, but also contributes to the preservation of biodiversity and the reduction of harmful gas emissions. Innovations in the field of biotechnology and genetic improvement of plants also contribute to resistance to diseases, drought and other stress factors, which is especially important in the conditions of increasingly pronounced climate changes.

In addition to environmental benefits, modern innovations also have social and economic significance - they enable the creation of new jobs, the development of rural areas, greater food security and a better position of agricultural producers on the domestic and foreign markets. However, in order to fully realize these benefits, it is necessary to provide institutional support through education, subsidies, research and development, as well as encouraging cooperation between scientific institutions, state authorities and the private sector.

In conclusion, a sustainable transformation of Serbian agriculture cannot be imagined without strategic investment in innovation. They represent a bridge between traditional production and modern, ecologically responsible agriculture that will meet the needs of current and future generations.

Conflict of interests

The authors declare no conflict of interest.

References

1. "Official Gazette of RS", No. 55/2013. Law on Innovation Activity. Taken from https://www.paragraf.rs/propisi/zakon_o_inovacionoj_delatnosti.html
2. Bastan, M., Khorshid-Doust, R.R., Sisi, S.D., & Ahmadvand, A. (2018). Sustainable development of agriculture: a system dynamics model. *Kybernetes: The international journal of systems, cybernetics and management science*, 47 (1), 142-162.
3. Birner, R. (2018): Bioeconomy Concepts. In: Iris Lewandowski (Ed.), Bioeconomy - Shaping the Transition to a Sustainable, Biobased Economy (pp. 17-39). Gewerbestrasse: Springer IP AG.

4. Comer, S., Ekanem, E., Muhammad, S., Singh, S. P. & Tegegne, F. (1999): Sustainable and Conventional Farmers: A Comparison of Socio-Economic Characteristics, Attitude, & Beliefs. *Journal of Sustainable Agriculture*, 15(1), 29–45
5. FAO (1989). 'Sustainable development and natural resources management', Twenty-Fifth Conference, Paper C 89/2 - Sup. 2, Food and Agriculture Organization, Rome.
6. Fraceto, L. F., Grillo, R., de Medeiros, G. A., Scognamiglio, V., Rea, G., & Bartolucci, C. (2016). Nanotechnology in Agriculture: Which Innovation Potential Does It Have? *Frontiers in Environmental Science*, 4 (20). 1-6.
7. Grujić, B., Kljajić, N. & Roljević Nikolić, S. (2015). The concept of innovation, knowledge management and implications for the agricultural sector of Serbia. Collection of scientific papers Agroeconomics (209-215), 21 (1-2). Belgrade: Institute for Agricultural Economics. Ghisellini, P., Cialani, C. & Ulgiati, S. (2016): A review on circular economy: the expected transition to a balanced interplay of environmental and economic systems. *Journal of Cleaner Production*, 114(2016), 11–32.
8. Hermans, F., Horlings, I., Beers, P., & Mommaas, H. (2010). The Contested Redefinition of a Sustainable Countryside: Revisiting Frouws' Ruralty Discourses. *Sociologia Ruralis*, 50 (1), 46–63.
9. Jordan, N.R., Bawden, R.J., & Bergmann, L. (2008). Pedagogy for Addressing the Worldview Challenge in Sustainable Development of Agriculture. *Journal of Natural Resources and Life Sciences Education*, 37 (1), 92-99.
10. Jun, H., & Xiang, H. (2011). Development of Circular Economy Is A Fundamental Way to Achieve Agriculture Sustainable Development in China. *Energy Procedia*, 5, 1530–1534.
11. Mathews, J. A. (2009): From the petroeconomy to the bioeconomy: Integrating bioenergy production with agricultural demands. *Biofuels, Bioproducts and Biorefining*, 3(6), 613–632.
12. OECD (2006): Scoping document: The bioeconomy to 2030: Designing a policy agenda. Paris: The Organisation for Economic Co-operation and Development.
13. Official Gazette of the RS, No. 85/14. Agriculture and rural development strategy of the Republic of Serbia for the period 2014-2024. Year Tait, J., & Morris, D. (2000). Sustainable development of agricultural systems: competing objectives and critical limits. *Futures*, 32 (3-4), 247–260.
14. Padel, S. (2001). Conversion to organic farming: a typical example of the diffusion of an innovation. *Sociologia Ruralis*, 41 (1), 40-61.
15. Pimentel, D., Hepperly, P., Hanson, J., Douds, D. & Seidel, R. (2005): Environmental, Energetic, and Economic Comparisons of Organic and Conventional Farming Systems. *BioScience*, 55(7), 573-582.
16. Rogers, E. (2003). Diffusion of innovations, Free Press, A Division of Simon & Schuster, Inc., New York.

17. Ronzon, T., Piotrowski, S., M'Barek, R. & Carus, M. (2017): A systematic approach to understanding and quantifying the EU's bioeconomy. *Bio-based and Applied Economics*, 6(1), 1-17.
18. Simiton, D. (2015). Profitability In The Context Of The Needs And Requirements Of Sustainable Farms Development. *Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development*, 15 (1), 467-472.
19. Singh, J. S., Pandey, V. C., & Singh, D. P. (2011). Efficient soil microorganisms: A new dimension for sustainable agriculture and environmental development. *Agriculture, Ecosystems & Environment*, 140 (3-4), 339-353.
20. Te Pas, C. M. & Rees, R. M. (2014): Analysis of Differences in Productivity, Profitability and Soil Fertility Between Organic and Conventional Cropping Systems in the Tropics & Sub - tropics. *Journal of Integrative Agriculture*, 13(10), 2299-2310.
21. Tomaš Simin, M. & Janković, D. (2014). Applicability of diffusion of innovation theory in organic agriculture. *Economics of Agriculture*, 61 (2), 517-529.
22. Tovey, H. (2008). Introduction: rural sustainable development in the knowledge society era. *Sociologia Ruralis*, 48 (3), 185-199.
23. UN(2015). Transforming our world: the 2030 Agenda for Sustainable Development. General Assembly. United Nations, Department of Economic and Social Affairs, Sustainable Development. New York, USA.
24. United Nations Serbia (2018). Sustainable Development Goals Serbia, Belgrade, 2018, available <https://www.stat.gov.rs/media/3707/un-sdgbrochure-srb-cir-2018-2-web.pdf>
25. Urbinati, A., Chiaroni, D. & Chiesa, V. (2017): Towards a new taxonomy of circular economy business models. *Journal of Cleaner Production*, 168, 487-498.
26. Vancley, F. M., Russell, A. W., & Kimber, J. (2013). Enhancing innovation in agriculture at the policy level: The potential contribution of Technology Assessment. *Land Use Policy*, 31, 406-411.
27. Vujičić, M. & Ristic, L. (2006): Economics of agriculture. Kragujevac: University of Kragujevac - Faculty of Economics.
28. Vujičić, M., Ristić, L. & Ćirić, N. (2012): Local Initiatives for Rural Vitality and Social Inclusion: Some Experiences from Serbia. *Eastern European Countryside*, 19, 105-126.
29. World Commission on Environment and Development. (1988). Our common future. Oxford: Oxford University Press.

THE ROLE OF THE VITICULTURE AND WINE SECTOR IN RURAL DEVELOPMENT AND THE AGRO-FOOD ECONOMY: EVIDENCE FROM NORTH MACEDONIA

Aleksandra Angeleska¹, Blagica Sekovska², Igor Esmerov³,
Elizabeta Dimitrieska Stojkovic⁴, Risto Uzunov⁵

*Corresponding author E-mail: bsekovska@fvm.ukim.edu.mk

ARTICLE INFO

Review Article

Received: 10 February 2026

Accepted: 15 April 2026

doi:10.59267/ekoPolj2603959A

UDC 634.8-
047.44:338.439(497.7)

Keywords:

*viticulture; wine production;
rural development; agro-food
economy; agroforestry; North
Macedonia; wine tourism;
organic viticulture*

JEL: Q13, Q17, R11

ABSTRACT

Viticulture and wine production represent a strategically important segment of the agri-food economy of North Macedonia, combining economic, social and territorial functions. This paper analyses the structural characteristics, economic performance and developmental role of the viticulture and wine sector, with particular emphasis on its contribution to rural development, exports and land use sustainability. The study is based on the analysis of secondary data obtained from the State Statistical Office of the Republic of North Macedonia, complemented by policy documents and relevant scientific literature. The results indicate that the sector plays a significant role in agricultural output and export performance, accounting for a substantial share of agri-food exports and providing income for approximately 20,000 rural households. The paper concludes that viticulture and winemaking function as a permanent agricultural system with relevance for agroforestry and sustainable land-use frameworks.

-
- 1 Aleksandra Angeleska, Ph.D. Senior research associate, Ss. Cyril and Methodius University in Skopje, Faculty of Veterinary Medicine - Skopje, Lazar Pop Trajkov 5-7, Skopje, North Macedonia, Phone: +38971332569, E-mail: mizasandra@yahoo.com, ORCID ID (<https://orcid.org/0000-0002-7109-2681>)
 - 2 Blagica Sekovska, Ph.D. full time professor, Ss. Cyril and Methodius University in Skopje, Faculty of Veterinary Medicine - Skopje, Lazar Pop Trajkov 5-7, Skopje, North Macedonia, E-mail: bsekovska@fvm.ukim.edu.mk, ORCID ID (<https://orcid.org/0000-0002-3529-418X>)
 - 3 Igor Esmerov, Ph.D. Senior research associate, Ss. Cyril and Methodius University in Skopje, Faculty of Veterinary Medicine - Skopje, Lazar Pop Trajkov 5-7, Skopje, North Macedonia, Phone: +38971262436, E-mail: i.esmerov@fvm.ukim.edu.mk, ORCID ID (<https://orcid.org/0009-0004-5320-0441>)
 - 4 Elizabeta Dimitrieska Stojkovic, Ph.D. Principal scientist, Ss. Cyril and Methodius University in Skopje, Faculty of Veterinary Medicine - Skopje, Lazar Pop Trajkov 5-7, Skopje, North Macedonia, Phone: +39870222049, E-mail: edimitrieska@fvm.ukim.edu.mk, ORCID ID (<https://orcid.org/0000-0001-8315-5267>)
 - 5 Risto Uzunov, Ph.D. Associate professor, Ss. Cyril and Methodius University in Skopje, Faculty of Veterinary Medicine - Skopje, Lazar Pop Trajkov 5-7, Skopje, North Macedonia, Phone: +38970316319, E-mail: risteuzunov@fvm.ukim.edu.mk, ORCID ID (<https://orcid.org/0000-0002-4901-1312>)

Introduction

Viticulture and wine production represent one of the most enduring and recognisable segments of agriculture and the agri-food industry in North Macedonia. Historical and archaeological evidence indicates a long-standing continuity of grape cultivation and wine production dating back to antiquity and the Roman period, while wine has also occupied an important place in the cultural and religious practices of the region. This long-term historical development has created a strong cultural and symbolic foundation upon which the contemporary viticulture and wine sector has been built. Unfortunately, in Macedonia, the wine culture is still at a very low level and continues the tradition of production and consumption of domestic poor quality wine, especially outside Skopje. (Risteska et al 2018)

Beyond its cultural significance, viticulture and winemaking have acquired a pronounced economic and strategic role in the country's agri-food economy over recent decades. According to official trade data, wine consistently ranks among the leading agri-food export products, alongside tobacco, accounting for a substantial share of foreign exchange earnings from agricultural exports. National strategies for agriculture, exports and rural development explicitly identify wine as a strategic product with high potential for value addition, branding and international competitiveness.

The economic importance of the sector extends well beyond export performance alone. Regional analyses for the Western Balkans suggest that grape production, together with the wine industry, contributes approximately 17–20% of the agricultural sector's share in the gross domestic product of North Macedonia (Beleski, 2019; International Trade Administration, 2024). Grape and wine production generate significant value added within agriculture and provide income for a large number of rural households. The sector is characterised by a structure in which numerous small-scale individual grape growers coexist with a relatively concentrated processing segment dominated by medium-sized and large wineries. This structure gives the sector a particular social and developmental relevance, especially in rural areas where viticulture represents a key source of income.

In recent years, the viticulture and wine sector has increasingly been linked to tourism, regional branding and the international promotion of the country. The development of wine tourism, wine routes and integrated gastronomic offerings generates additional economic effects and creates opportunities for rural economic diversification. Research on wine tourism in North Macedonia suggests that wineries, wine trails and wine-related experiences can generate supplementary economic benefits, contribute to rural diversification and enhance the recognition of wine regions as tourist destinations (Kitanov, 2024).

At the same time, the sector faces a range of structural and external challenges, including fragmented vineyard ownership, a historical orientation towards bulk wine production, climate change, and shifting consumer preferences in global markets.

The geographical diversity and climatic conditions of North Macedonia provide favourable conditions for grape cultivation (Angelovska et al., 2022). According to Invest North Macedonia, the country is divided into three main wine regions: the central Vardar River Valley region, covering approximately 24,664 hectares (87% of total vineyard area), the Western Pelagonia–Polog region with 1,817 hectares, and the Eastern Pčinja–Osogovo region with 1,733 hectares. The total vineyard area amounts to approximately 33,423 hectares, of which around 28,213 hectares are dedicated to wine grapes (Invest North Macedonia, n.d.). These figures highlight the dominance of the Vardar Valley and explain the spatial concentration of wineries in this region.

Local grape varieties thrive under these conditions. Red varieties such as Vranec, Prokupac and Gamay continue to dominate the red wine segment, while Cabernet Sauvignon, Merlot and Pinot Noir have gained importance in recent years. Among white grapes, the autochthonous varieties Smederevka and Žilavka remain widely cultivated alongside international varieties such as Riesling, Chardonnay and Sauvignon Blanc. Invest North Macedonia identifies Vranec as the leading grape variety in the country. This combination of local and international varieties provides producers with flexibility to target both domestic and export markets.

The Standing Working Group for Regional Rural Development reports that vineyards in North Macedonia account for approximately 40% of total vineyard areas in the Western Balkans. In 2020, the country reported 28,213 hectares of vineyards, significantly exceeding Serbia (19,840 hectares) and Albania (12,007 hectares) (Beleski et al., 2023). The same report highlights that North Macedonia recorded 129.35 hectares under conversion to organic production—the highest figure in the region—and 17.6 hectares already certified as organic (Beleski et al., 2023). These figures indicate both the scale of the sector and a modest but growing shift towards organic viticulture.

According to available estimates, the country has approximately 99 registered wineries producing slightly over 100 million litres of wine annually. Vineyard management involves around 20,000 individual grape growers alongside a smaller number of large companies. Wine grape varieties account for approximately 85% of all vineyards, while the remaining 15% are planted with table grapes (Invest North Macedonia, n.d.). Annual harvests yield up to 125,000 tonnes of grapes (Invest North Macedonia, 2021). Approximately 40% of wine production is bottled, while around 60% is sold in bulk (Invest North Macedonia, 2021).

Manevska-Tasevska (2006) argues that the sector's main strengths lie in favourable natural conditions and a skilled labour force, while its weaknesses stem from insufficient investment in infrastructure and weak management strategies. Using Porter's diamond model, the author demonstrates that domestic demand, related industries and factor conditions provide competitive advantages, whereas support policies and industry organisation require improvement. Although dated, covering the period 1995–2004, this study continues to offer a relevant theoretical framework for analysing contemporary challenges.

Government policies and international cooperation play a crucial role in the development of viticulture and winemaking. The EU accession process has influenced regulatory frameworks and market access conditions. Manevska-Tasevska (2006) notes that the Stabilisation and Association Agreement enabled North Macedonia to export 300,000 hectolitres of wine to the EU at zero tariff during the transition period. While this preferential quota supported producers, it also reduced incentives to upgrade quality. More recent strategies emphasise diversification towards bottled wine and higher value-added segments. The 2023 SWG report underscores the expansion of organic vineyards and highlights the need for measures supporting certification, conversion and marketing (Beleski et al., 2023).

Wine tourism has emerged as a complementary activity capable of adding value to grape and wine production. Winery visits, tasting experiences, and the integration of gastronomy and landscape are key elements of the tourism product (Carlsen & Charters, 2006; Nickova, 2021). Wine tourism thus connects agriculture, culture, and hospitality and is recognised as an effective instrument for rural diversification, generating multiplier effects through the integration of agriculture, tourism, and local gastronomy (Hall et al., 2000; Getz & Brown, 2006)

The aim of this paper is to analyse the economic, structural and developmental role of the viticulture and wine sector in North Macedonia and to argue its position as a strategic pillar of the agri-food economy. Through a synthesis of official statistical data, relevant policy documents and existing scientific studies, the paper seeks to demonstrate how the sector contributes to agricultural production, exports, rural incomes and national branding. By systematising available information, the study provides an analytical basis for informed discussions on future development priorities and policy directions in viticulture and winemaking.

Materials and methods

The methodology is based on the analysis of secondary data obtained from the State Statistical Office of the Republic of North Macedonia. The study uses annual datasets on agricultural production, vineyard areas, grape purchase and sales, as well as wine production and exports by year. Data were compared across different years in order to identify trends, growth or decline, and structural changes within the sector. Simple comparative tables and descriptive indicators were employed to illustrate production dynamics and the economic significance of the viticulture and wine sector.

Results and discussion

Results

The analysis of secondary data from the State Statistical Office and relevant institutional sources indicates that the viticulture and wine sector occupies a stable and significant position within the agri-food economy of North Macedonia, while simultaneously facing structural constraints that affect its long-term competitiveness.

Vineyard area and production structure

Table 1. Productional areas, total production and yield of vineyards in North Macedonia (2014-2024)

Year	Harvested areas (ha)	Total production (tones)	Average yield (kg/ha)
2014	22 918	195 888	8 620
2015	23 192	324 769	14 171
2016	23 192 (≈)	333 319	14 372
2018	23 670	294 497	12 442
2019	23 996	258 960	10 792
2020	23 709	317 550	13 394
2021	19 384	269 131	11 509
2022	23 047	265 556	11 522
2023	21 972	149 006	6 782
2024	21 534	205 571	9546

Source: State Statistical Office of the Republic of North Macedonia – *MAK-STAT database*

The data show that vineyard areas have remained relatively stable, fluctuating around 22,000–24,000 hectares, with 21,534 hectares recorded in 2024. Total production volumes exhibit considerable variability, with peak production in 2015 and 2016 and a notably weak harvest in 2023. Average yields range between 8,620 and 14,372 kg/ha, reflecting sensitivity to climatic conditions and vineyard management practices.

Table 2. Number of vine stocks (total and native) in North Macedonia (2014-2024)

Year	Total number of vine stocks ('000)	Number of native vine stocks ('000)
2014	86 313	84 481
2015	87 668	85 950
2016	87 668 (≈)	85 950 (≈)
2018	88 356	86 591
2019	88 520	86 387
2020	85 597	84 280
2021	89 817	87 954
2022	83 709	82 062
2023	80 510	78 778
2024	79 314	77 046

Source: State Statistical Office of the Republic of North Macedonia – *MAK-STAT database*

The number of vine stocks has gradually declined over the observed period, primarily due to vineyard ageing, recultivation and replanting. More than one-third of vineyards are older than 30 years, while only around 2% of the total area is under organic conversion (SWG, 2023), indicating significant scope for structural renewal and sustainability-oriented investment.

Table 3. Main Wine Regions in North Macedonia, Climatic Characteristics, and Dominant Grape Varieties

Wine Region	General Climatic Conditions	Dominant Varieties
Tikveš (Central Vardar)	The warmest and driest region with a long growing season (average annual > 2,700 sunshine hours)	Vranec, Kratošija, Smederevka, Temjanika
Skopje Region	Moderate continental climate with mild summer temperatures and relatively cool nights	Smederevka, Chardonnay, Cabernet Sauvignon
Veles (Vardar) Valley	Warm and dry, with gentle relief	Vranec, Cabernet Sauvignon, Rkaciteli
Pelagonia–Polog Region	Mountain climate with lower temperatures and higher precipitation; suitable for late varieties	Vranec, Cabernet Sauvignon, Riesling
Eastern Region (Bregalnica, Tikveš, Štip)	Warm and semi-dry with larger temperature differences during the day	Vranec, Smederevka, Sauvignon Blanc

Source: Metodijeski et al, 2020

North Macedonia is divided into several wine regions with different microclimates. Tikveš Valley is the most fertile region, covering over half of the vineyard area and dominated by Vranec. The regions around Skopje and Veles produce a variety of white and red grapes, while the mountainous Pelagonia–Polog region yields fresh and acidic wines.

Table 4. Age Structure of Vineyards and Organic Production (2023)

Category	Share of Total Area (%)
Vines aged < 10 years	~24%
Vines aged 10–30 years	~41%
Vines aged > 30 years	~34%
Vineyards under organic conversion	~2%

Source: SWG, 2023

The analysis of vineyard areas shows that viticulture in North Macedonia is a relatively stable sector in terms of land coverage, with total areas around 33–34 thousand hectares in recent years. Wine grape varieties dominate, accounting for approximately 85% of the total area, while the remainder is table grapes. This structure confirms the strong orientation of the sector towards wine production rather than direct sales of fresh grapes. According to the regional Western Balkan report (SWG, 2023), Macedonian vineyards are relatively old: more than one-third of the vineyards are over 30 years old. Only about 2% of the area is undergoing organic conversion, indicating potential for growth in organic production.

Regional distribution is notably uneven. The central wine region, namely the Vardar Valley, concentrates about 87% of the total vineyard area, highlighting its dominant role in national production. This concentration allows economies of scale and the development of specialized infrastructure, but also increases the sector's vulnerability to regional climatic shocks.

Table 5. Key Economic Indicators of the Macedonian Wine Sector

Indicator	Value/Range
Share of viticulture and winemaking in agricultural added value	~17–20% of agricultural GDP
Share of wine exports in total agri-food exports	Second most significant export product after tobacco; around 15% of the value of agri-food exports
Total value of wine exports	≈ 50–60 million USD annually; >80% intended for export
Number of registered wineries	70–80 production facilities (from small family-run to large industrial)
Main export markets	Germany, Croatia, Poland, Serbia, China, USA

Source: Beleski, 2019

Grape and wine production, export performance and regional comparison

Annual grape production reaches up to 120–125 thousand tonnes, with most grapes purchased by wineries, confirming strong vertical integration between primary production and processing. Approximately 85% of wine production is exported, positioning the sector as one of the most export-oriented segments of North Macedonia's agri-food economy.

Table 6. Production and export in North Macedonia (2019–2024)

Year	Production(mhl)	Export (mhl)	Export share
2019	1,00	0,85	85 %
2020	0,90	0,77	85 %
2021	0,95	0,81	85 %
2022	0,90	0,77	85 %
2023	1,00	0,85	85 %
2024	1,00	0,85	85 %

Source: State Statistical Office of the Republic of North Macedonia – *MAK-STAT database*

According to official promotional materials, 99 registered wineries produce slightly over 100 million liters of wine annually. Another source reports annual production of approximately 90 million liters, with around 85% of the production exported. The table below uses a series with moderate fluctuations between 0.90 and 1.00 mhl to illustrate changes in recent years. Red grape varieties such as Vranec dominate the country, although white varieties like Smederevka and Žilavka are also cultivated.

Table 7. Wine Production and Export in Serbia (2019–2024)

Year	Production (mhl)	Export (mhl)*	Export Share (≈)	Ratio to Macedonia (Production)	Ratio to Macedonia (Export)
2019	0.62	0.31	50%	0.62	0.36
2020	0.56	0.28	50%	0.62	0.37
2021	0.54	0.27	50%	0.57	0.34
2022	0.46	0.23	50%	0.51	0.30
2023	0.44	0.22	50%	0.44	0.26
2024	0.41	0.21	50%	0.41	0.24

Source: Statistical Office of the Republic of Serbia

By 2023, Serbia had around 430 registered producers, with total production around 30 million liters per year. Statswine data show a gradual decline in production from 0.62 mhl in 2019 to 0.41 mhl in 2024. More than half of Serbian wine is exported, with roughly 5.5 million liters going to Russia (about one-third of exports) and 17% to the European Union. Main grape varieties include Prokupac, Grašac, and Tamjanika.

Table 8. Wine Production and Export in Montenegro (2019–2024)

Year	Production (mhl)	Export (mhl)	Export Share	Ratio to Macedonia (Production)	Ratio to Macedonia (Export)
2019	0,17	0,057	33 %	0,17	≈ 0,07
2020	0,17	0,057	33 %	0,19	≈ 0,07
2021	0,17	0,057	33 %	0,18	≈ 0,07
2022	0,17	0,057	33 %	0,19	≈ 0,07
2023	0,17	0,057	33 %	0,17	≈ 0,07
2024	0,17	0,057	33 %	0,17	≈ 0,07

Source: MONSTAT. (2024). *Montenegro wine production and export statistics*. Podgorica: Statistical Office of Montenegro.

Official data indicate that around 108 registered wineries on 2,850 ha produce about 17 million liters of wine annually and export 5.7 million liters. The largest producer is the state-owned company 13. Jul – Plantaže. The main Montenegrin variety is Vranac, while white wines are produced from Krstac and Žižak.

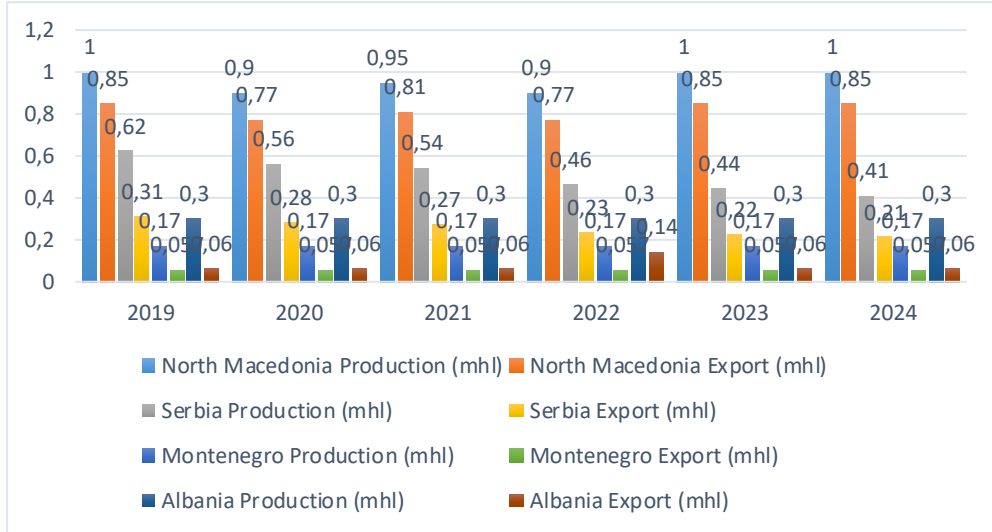
Table 9. Wine Production and Export in Albania (2019–2024)

Year	Production (mhl)	Export (mhl)	Export Share	Ratio to Macedonia (Production)	Ratio to Macedonia (Export)
2019	0,30	0,06	20 %	0,30	0,07
2020	0,30	0,06	20 %	0,33	0,08
2021	0,30	0,06	20 %	0,32	0,07
2022	0,30	0,14	46 %	0,33	0,18
2023	0,30	0,06	20 %	0,30	0,07
2024	0,30	0,06	20 %	0,30	0,07

Source: Wine production in Albania.” (2024). *Decanter Magazine*.

According to Decanter (2024), Albania has about 8,000 ha of vineyards and produces nearly 3 million liters of wine annually, with one-fifth exported. Ministry of Agriculture reports confirm that in 2022, 3.03 million liters were produced, with 46.4% exported. Indigenous varieties such as Kalmet, Sheshi, and Vlosh dominate production.

Figure 1. Comparison of wine production and wine export between different countries



The Figure 1 presents a year by year comparison of wine production and export volumes, expressed in million hectolitres, for North Macedonia, Serbia, Montenegro, and Albania over the period from 2019 to 2024. North Macedonia clearly stands out as the dominant producer among the four countries, with production fluctuating around one million hectolitres throughout the observed period. Its export volumes closely follow production levels, indicating a strong export orientation and a stable external demand for Macedonian wine. Serbia shows a noticeably lower production capacity compared to North Macedonia, with a gradual decline in production from 2019 onward. Export volumes follow the same downward pattern, reflecting a proportional relationship between domestic output and exports. This suggests that Serbian wine exports remain largely dependent on overall production trends rather than market expansion. Montenegro maintains a very stable production level across all years, with minimal variation. Export volumes remain consistently low, which points to a production structure focused primarily on the domestic market or limited export channels. Albania also demonstrates stable production figures, but with a notable increase in exports in 2022. This temporary rise suggests a short-term expansion in export activity, possibly driven by favorable market conditions or specific trade agreements, before returning to previous levels.

The analysis of trade data confirms that wine is among the leading agri-food export products of North Macedonia. In most years analyzed, wine ranks second in export value, just after tobacco, contributing significantly to total agricultural exports.

Globally, the viticulture and wine sector is considered one of the most internationalized segments of the agri-food economy, with strong export orientation and high sensitivity to quality, branding, and origin (Anderson & Nelgen, 2011; OIV, 2023).

Although export volumes are relatively stable, the structure shows a dominance of bulk wine exports, limiting the potential to increase export value without expanding physical volume. This highlights the need for strategic orientation toward bottled wine and higher-value segments, particularly in European Union markets.

Comparative analysis with Serbia, Montenegro and Albania shows that North Macedonia is the leading wine producer in the Western Balkans in terms of volume, with significantly higher export intensity. However, the dominance of bulk wine exports constrains export value growth and reinforces the need for a strategic shift towards bottled wine and higher value-added segments.

Table 10. Correlation Matrix Between Vineyard Area, Quantity, and Yield in North Macedonia (2014–2024)

Variable	Harvested Area (ha)	Total Production (t)	Average Yield (kg/ha)
Harvested Area (ha)	1.00	0.34	0.32
Total Production (t)	0.34	1.00	0.99
Average Yield (kg/ha)	0.32	0.99	1.00

Source: State Statistical Office of the Republic of North Macedonia. (2025). *Agricultural statistics 2014–2024*

Correlation analysis between vineyard area, total production, and average yield shows several clear relationships. The relationship between harvested area and total production is weak to moderate and positive ($r \approx 0.34$), indicating that during 2014–2024, increases in vineyard area were generally associated with higher grape quantities, though this is not the dominant factor. Similarly, the correlation between area and average yield is weak and positive ($r \approx 0.32$), suggesting that yield per hectare depends more on agronomic practices, vineyard age, and yearly climatic conditions rather than the total area planted.

The strongest correlation is between total production and average yield ($r \approx 0.99$), which is expected, as higher yields per hectare almost proportionally increase total harvested grapes, even when vineyard area changes minimally. This indicates that, while vineyard size is important, the key determinant of total production during the analyzed period is production intensity and yield levels rather than vineyard area alone.

Socio-economic significance and rural development

The sector involves approximately 20,000 individual grape growers, underscoring its importance for rural incomes and employment. Viticulture thus performs a dual function: as an export-oriented industry and as a mechanism of social stability in rural regions. Nevertheless, fragmented ownership and limited access to finance remain major constraints for small producers.

Emerging trends: organic production and wine tourism

Although organic viticulture still occupies a small share of total vineyard area, North Macedonia stands out regionally in terms of land under conversion to organic production (Willer & Lernoud, 2023). This indicates potential for product differentiation and access to niche markets. Wine tourism is also gradually developing as a complementary activity, contributing to regional branding and additional income generation.

Discussion

The results of the analysis confirm the central economic and developmental role of the viticulture and wine sector in the agri-food economy of North Macedonia, while also highlighting structural limitations that reduce its long-term competitive potential. Wine is confirmed as a strategic export product, playing a significant role in agricultural exports, in line with national and regional studies (Beleski, 2019; SWG, 2023).

The sector's structure, characterized by the coexistence of numerous small individual grape producers and a relatively concentrated processing segment, creates specific relationships within the agri-value chain. On one hand, this structure provides a broad social base and contributes significantly to rural livelihoods, consistent with sustainable rural development concepts. On the other hand, fragmented vineyard ownership, limited bargaining power of small producers, and constrained access to financial resources reduce efficiency and increase dependence on purchase prices, representing a long-term developmental risk (Metodijeski et al., 2020).

The analysis of production and export structure shows a dominance of bulk wine, which limits export value per unit of product (Tables 7–9). While this model provides stable market placement and foreign exchange inflow, it is less compatible with strategies based on quality, branding, and geographical differentiation. This finding aligns with Manevska-Tasevska, who concluded that the sector's competitive advantages derive from natural conditions and human capital, while weaknesses relate to institutional support, investment, and strategic management.

From the perspective of Porter's Diamond Model, factor conditions (climate, soil, autochthonous and adapted varieties) and related industries (processing, tourism, gastronomy) represent significant strengths. However, domestic demand conditions and firm strategies still do not create sufficient pressure for innovation or a shift toward higher value-added segments. This can be linked to a historical focus on mass production and the limited capacity of the domestic market to stimulate qualitative differentiation (Anderson, 2016; Anderson & Nelgen, 2011; OIV, 2023).

Results related to organic viticulture indicate potential pathways for diversification and increased sector resilience. Although organic production currently occupies a small share of total vineyard areas, the relatively high proportion of vineyards in conversion demonstrates interest and developmental potential, as eco-labeling and certification can create price premiums and market differentiation (Delmas & Grant, 2014; Reganold

& Wachter, 2016). Wine tourism, as a complementary activity, reinforces the idea that integrating agriculture with services can generate multiplier economic effects, increase local consumption, and contribute to regional and national branding (SWG, 2023).

From the perspective of land use and agroforestry-oriented development, viticulture can be regarded as a long-term, permanent agricultural system contributing to the stability of rural landscapes, the preservation of agricultural land, and continuity of rural employment. This dimension is particularly important in the context of climate change and increased market instability, where permanent plantations play a significant role in enhancing rural resilience (Table 10).

Globally, the viticulture and wine sector is considered one of the most internationalized segments of the agri-food economy, with strong export orientation and high sensitivity to quality, branding, and product origin (Anderson & Nelgen, 2011; OIV, 2023). In the context of North Macedonia, public policies play a key role in guiding sector development. Existing financial support measures are limited in effectiveness due to insufficient coordination, administrative barriers, and unequal access of small producers to financial instruments, highlighting the need for an integrated approach that links subsidies, investments, marketing, and rural development within a unified strategic framework.

Conclusion

The study confirms that viticulture and winemaking represent one of the key strategic pillars of North Macedonia's agri-food economy, with substantial contributions to agricultural output, exports, rural incomes and international visibility. While the sector benefits from favourable natural conditions and a long tradition, it remains predominantly oriented towards lower value-added production models.

At the same time, clear development opportunities exist. A transition towards bottled wine, terroir-based branding, expansion of organic viticulture and integration with wine tourism could significantly enhance value creation and sectoral resilience. Public policies should therefore adopt a more integrated approach, linking production support with quality improvement, investment, marketing and rural development, with particular attention to strengthening the position of small producers within the agri-food value chain.

Conflict of interests

The authors declare no conflict of interest.

References

1. Anderson, K. (2016). Wine's evolving globalization: A new comparative economic perspective. *Economic Papers*, 35(3), 187–198.
2. Anderson, K., & Nelgen, S. (2011). *Global wine markets, 1961–2009: A statistical compendium*. University of Adelaide Press.

3. Angelovska, A., Angeleska, A., Blagoevska, K., Hajrulai Musliu, Z., & Chrcheva Nikolovska, R. (2022). Examination of radioactivity and presence of additives in wines from Tikveš region. *Journal of Agriculture and Plant Sciences*, 20(1), 17–23. <https://doi.org/10.46763/JAPS22201017a>
4. Beleski, B. (2019). *Agricultural development and rural transformation in the Western Balkans*. Standing Working Group for Regional Rural Development.
5. Beleski, B., Gjorgjievski, D., & Petkovski, V. (2023). *Viticulture and wine sector in the Western Balkans: Trends, challenges and policy implications*. Standing Working Group for Regional Rural Development (SWG).
6. Carlsen, J., & Charters, S. (2006). *Global wine tourism: Research, management and marketing*. CABI.
7. Decanter Magazine. (2024). *Wine production in Albania*.
8. Delmas, M. A., & Grant, L. E. (2014). Eco-labeling strategies and price premiums: The wine industry puzzle. *Business & Society*, 53(1), 6–44.
9. Getz, D., & Brown, G. (2006). Critical success factors for wine tourism regions. *Tourism Management*, 27(1), 146–158.
10. Hall, C. M., Sharples, L., Cambourne, B., & Macionis, N. (2000). *Wine tourism around the world: Development, management and markets*. Butterworth-Heinemann.
11. iller, H., & Lernoud, J. (2023). *The world of organic agriculture: Statistics and emerging trends*. FiBL & IFOAM Organics International.
12. International Trade Administration. (2024). *North Macedonia country commercial guide: Wine sector overview*. U.S. Department of Commerce.
13. Invest North Macedonia. (2021). *Agri-food export and wine production statistics*. Government of the Republic of North Macedonia.
14. Invest North Macedonia. (n.d.). *Wine sector profile*. Government of the Republic of North Macedonia.
15. Kitanov, V. (2024). Wine tourism as a driver of rural diversification in North Macedonia. *Tourism and Hospitality Studies*, 9(1), 55–69.
16. Manevska-Tasevska, G. (2006). Competitiveness of the wine industry in the Republic of Macedonia. *Agricultural Economics Review*, 7(2), 89–103.
17. Metodijeski, D., Popovska, M., & Iliev, D. (2020). Wine tourism development and regional branding in North Macedonia. *Journal of Tourism and Cultural Change*, 18(4), 487–503.
18. MONSTAT. (2024). *Montenegro wine production and export statistics*. Statistical Office of Montenegro.
19. Nickova, S. (2021). Terroir and wine tourism as tools for regional development. *Tourism International Journal*, 66(3), 221–235.

20. Reganold, J. P., & Wachter, J. M. (2016). Organic agriculture in the twenty-first century. *Nature Plants*, 2, 15221.
21. Ristevka-Jovanovska, S., Sekovska, B., & Dimovska, A. (2018). Targeting markets for export of Macedonian wines to the EU. *Economics of Agriculture*, 65(3), September.
22. Standing Working Group for Regional Rural Development. (2023). *Viticulture and wine sector in the Western Balkans: Annual report*.
23. State Statistical Office of the Republic of North Macedonia – MAK-STAT. (2024).
24. Statistical Office of the Republic of Serbia. (2025).

STRATEGIC ANALYSIS OF BILATERAL TRADE BETWEEN NORTH MACEDONIA AND SERBIA: ECONOMIC AND FINANCIAL TRENDS

Aleksandar Lukić ¹, Milan Novović ², Dragan Milačić ³

*Corresponding author E-mail: aleksandarlukic.info@gmail.com

ARTICLE INFO	ABSTRACT
Review Article	This study examines bilateral trade between North Macedonia and Serbia from 2020 to 2024, with a focus on sectoral dynamics, structural changes, and development implications. Quantitative and qualitative analysis was conducted using export and import data classified by the Standard International Trade Classification (SITC Rev. 4) and descriptive statistical methods. Results indicate a steady increase in trade flows, with high-tech industry, chemicals, machinery, and the food sector showing strong growth, while traditional sectors such as raw materials and mineral fuels stagnated. The analysis reveals structural diversification and a shift toward higher value-added products, reflecting modernization of production and enhanced competitiveness. Recommendations include aligning industrial policies, fostering innovation, and strengthening sectoral specialization to support sustainable trade growth. The findings provide a clear overview of bilateral trade dynamics and sectoral developments.
Received: 18 February 2026	
Accepted: 20 April 2026	
doi:10.59267/ekoPolj2603973L	
UDC 339.5:005.52(497.7:497.11)	
Keywords: <i>Serbia, North Macedonia, bilateral trade, export, import</i>	
JEL: F14, F10, O24	

Introduction

Bilateral trade represents one of the fundamental mechanisms of contemporary international economic cooperation, as it enables not only the exchange of goods and services but also the diffusion of technology, transfer of knowledge, integration into regional and global value chains, and the enhancement of productivity and competitiveness of national economies. From a theoretical perspective, bilateral trade relations reflect the interaction of comparative advantages, production capacity

-
- 1 Aleksandar Lukić, Ph.D., Professor of Applied Studies, College of Applied Studies in Economics, Address: Gradski park 2, 11080 Belgrade, Serbia, Phone: +381 60 427 19 75, E-mail: aleksandarlukic.info@gmail.com, ORCID ID (<https://orcid.org/0000-0002-4922-2937>)
 - 2 Milan Novović, Ph.D., Assistant Professor, Academy of Hospitality, Tourism and Wellness, Address: Tošin bunar 179D, 11000 Belgrade, Serbia, Phone: +381 64 301 85 35, E-mail: mnovovic@akademijahtw.bg.ac.rs, ORCID ID (<https://orcid.org/0000-0002-6944-7973/>)
 - 3 Dragan Milačić, Ph.D., Professor of Applied Studies, College of Applied Studies in Economics, Address: Gradski park 2, 11080 Belgrade, Serbia, Phone: +381 62 871 87 70, E-mail: milacidragan@gmail.com, ORCID ID (<https://orcid.org/0000-0002-3380-1678>)

structures, and the institutional framework that defines the conditions of exchange. Accordingly, the analysis of foreign trade flows between the Republic of Serbia and the Republic of North Macedonia provides a significant contribution to understanding the dynamics of economic relations within the Western Balkans region, particularly in the context of deepening regional integration and gradual harmonization with the European economic area (Ignjatović, Kisin, & Mašović, 2023).

Trade relations among Western Balkan countries are largely determined by institutional arrangements, most notably membership in the Central European Free Trade Agreement (CEFTA), which has established a framework for trade liberalization, reduction of tariff barriers, and improvement of regulatory cooperation. Beyond tariff liberalization, non-tariff measures, technical barriers, customs procedures, and logistical infrastructure have gained increasing importance, directly influencing the efficiency and scope of trade among member states (Mojsovska & Bijelić, 2022). In this regard, qualitative aspects of trade integration have become equally important as the formal removal of tariffs.

The study of bilateral trade between Serbia and North Macedonia cannot be viewed in isolation from contemporary regional initiatives aimed at intensifying economic cooperation, such as the Open Balkan initiative, which seeks to facilitate the movement of goods, services, capital, and labor through simplified administrative procedures and strengthened institutional coordination (Toshevska-Trpchevska et al., 2022). These initiatives contribute to the creation of a more integrated regional market, reduction of transaction costs, and greater predictability of the business environment, thereby indirectly shaping the structure of bilateral trade exchange.

In recent years, trade flows between Serbia and North Macedonia have exhibited differentiated growth patterns, accompanied by structural changes and pronounced sectoral asymmetries. These developments have unfolded against the backdrop of external economic shocks, disruptions in global supply chains, and fluctuations in energy prices, which further complicate the analysis of stability and resilience of regional economies (Jelisavac Trošić & Arnaudov, 2023). Thus, the consideration of bilateral trade between the two countries is relevant not only in terms of quantitative trade volumes but also from the perspective of qualitative transformation of production and export structures.

The analysis of the determinants of bilateral trade flows-including the size and structure of economies, dynamics of economic growth, geographical proximity, institutional arrangements, and trade policies-provides the theoretical foundation for empirical assessment of trade dynamics and identification of comparative advantages (Kikerkova et al., 2021). In this context, bilateral exchange between Serbia and North Macedonia may be viewed both as an indicator of economic complementarity and as a reflection of structural constraints and developmental potentials of the two economies.

Building on these theoretical and institutional frameworks, the objective of this research is to conduct a systematic and comprehensive analysis of bilateral trade between North Macedonia and Serbia in the period 2020–2024, with particular emphasis on sectoral

dynamics, structural changes, and implications for regional economic integration. This approach enables the identification of key factors shaping trade exchange, assessment of diversification and competitiveness, and formulation of relevant policy recommendations for the advancement of trade and industrial strategies aimed at sustainable and long-term economic development.

Materials and methods

The methodological framework of this study is based on an integrated approach that combines quantitative and qualitative research methods to provide a comprehensive analysis of Serbia's foreign trade flows and its bilateral trade exchange with the Republic of North Macedonia during the period 2020–2024. The research design is conceived as an empirical, retrospective, and descriptive-analytical study, aimed at identifying the dynamics, structure, and developmental trends in bilateral trade.

The theoretical foundation of the research relies on concepts from international economics, particularly the theory of comparative advantage, determinants of trade flows, analysis of trade balance, and indicators of economic openness (Kovačević, 2008). In this context, bilateral trade is examined as a function of the size and structure of economies, sectoral specialization, institutional frameworks, and the degree of integration into regional and international exchange flows.

The core research method is quantitative analysis of statistical data on exports and imports of goods. Data for North Macedonia were obtained from the official statistical yearbooks of the State Statistical Office of the Republic of North Macedonia, while aggregated data were systematized and processed in accordance with standardized methodological principles of foreign trade and macroeconomic indicator analysis (Pelević & Vučković, 2007). Data are expressed in U.S. dollars and presented at current prices, ensuring temporal comparability and enabling the assessment of nominal trade dynamics.

Within the quantitative framework, descriptive statistical methods were applied, including analysis of absolute and relative indicators, calculation of growth rates, determination of sectoral shares in total trade, as well as examination of trade balance and the export-to-import coverage ratio. These indicators represent standard instruments for assessing external equilibrium, import dependence, and the competitiveness of national economies in the international market (Mladenović, 2013). Special emphasis was placed on identifying structural changes in the sectoral composition of trade and conducting comparative analysis of the dynamics across different economic groupings.

Sectoral analysis of bilateral trade was conducted using the Standard International Trade Classification (SITC Rev. 4), in line with United Nations methodological guidelines (United Nations, 2018), thereby ensuring international comparability of data and consistency in product classification across economic categories. This approach enables precise observation of structural transformations in trade flows and identification of sectors with increasing or declining significance in bilateral exchange.

In addition to quantitative analysis, qualitative interpretation of results was carried out within the broader context of the macroeconomic environment, European integration processes, and regional economic cooperation. Particular attention was devoted to the impact of institutional reforms, regulatory harmonization, and integration initiatives on trade dynamics (Miteva-Kacarski et al., 2022), with results analyzed in light of the stability and resilience of economies to external shocks.

The study adopts a multi-year temporal perspective, with the aim of identifying short-term fluctuations as well as medium-term structural trends in bilateral trade. Limitations of the research include reliance on nominal aggregated data without adjustments for inflationary, price, and currency effects, as well as the absence of advanced econometric modeling to assess causal relationships. These limitations represent potential directions for future research, which could incorporate real indicators, price competitiveness indices, and the application of more sophisticated analytical models.

Results

Serbia and North Macedonia maintain long-standing and intensive trade relations, rooted in geographical proximity, historical interconnectedness of their economies, and the institutional framework of regional cooperation. Within the context of deepened regional integration and liberalization of trade flows, bilateral exchange gains additional importance as a factor of stability, complementarity, and mutual economic interdependence. The analysis of the structure and dynamics of exports from North Macedonia to Serbia provides a more precise understanding of sectoral specialization, competitive advantages, and the direction of structural transformation of the Macedonian economy in the regional context.

The following table presents data on exports from North Macedonia to Serbia for the period 2020-2024, disaggregated by major product categories according to the Standard International Trade Classification (SITC):

Table 1. Exports from North Macedonia to Serbia by economic groupings according to SITC sectors, 2020–2024 (in thousands of USD)

No.	Products	2020	2021	2022	2023	2024
1	Food and live animals	55,332	63,977	69,086	82,455	94,807
2	Beverages and tobacco	16,390	18,382	26,036	31,105	35,939
3	Crude materials, inedible, except fuels	6,797	10,231	10,413	11,297	8,539
4	Mineral fuels, lubricants and related products	12,503	19,931	58,867	52,621	61,952
5	Animal and vegetable oils, fats and waxes	296	1,242	14	594	338
6	Chemicals and related products, n.e.s.	44,959	59,284	81,085	98,015	101,506
7	Manufactured goods classified by material	93,290	139,403	120,799	108,853	113,623
8	Machinery and transport equipment	11,760	16,216	21,278	30,952	52,413

No.	Products	2020	2021	2022	2023	2024
9	Miscellaneous manufactured articles	14,280	15,808	14,195	15,964	16,471
10	Commodities and transactions not classified	30	18	582	1,281	2
	Total	255,637	344,493	402,354	433,138	485,591

Source: Statistical Yearbook of the Republic of North Macedonia, 2021-2025, State Statistical Office, Skopje

The data presented in Table 1 indicate a pronounced upward trend in total exports from North Macedonia to Serbia throughout the observed period. Following a strong increase of 34.7% in 2021, exports continued to grow in subsequent years, reaching USD 485,591 thousand in 2024. The overall nominal growth of approximately 90% between 2020 and 2024 reflects the intensification of bilateral trade flows and the increasing integration of the two markets. Dynamically, the growth is not linear but rather mirrors a combination of expanding trade volumes, shifts in price relations, and sectoral adjustments in the export structure.

Sectoral analysis reveals that food products, specifically the category of food and live animals, maintain a significant and stable share in total exports. The continuous growth of this sector confirms the existence of a relative comparative advantage in agri-food production, as well as the strong market position of Macedonian products in Serbia. Although its relative share has slightly fluctuated, the absolute growth in export value demonstrates stable demand and resilience to external shocks.

The beverages and tobacco sector records above-average growth rates, emerging as one of the more dynamic segments of consumer goods in bilateral trade. Such developments may be linked to rising consumption, strengthening of brands, and competitive positioning of producers in the regional market.

In contrast, the raw materials sector shows limited structural importance and pronounced volatility, reflecting its dependence on cyclical movements in industrial production and shifts in regional demand. Similar volatility is observed in mineral fuels, where sharp increases during periods of energy instability were followed by corrective fluctuations in subsequent years. These dynamics highlight the influence of external factors, including energy price changes and supply chain disruptions.

A particularly significant aspect of export dynamics relates to the growth of chemical products and machinery and transport equipment. The expansion of these sectors points to rising technological intensity in the export structure and a shift toward products with higher added value. The share of machinery and transport equipment in total exports more than doubled during the observed period, serving as an indicator of structural transformation and potential strengthening of the industrial base. The chemical industry, with stable and continuous growth, confirms its role as one of the drivers of export expansion.

Manufactured goods classified by material remain the single most important category in the export structure. Although a decline was recorded after the peak in 2021, this

sector retains its dominant position, underscoring its central role in bilateral trade and the relatively high degree of industrial complementarity between the two economies.

Overall, the structure of exports from North Macedonia to Serbia demonstrates a tendency toward gradual diversification and reduced reliance on primary and raw material products. The growing importance of industrial and technologically more intensive sectors indicates a process of modernization of the export structure and enhanced competitiveness within regional frameworks. Such dynamics create conditions for deeper integration into regional value chains and more stable long-term growth.

Parallel to exports, bilateral trade is also characterized by a significant volume of imports from Serbia, which represent an important segment of North Macedonia's foreign trade. The structure of imports encompasses a wide range of products-from food and consumer goods to industrial inputs and capital equipment-reflecting pronounced economic complementarity but also a certain degree of dependence on the Serbian market. Between 2020 and 2024, import dynamics were shaped by a combination of regional liberalization, price fluctuations (particularly in the energy sector), and adjustments to institutional and trade frameworks within the CEFTA agreement.

Table 2. Imports into North Macedonia from Serbia by economic groupings according to SITC sectors, 2020–2024 (in thousands of USD)

No.	Products	2020	2021	2022	2023	2024
1	Food and live animals	158,744	189,382	203,607	211,067	223,918
2	Beverages and tobacco	33,313	38,250	45,274	53,868	59,789
3	Crude materials, inedible, except fuels	38,848	41,096	22,205	20,541	12,335
4	Mineral fuels, lubricants and related products	104,138	122,002	140,383	85,782	68,474
5	Animal and vegetable oils, fats and waxes	21,975	39,208	29,345	21,622	23,023
6	Chemicals and related products, n.e.s.	54,776	65,429	61,477	69,542	76,043
7	Manufactured goods classified by material	101,073	125,138	155,058	132,520	140,677
8	Machinery and transport equipment	89,515	111,977	100,611	98,516	89,117
9	Miscellaneous manufactured articles	35,894	44,677	36,293	41,000	42,389
10	Commodities and transactions not classified	187	870	1,626	1,241	178
	Total	638,463	778,029	795,878	735,699	735,942

Source: Statistical Yearbook of the Republic of North Macedonia, 2021-2025, State Statistical Office, Skopje

The data in Table 2 show that imports from Serbia to North Macedonia experienced a phase of intensive expansion during the first three years of the observed period, reaching a peak in 2022, followed by stabilization in 2023 and 2024 at approximately USD 736 million. The overall nominal growth of about 15.3% compared to 2020

indicates an increase in bilateral trade volumes, though import growth was slower than the export growth from North Macedonia to Serbia, implying a gradual narrowing of the trade gap.

Structural analysis highlights a strong concentration in several key sectors. Food and live animals represent the dominant category, with continuous growth and rising relative share in total imports. This structure points to the strong interconnectedness of the two countries' food systems and a high degree of market integration in the agri-food segment. The growth of this sector can be interpreted through the lens of comparative advantages, economies of scale, and functional complementarity of production structures.

The beverages and tobacco sector demonstrates stable and dynamic growth throughout the entire period, confirming the consolidated position of Serbian producers in the Macedonian market. The continuous increase in import value in this segment reflects strengthening consumer demand and long-term market embeddedness of these products, contributing to the stability of bilateral trade flows.

In contrast, the sector of crude materials, inedible except fuels, shows a pronounced downward trend. The decline in import value during the observed period may be linked to changes in industrial production structures, rationalization of inputs, and possible diversification of supply channels. This dynamic indicates a gradual reduction in the relative importance of primary products in overall trade exchange.

Mineral fuels, lubricants, and related products are characterized by significant variations over the period, with growth until 2022 followed by a decline in subsequent years. The share of this category in total imports shows a downward tendency, contributing to greater structural balance in trade flows and reduced concentration in energy-intensive products.

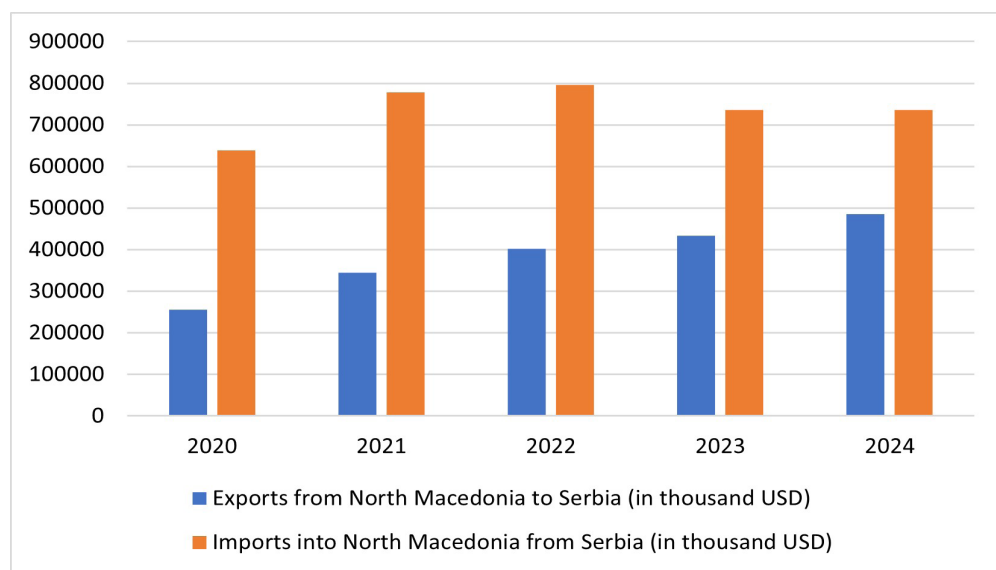
Manufactured goods classified by material, together with chemical products, represent one of the most significant segments of imports. Their stable and relatively high share points to developed production linkages and the fact that bilateral trade encompasses not only final goods but also intermediate inputs integrated into further production. This structure confirms the existence of vertical specialization and functional integration of production chains between the two economies.

Machinery and transport equipment retain an important position in the import structure, despite a slight decline after 2021. This category is particularly significant as it reflects the investment component of trade and contributes to the technological upgrading of production capacities. The stable level of imports of capital goods from Serbia indicates long-term industrial interconnectedness and the transfer of technical-technological solutions within the region.

A graphical comparison of total exports from North Macedonia to Serbia and imports from Serbia to North Macedonia for the period 2020–2024 provides immediate visual interpretation of bilateral trade dynamics. The data reveal stable export growth

from North Macedonia, accompanied by a progressive reduction of the relative gap compared to imports from Serbia, which remain dominant in absolute values. This difference in trade flows reflects structural asymmetry between the two economies but also a high degree of complementarity: imports from Serbia continuously supplement domestic consumption and production capacities, while exports from North Macedonia gradually gain importance through products with higher added value.

Figure 1. Total exports and imports between North Macedonia and Serbia by year (2020–2024, in thousands of USD)



Source: Authors' calculations

The structure of imports from Serbia to North Macedonia is characterized by a combination of consumer goods, industrial inputs, and investment products, confirming the multilayered nature of bilateral trade. The dominance of food and industrial products, alongside the relative decline in raw material categories, points to a gradual transformation of trade flows toward higher value-added goods and deeper functional integration.

From a broader economic perspective, this import structure underscores the high degree of complementarity between the two economies. It suggests that bilateral exchange between Serbia and North Macedonia goes beyond the classical model of final goods trade, evolving into a form of regionally integrated market space with pronounced production and consumption linkages.

In the long term, further diversification of sectoral composition and the strengthening of technologically intensive segments could contribute to greater sustainability and qualitative enhancement of bilateral trade cooperation. This trajectory not only supports modernization of production structures but also reinforces the role of bilateral trade as a driver of regional cohesion and competitiveness.

Discussions

The results of the export and import analysis between North Macedonia and Serbia point to a high degree of trade interconnectedness, yet also reveal a pronounced structural asymmetry in bilateral exchange. While exports from North Macedonia record dynamic nominal growth and gradual diversification toward industrial and technologically more intensive products, imports from Serbia remain predominantly concentrated in food and industrial sectors, with significantly higher absolute values. This structural difference reflects the distinct stages of development and comparative advantages of the two economies: Serbia functions as a regional supplier of a wide range of products, whereas North Macedonia increasingly positions itself in niche segments of higher value-added goods.

One of the key findings is the persistent trade surplus of Serbia in bilateral exchange, corresponding to a structural trade deficit for North Macedonia. Throughout the observed period, the value of imports from Serbia consistently exceeds exports from North Macedonia, underscoring Serbia's stronger production and technological base, broader product diversification, and higher competitiveness of its goods in the Macedonian market. Serbia's exports to North Macedonia are dominated by food products, manufactured goods classified by material, and energy resources, highlighting the complementarity of the two economies and the functional integration of production chains. Conversely, the growth of Macedonian exports in chemical products, machinery, and transport equipment suggests initial but significant shifts toward higher value-added and technologically intensive activities.

Sectoral analysis shows that food products and industrial inputs dominate North Macedonia's import portfolio, while chemicals and machinery represent sectors with growing potential. Manufactured goods and chemicals maintain relatively stable shares in imports, confirming their functional importance for production processes and regional integration. Machinery and transport equipment, although smaller in absolute terms compared to other sectors, represent capital goods that enable technological upgrading and greater production efficiency in North Macedonia.

Overall, bilateral trade between Serbia and North Macedonia is characterized by stability and gradual structural transformation. The dominance of food and industrial products in imports, alongside the growth of higher value-added exports, indicates a progressive reduction in the relative importance of primary products and an increase in technological and industrial complementarity between the two economies. This dynamic has multiple implications for economic policy: on one hand, it opens space for strengthening North Macedonia's export competitiveness in high-growth sectors, while on the other, it highlights the need for import substitution through the development of domestic capacities and investment in key industrial segments.

In the broader regional and theoretical context, the observed bilateral trade confirms that market integration within the Western Balkans contributes to the establishment of functional linkages between economies, enabling technology transfer, improvement

of production chains, and an increase in overall added value. Further intensified cooperation and strengthening of production and export capacities could lead to more balanced trade exchange, improved economic performance of both countries, and gradual reduction of structural asymmetries.

Conclusions

The analysis of bilateral trade between North Macedonia and Serbia during the period 2020–2024 demonstrates that the economic relations between the two countries are both stable and evolutionary, with clear growth in high-tech industries, chemical products, and the food sector. These sectors contribute to increasing added value and reflect North Macedonia's capacity to adapt to the demands of the regional market, while imports from Serbia complement domestic consumption and industrial production, maintaining trade balance.

Structural changes in trade flows point to a gradual modernization of the economy and diversification of sectors, with reduced dependence on traditional raw materials and energy products. This transformation enhances the resilience of bilateral trade to external shocks, including price fluctuations and shifts in regional demand, while simultaneously enabling strategic positioning of both markets within the broader Balkan and European economic context.

Beyond economic implications, the results show that bilateral trade functions as a mechanism of industrial modernization, innovation stimulation, and competitiveness strengthening. Sectors with declining or marginal trends highlight the need to improve production capacities and diversify product portfolios, while growing sectors provide a foundation for future investment and reinforcement of regional value chains.

The analysis confirms that the continuation of a strategy of export and import diversification, with a focus on higher value-added products and the strengthening of sectoral adaptability, represents key factors for the sustainable growth of bilateral trade, long-term economic stability, and deeper regional economic integration between North Macedonia and Serbia.

Conflict of interests

The authors declare no conflict of interest.

References

1. Državni zavod za statistiku Republike Severne Makedonije. (2021). *Statistički godišnjak Republike Severne Makedonije 2020*. Skoplje: Državni zavod za statistiku. [in English: State Statistical Office of the Republic of North Macedonia. (2021). *Statistical Yearbook of the Republic of North Macedonia 2020*. Skopje: State Statistical Office.]

2. Državni zavod za statistiku Republike Severne Makedonije. (2022). *Statistički godišnjak Republike Severne Makedonije 2021*. Skoplje: Državni zavod za statistiku. [in English: State Statistical Office of the Republic of North Macedonia. (2022). *Statistical Yearbook of the Republic of North Macedonia 2021*. Skopje: State Statistical Office.]
3. Državni zavod za statistiku Republike Severne Makedonije. (2023). *Statistički godišnjak Republike Severne Makedonije 2022*. Skoplje: Državni zavod za statistiku. [in English: State Statistical Office of the Republic of North Macedonia. (2023). *Statistical Yearbook of the Republic of North Macedonia 2022*. Skopje: State Statistical Office.]
4. Državni zavod za statistiku Republike Severne Makedonije. (2024). *Statistički godišnjak Republike Severne Makedonije 2023*. Skoplje: Državni zavod za statistiku. [in English: State Statistical Office of the Republic of North Macedonia. (2024). *Statistical Yearbook of the Republic of North Macedonia 2023*. Skopje: State Statistical Office.]
5. Državni zavod za statistiku Republike Severne Makedonije. (2025). *Statistički godišnjak Republike Severne Makedonije 2024*. [in English: State Statistical Office of the Republic of North Macedonia. (2025). *Statistical Yearbook of the Republic of North Macedonia 2024*. Skopje: State Statistical Office.]
6. Ignjatović, J., Kisin, J., & Mašović, A. (2023). The analysis of foreign trade in Serbia and North Macedonia. *Poslovna ekonomija*, 17(2), 68–80. DOI: 10.5937/poseko23-45312
7. Jelisavac Trošić, S., & Arnaudov, M. (2023). Serbia and North Macedonia in 2023: Economic risks, political challenges and security threats. *Security Dialogues*, 14(2), 149–165. Retrieved from <http://repozitorijum.diplomacy.bg.ac.rs/1244/1/2095-Article%20Text-4044-1-10-20240206.pdf>
8. Kikerkova, I., Makrevska Disoska, E., Toshevska Trpchevska, K., & Tonovska, J. (2021). Determinants of the bilateral trade flows of North Macedonia – A gravity model approach. In *The Dubrovnik International Economic Meeting (DIEM)*, 6(1), 98–107. doi.org/10.17818/DIEM/2021/1.10
9. Kovačević, R. (2008). *Ekonomski odnosi Srbije sa inostranstvom*. Beograd: Ekonomski fakultet. [in English: Kovačević, R. (2008). *Economic Relations of Serbia with Foreign Countries*. Belgrade: Faculty of Economics.]
10. Miteva Kacarski, E., Panova, K., & Gjorgieva Trajkovska, O. (2022). Analysis of the trade relations between the countries being part of the Open Balkan initiative. *Journal of Economics*, 7(2), 40–47. Retrieved from <https://eprints.ugd.edu.mk/30408/1/Analysis%20of%20the%20trade%20relations%20between%20the%20countries%20being%20part%20of%20the%20Open%20Balkan%20Initiative.pdf>

11. Mladenović, D. (2013). *Ekonomska statistika*. Beograd: Ekonomski fakultet. [in English: Mladenović, D. (2013). *Economic Statistics*. Belgrade: Faculty of Economics.]
12. Mojsovska, S., & Bjelić, P. (2022). Nontariff measures in CEFTA2006: Perspectives of North Macedonia and Serbia. In *3rd International Conference "Economic and Business Trends Shaping the Future"*, Faculty of Economics Skopje, Ss. Cyril and Methodius University in Skopje, 213–223. DOI:10.47063/EBTSF.2022.0019
13. Pelević, B., & Vučković, V. (2007). *Međunarodna ekonomija*. Beograd: Ekonomski fakultet. [in English: Pelević, B., & Vučković, V. (2007). *International Economics*. Belgrade: Faculty of Economics.]
14. Toshevska Trpchevska, K., Makrevska Disoska, E., Kikerkova, I., & Tonovska, J. (2022). Challenges for Western Balkan countries regional integration: The case of North Macedonia. *European Scientific Journal (ESJ)*, 18(22), 23-36. doi.org/10.19044/esj.2022.v18n22p23
15. United Nations. (2018). *Standard International Trade Classification (SITC)*, Revision 4. United Nations.

ECONOMIC ANALYSIS OF JOB SATISFACTION OF EMPLOYEES IN THE SERVICE OF AGRAR SECTOR IN THE REPUBLIC OF SERBIA

Julija Avakumović¹, Jelena Avakumović²

*Corresponding author E-mail: jelenalav@yahoo.com

ARTICLE INFO

Review Article

Received: 30 March 2026

Accepted: 25 June 2026

doi:10.59267/ekoPolj2603985A

UDC

331.101.32:338.43(497.11)

Keywords:

*job satisfaction, agriculture
sector, management, HRM*

JEL: J50, J53

ABSTRACT

In the age of digital economy, the increasingly and dynamic needs of the market require an increasing competitiveness of the organization. The competitiveness of an organization based on human resources. They should have knowledge, skills, expertise, creativity and be innovated. Individual results could contribute to better economic results of whole organization, and it's had direct connection with job satisfaction of employees. Job satisfaction has to be measured with general satisfaction indicators and some specific partial indicators, too. In this paper, authors researched job satisfaction of employees in the service of Agriculture sector of the Republic of Serbia, used a Survey on sample of 420 employees. The survey conducted from February to May 2025. The results could be use like guideline of business, especial in the digital environment.

Introduction

The age of the digital economy brings turbulent business environment. This contributes to the fact that the competitiveness of an organization are primarily based on intangible (human) resources, among which knowledge, skills, expertise, creativity and innovation of employees occupy important place. Needs of the market are becoming more dynamic and subtle, and competition is getting stronger, the constant actualization, of employee job satisfaction imposes as an imperative for the long-term survival of every organization. In digital environment, human resources, time and money are the most important input for successfully business (Avakumovic & Avakumovic, 2025, 11).

-
- 1 Julija Avakumović, Ph.D., Academy of Technical and Artistic Vocational Studies, Starine Novaka 24, 11000 Belgrade, Serbia, Phone: +381113232430, E-mail: julijaavakumovic@yahoo.com, ORCID (<https://orcid.org/0000-0002-2161-9393>)
 - 2 Jelena Avakumović, Ph.D., College „Dositej“, Nušićeva 12a, 11000 Belgrade, Serbia, Phone: +381113235500, E-mail: jelenalav@yahoo.com, ORCID (<https://orcid.org/0000-0002-7856-8064>)

It is important to emphasize that there are significant reasons why job satisfaction has got special attention. The reasons for studying can be classified according to the focus on the employee or on the organization. First is the *humane aspect*, which is important because people deserve to be treated fairly and with respect. Job satisfaction is a reflection of one such treatment, and can also be considered an indicator of the emotional well-being or mental health of the employee. The second reason is *utility*, because employee satisfaction brings many benefits to the company. Since job satisfaction is conditioned by the behavior of the employee, which has an impact on the *functioning of the whole organization*, we can single it out as a third aspect. Differences of job satisfaction between organizational units can indicate potential problems inside of them (Spector, 1997, 2).

The research of attitudes and achievements in the field of the impact of HRM activities on employee satisfaction, presented in available professional books, scientific journals and Internet sources, used for research on the impact of job satisfaction of employees in the agricultural sector.

In the Republic of Serbia, the agricultural sector is developed and in addition to the production of agricultural goods (crop production, livestock farming, production of organic products); we also encounter a developed service activity of the agricultural sector. Service providers in the agricultural sector, whose employees were in the focus of this research, are specialized retail stores in which agricultural goods are placed, and veterinary stations and clinics in which employees provide support to sustainable and healthy growth and development of livestock.

The survey was conducted through an on-line questionnaire, available on the website that was formed like the basis of open access to Google surveys (Google questionnaire), compiled of standardized instruments that were combined in one questionnaire and selected in accordance with the research goals.

The research sample consists of 420 employees in the service of agriculture sector of the Republic of Serbia, which represents a quota sample. The sample size is determined according to the view of the author Anderson (2004), who proposes that for research in human resource management, where the basic set is larger than 15000, a sample of 1% is appropriate. In the research period from February to May 2024, based on the data of the Statistical Office of the Republic of Serbia contained in the Statistical Yearbook of the Republic of Serbia (2023, 224, 231), 36,616 persons were engaged in the service activity of the agrarian sector of the Republic of Serbia, which include employees on the holdings of legal entities and entrepreneurs and family farms, of which respondents who are also engaged in the placement of products of the agrarian sector were singled out, as well as 2214 employees in veterinary stations and clinics.

Descriptive statistics, correlation analysis, and hierarchical multiple regression analysis were used to analyze the collected data. IBM SPSS Statistics 24 and MS Office Excel were used for data processing.

Job satisfaction

There are many definitions of job satisfaction in the literature. In the continuation of the paper work, we present the most famous.

Hollenbeck and Wright (2015) define job satisfaction as the “pleasant feeling” that arises from the notion that one’s job fulfills or enables the fulfillment of an employee’s important business values. This expresses three essential aspects of job satisfaction: functional value (defined as something that a person consciously or unconsciously wants to achieve); Employees have different views on what skills are important (which is critical in determining the nature and degree of their job satisfaction); and one’s perception of the situation with regard to the values they value (Radić & Radić, 2015, 355).

Generally, job satisfaction is an *attitude* that manifests itself at the workplace as an individual behavior of an employee and can have an impact on the organization and organizational behavior. It encourages employees to increase personal performance, commitment to the organization, reduces absenteeism from the workplace and increases interest in the profession. Job satisfaction is equally important in both the private and public sectors, as well as in developed and less developed countries (Avakumović, 2020).

Attitude can also be defined as the degree of positive or negative feelings that a person has towards to another person, place, or thing (Levy, 2003, 278), and can be positive or negative (Saba, 2011, 2). An employee’s attitudes consist of feelings, thoughts, and intentions about how to behave while performing their work. An employee, as an individual, often adjusts his/her attitude in accordance with the attitudes of the group (team) within which performs his/her activity.

Attitudes are generally acquired over a long time period, so job satisfaction or dissatisfaction emerges as an employee receives more and more information about the workplace. If the *causes of job satisfaction* are identified, they should not be ignored later, because that could lead to variations and job dissatisfaction (Milojević, Milanović, 2025). Constant monitoring and measurement of job satisfaction is a need that arises from the fact that job satisfaction is a dynamic attitude of employees. Job satisfaction is part of the life satisfaction and despite the influence of family, religion, politics and leisure (Newstrom, 2007, 204-205) it has a significant impact on “work-life balance”.

Đorđević et al. (2017, 264) put point that job satisfaction can be seen as a phenomenon – a global feeling about work, as a constellation of attitudes about different aspects of work. Author Saba finds that job satisfaction is an important concept in any work environment that analyzed in a large number of studies by various authors in the field of human resource management (Saba, 2011, 2) and the field of psychology (Levy, 2003, 281), in which employee attitudes and organizational commitment were examined.

Ivanović-Djukic et al. (2018, 14) define job satisfaction as an attitude towards work that arises as a result of cognitive, affective, and evaluative individual responses to

different characteristics of the workplace. Authors (Saiti & Papadopoulos, 2014, 74; Khan et al., 2014, 53) point out that job satisfaction can be defined as a cognitive, affective, or emotional, and evaluative reaction of an individual to job. The cognitive component contains what one believes one knows about the object of the attitude, the evaluative component refers to how much we like or dislike a thing (or person), and the behaviorist component contains a certain predisposition to act in a certain direction (Zimanji & Susnjar, 2007, 135).

Stankovska et al. (2017, 160) emphasize that job satisfaction is an emotional response to the current situation in the workplace, which the employee is facing, i.e. the employee's perception between what he/she wants from work and what is realistically provided to him/her at that job. Amaresena (2015, 541) sees as a "key element" of job satisfaction emotional fulfillment through earnings, promotion, or harmony between the rewards offered by the work environment and the individual's desire for these rewards Kuskü (2001, 146).

It is important to note that employee dissatisfaction can also manifest at job place. If an employee is insufficiently or inadequately engaged in the workplace, he/she will show a low level of commitment to the organization, spreading a strong negative mood that can cause a wide range of negative consequences. Newstrom (2007, 208) emphasizes that employee dissatisfaction can manifest itself as psychological absence from work (lack of interest) during the working day, or physical absence (unjustified absence, leaving the workplace before the end of working hours, longer breaks than prescribed, slowness in work - less performance), up to the manifestation of aggressive behavior.

In everyday conversation, job satisfaction is often equated with motivation. It's important to understand the difference between satisfaction and motivation. Motivation is interpreted like the pursuit and effort to satisfy needs or goals, while satisfaction refers to the reaction felt as a result of the satisfaction or non-satisfaction of needs. In other words, motivation directs activities towards achieving the desired results, while satisfaction is a consequence of that result. Employees need to be motivated to work, and according to Hadžić and Nedeljković (2010, 90), in addition to the individual characteristics of the employee and his/her personal potential, motivation can also be influenced by factors related to the work environment and the wider community.

There are many theories of motivation, the most prominent of which is Herzberg's two-factor theory of motivation. Herzberg investigated the factors that lead to employee satisfaction and came to the conclusion that these factors can be divided into two groups: hygiene factors and motivation factors. Compliance of hygienic factors prevents the occurrence of dissatisfaction. They are preventive in nature and are not factors that encourage a person to work better and more, but only prevent job dissatisfaction. These factors include earnings, employment status, job security, working conditions, company policy, relationships with colleagues and superiors, etc. Motivation factors are factors that lead to satisfaction, have a positive effect on motivation and include: success in work, recognition, promotion, character of the job itself, the potential of

workers to learn and develop their abilities (according to Avakumović, 2021). Stepanov et al. (2016) argue that Herzberg's theory is based on two assumptions. The first is satisfaction and dissatisfaction, which are not in opposite, but its are two separate ends connected by different factors, which means that the opposite end of job satisfaction is not dissatisfaction but the absence of satisfaction. Another important assumption of the model is the different categories of motivational factors: hygienic (situational factors) and factors related to the work that a person performs (Bahtijarević-Šiber, 1999). With his theory, Herzberg tries to emphasize the need to transform work so that it enables the individual development of the individual within the business organization, whereby it is necessary to make the work more creative, to encourage the development of the individual's abilities, that is, he develops the idea of enriching work and work tasks as the most important motivational factor (Stepanov et al., 2016, 56).

Job satisfaction directly influences professional (Shamina, 2014, 1-3) and organizational (Trivellas & Santouridis, 2016, 171) commitment and motivates employees to increase their productivity (Khan et al, 2014, 54). Certainly the key principle of motivation (Armstrong, 2011) based in the fact that performance is based on a person's abilities and motivation (Radić & Radić, 2015, 355).

The causes of Job satisfaction

Spector (1997, 30) emphasizes that the causes of job satisfaction can be classified into two main categories: work-related factors and personal factors. The first category includes work-related factors (employee treatment, nature and type of work, relationship with other employees, and rewards), while the second category includes individual factors (personality characteristics and previous experiences). Levy (2003, 282) select job characteristics like individual/personal characteristics, social factors, and developmental opportunities. The characteristics of the job include the diversity of skills, the identity of the work task, the importance of the work task, autonomy, feedback, stress and workload, and as individual/personal characteristics he singles out affective characteristics, personality and self-confidence. By social factors, Levy (2003) includes relationships with superiors, co-workers, the role of the employee, and fairness within the organization, and the possibility of advancement includes promotion, salary, and benefits, as well as work-family roles.

The causes of job-related job satisfaction include: the nature of the job, the scope of work, the length of service with a specific employer and the job position.

Organizational causes of job satisfaction, in addition to leadership style, are career development and professional development opportunities, compensation systems, organizational communication, relationships with colleagues and teamwork, stability-security of the workplace, working conditions, work-family conflict, flexible working hours and alternative work programs, as well as the size of the organization.

Organizational causes of job satisfaction include *flexible working time* and *alternative work engagements*.

In addition to the causes related to work and organization, job satisfaction is also significantly influenced by *personal causes* of job satisfaction: harmony between work and the individual, personality traits and demographic characteristics (gender, age). Edwards (1991) believes that harmony exists when the characteristics of the employee coincide with the characteristics of the job. Writing about the influence of personality traits on job satisfaction, it is important to point out that a large number of studies suggest that people have characteristics that predispose to a positive or negative reaction to work, that is, some people are usually satisfied, while others are usually dissatisfied with their job. Stew and Ross (1985) found a moderate correlation between determining the degree of job satisfaction over time, finding that there was stability in job satisfaction scores even when individuals changed jobs. (Avakumović, 2020).

Two traits that show a significant positive correlation with job satisfaction are the internal locus of control and negative affective.

A locus of control is a cognitive variable that represents a person's individual belief in their ability to cope with positive and negative situations in life (Jakšić, Zekić, 2025). The internal locus of control has an impact on performance, leadership, job perception, and work motivation, and is also correlated with job satisfaction (Spector, 1997, 51). Negative affective is a personality variable that reflects a person's tendency to experience negative emotions, such as anxiety or depression in various situations. Watson et al. (1986) believe that people who exhibit high levels of negative affective will experience work in more negative ways, which will certainly be reflected in extremely low levels of job satisfaction. Schaubroeck et al. (1994) considered that a low level of negative affective makes a person make a better job choice and thus will achieve a higher level of job satisfaction, because he is in a better job (Spector, 1997, 52).

Demographic characteristics of an employee (age, gender) can certainly be the cause of (dis)satisfaction of work, and as Noé (2004) pointed out, there are quite complex relationships between the demographic characteristics of employees and their job satisfaction.

The Effects of Job Satisfaction

There are many classifications of the consequences of job satisfaction. According to Spector (1997, 1955), employee behavior in the workplace is a consequence of job satisfaction or dissatisfaction, and is expressed through work-related variables (employee performance and turnover) or non-work-related variables (health and satisfaction with private life).

Robbins and Judge (2013, 82-83) have shown what happens when an employee (dis)likes their job, providing a theoretical model/framework in which the four responses to dissatisfaction are classified as constructive/destructive and/or active/passive. These answers are: exit, voice, loyalty, and neglect. *Exit*, as an active-destructive response, directs the behavior of employees towards leaving the organization, including looking for a new position, as well as resigning. *Voice*, as an active-constructive response,

includes an active and constructive attempt to improve conditions, including suggestions, discussion with superiors regarding problem solving, as well as some form of union activity. *Loyalty*, as a passive-constructive response, is an optimistic wait for conditions to improve, including the “defense” of an organization that is faced with external pressure and the belief that management is “doing the right thing.” *Neglect*, as a passive-destructive response, leads to conditions deteriorating, including chronic delays, absenteeism, reduced work activities, and an increase in the rate of errors in the workplace.

The impact of employee satisfaction can be felt on an *individual* and *organizational* level.

Physical and *mental* well-being is another individual consequence of job satisfaction, and according to the World Health Organization (WHO), health is physical, mental, and social well-being. We can conclude that ensuring physical and mental well-being in the workplace is important for the employee, and according to the authors of the dissertation, it also has significant effects on individual performance.

Regarding absenteeism from work (absenteeism), it is important to point out that absenteeism is divided into unjustified (voluntary) and justified or unavoidable (illness, important family problems, etc.).

Rodić (2020) points that absenteeism from work for any reason and an indicator of problems, dissatisfaction of employees with the organization and its management. One of the main effects of job satisfaction, along with productivity and turnover, is absenteeism (Mirković, 2025). Empirical research has confirmed that satisfied workers are less likely to be absent from work, although the correlation between job satisfaction and absenteeism is not as strong as expected. For this reason, it is possible that even dissatisfied workers come to work regularly in fear of losing their jobs (Rodić, 2020, 302).

Spector (1997) points that employee turnover is the result of job dissatisfaction, and that therefore employees who do not like their job will do everything to find another one.

According to Strizović (2019, 48), counterproductive work behaviors are defined as any type of intentional behavior of members of an organization that is contrary to organizational goals and that potentially threatens its interests. Counterproductive work behaviors include various negative actions, such as: refusal to perform work tasks, unjustified sick leave, all the way to destructive actions such as aggressive behavior, destruction of the organization’s property or theft.

Measuring of Job Satisfaction

Vilares and Coelho (2003) pointed that job satisfaction is a latent construct that cannot be directly measured, but is assessed on the basis of certain indicators. Thus, in most studies, job satisfaction was measured using partial measures (subscales: nature of work, co-workers, earnings, promotions, occasional rewards, flexible benefits, communication, superiors, and working conditions) (Spector, 1997, 9).

Hadžić and Nedeljković (2010, 42-43) specify that Hapok (1935) was the first to introduce a measure of general job satisfaction of 4 items, and later numerous questionnaires appeared that measure both general job satisfaction and satisfaction with certain dimensions (aspects) of work. Thus, job satisfaction can be viewed through the sum of all indicators, the result of which is the level of general satisfaction (Spector, 1985).

Measuring of job satisfaction is important because the results indicate the difference between an individual's expectations of a job and what that job actually provides (Hadžić & Nedeljković, 2010, 42-52).

Different methods of measuring job satisfaction can be measured by Héthy and Mako (1981) as direct (subjective) and indirect (objective). Direct methods are, for example, questionnaires or interviews, while indirect methods can be the research of specific documents and data.

The most commonly used methods of measuring job satisfaction are: rating scales and questionnaires, critical incidents and interviews, and confrontation meetings (Avakumović, 2021).

For job satisfaction studies, it is typical according to Newstrom (2007, 217-218) that data is collected through questionnaires where we can use closed or open questions. In the case of "closed questions" we can offer "ready-made answers" that the employee will mark (choose according to their own attitude), while the employee will answer the "open questions" in their own words. In addition to questionnaires, we can also use rating scales to measure job satisfaction, when respondents receive a set of statements and each should indicate the extent to which they agree with the given statement.

Job satisfaction in the services of Agriculture sector of the Republic of Serbia

As already stated, although there are numerous methods for measuring the level of job satisfaction, it is a complex construct and therefore various challenges can arise in measuring partial or general satisfaction.

This research was conducted in the service industry of the agriculture sector of the Republic of Serbia, using the method of a survey that was set up through free access on the Google platform, and the sample represents 420 responses from employees.

The Survey was conducted anonymously, and employees answered in the form of a grade from 1(one) to 5(five), where the grade 1(one) was the lowest, and the grade 5(five) was the highest: (1-very bad, 2-bad, 3-average, 4-good and 5-excellent) or descriptive through a free-form answer.

The responses of the employees on which basis we made the analysis were related to the sex of the employees, the age of life, the length of service (Stojković, Kocić, 2024). Partial indicators are classified into: satisfaction with management, communication in the workplace, possibility of advancement and working conditions.

Satisfaction with the management is observed through trust in the management of the facility, clearly defined goals and consideration of the employees' suggestions by the management.

Satisfaction with communication in the workplace was observed and analyzed through the existence of communication problems that can cause conflicts and disrupt interpersonal relationships (Slavić, Avakumović, Berber, 2019) on whether we can freely turn to colleagues and superiors for help in the implementation of tasks.

Satisfaction with the possibility of advancement are monitoring through training, training and career development.

Satisfaction with working conditions through satisfaction with going to work, a good working environment, the benefits offered by the workplace, the regularity of salary payments and the possibility of a balance between private and business life.

Employees were then asked to give suggestions and suggestions in their own words, which should be taken into account and implemented by the management in order to increase employee satisfaction.

Below are the results of research, analyses, assessments of general job satisfaction and suggestions for increasing employee satisfaction.

Out of 420 employees, 90 are male and 330 are female.

According to the age of life, 70 employees are aged between 18 – 25 years, 160 employees are aged between 26 – 35 years, 150 employees are aged between 36 – 45 years, 20 employees are aged between 46 – 55 years and 20 are over 55 years old.

According to years of work, 110 employees have less than 1 (one) year in the sector, 170 are from 1 (one) – 5 (five) years in the company, 50 from 6 (six) – 10 years, 40 are from 11 – 15 years, 30 from 16 to 20, while 20 employees in the company have over 20 years.

In the Table 1: Satisfaction with the management, is an overview of the evaluation of employees in the the Agriculture sector of the Republic of Serbia.

Table 1. Satisfaction with the management.

<i>Questions/Answers</i>	Very bad (1)	Bad (2)	Average (3)	Good (4)	Excellent (5)
<i>I have confidence in the management of the sales facility/ambulance/station</i>	/	10	50	210	150
<i>The objectives of the business are clearly defined</i>	10	20	120	140	130
<i>Management takes the suggestions of employees</i>	/	20	160	130	110

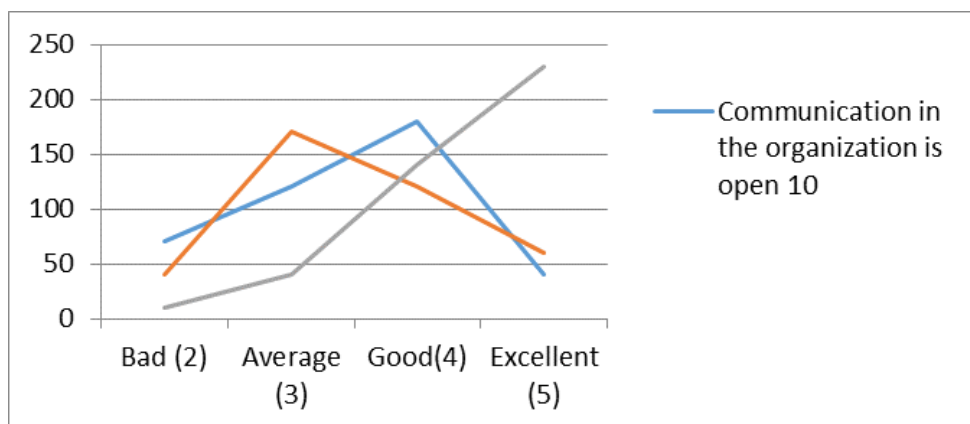
Source: Author's research

Based on the analysis of the results presented in Table 1: Satisfaction with the management, where employees gave grades from 1 (one) to 5 (five), the average grades are:

1. I have confidence in the management of the sales facility/ambulance/station – 4,19
2. The objectives of the business are clearly defined 3,86
3. Management takes the suggestions of employees– 3,78

Next image (Figure 1) is a graphic representation of satisfaction with management.

Figure 1. Satisfaction with the management.



Source: Author's research

More detailed analysis of all the responses, we can find that the average rating of satisfaction with the management is **3.94**.

In the Table 2: Communication at the workplace is an overview of the evaluation of employees in the Agriculture sector of the Republic of Serbia.

Table 2. Communication at the workplace

<i>Questions/Answers</i>	Very bad (1)	Bad (2)	Average (3)	Good(4)	Excellent (5)
<i>Communication in the organization is open</i>	10	70	120	180	40
<i>There are no communication problems that can cause conflicts and disrupt interpersonal relationships</i>	30	40	170	120	60
<i>I feel free to ask questions to colleagues and superiors if the work task is not clear to me</i>	/	10	40	140	230

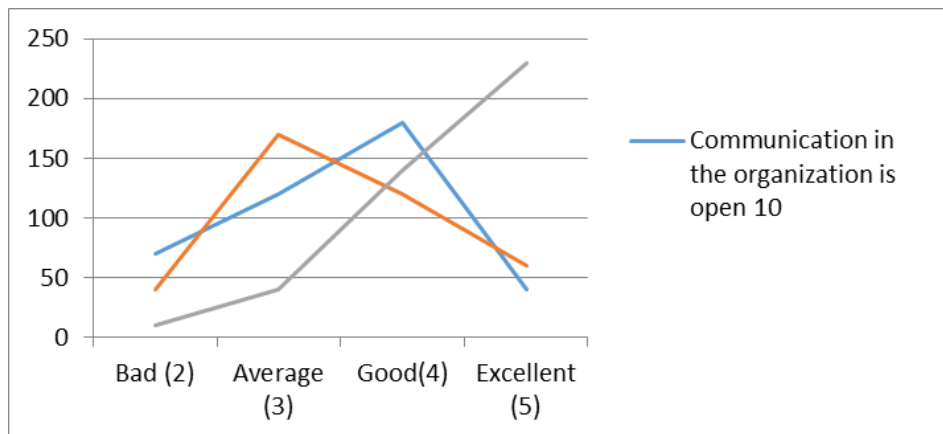
Source: Author's research

Based on the analysis of the results presented in Table 2: Communication at the workplace, where employees gave grades from 1 (one) to 5 (five), the average grades are:

1. Communication in the organization is open – 3,40
2. There are no communication problems that can cause conflicts and disrupt interpersonal relationships – 3,33
3. I feel free to ask questions to colleagues and superiors if the work task is not clear to me – 4,40

Next image (Figure 2) is a graphic representation of communication in the workplace.

Figure 2. Satisfaction with Communication at the workplace



Source: Author's research

Detailed analysis of all responses represents the average score of employee satisfaction with communication at the workplace is **3.71**.

In the Table 3: Possibility of promotion is an overview of the evaluation of employees related to the possibilities of promotion, i.e. career development in the service activity of the agrarian sector of the Republic of Serbia.

Table 3. Possibility of promotion

Questions/Answers	Very bad (1)	Bad (2)	Average (3)	Good (4)	Excellent (5)
<i>I have the opportunity to learn and improve</i>	/	20	80	160	160
<i>I have the opportunity for training and training</i>	10	20	80	160	150
<i>I've got a chance to move forward</i>	10	50	70	200	90

Source: Author's research

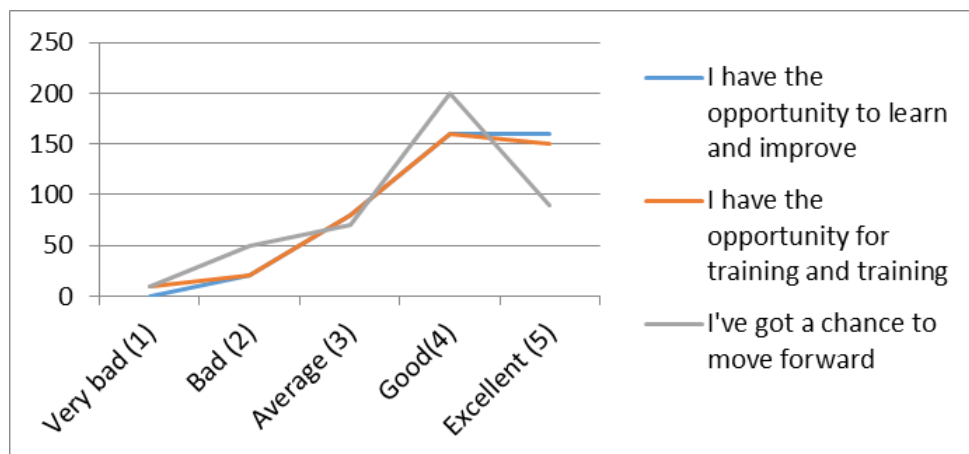
Based on the analysis of the results presented in Table 3: Possibility of promotion, where employees gave grades from 1 (one) to 5 (five), the average grades are:

1. I have the opportunity to learn and improve – 4,09

2. I have the opportunity for training and training - 4
3. I've got a chance to move forward – 3,74

Next image (Figure 3) is a graphic representation of Possibility of promotion.

Figure 3. Satisfaction with possibility of promotion



Source: Author's research

Detailed analysis of all responses represents the average score of employee satisfaction with possibility of promotion **3.94**.

In the Table 4: Terms and Conditions is an overview of the evaluation of employees in the Agriculture sector of the Republic of Serbia.

Table 4. Terms and Conditions

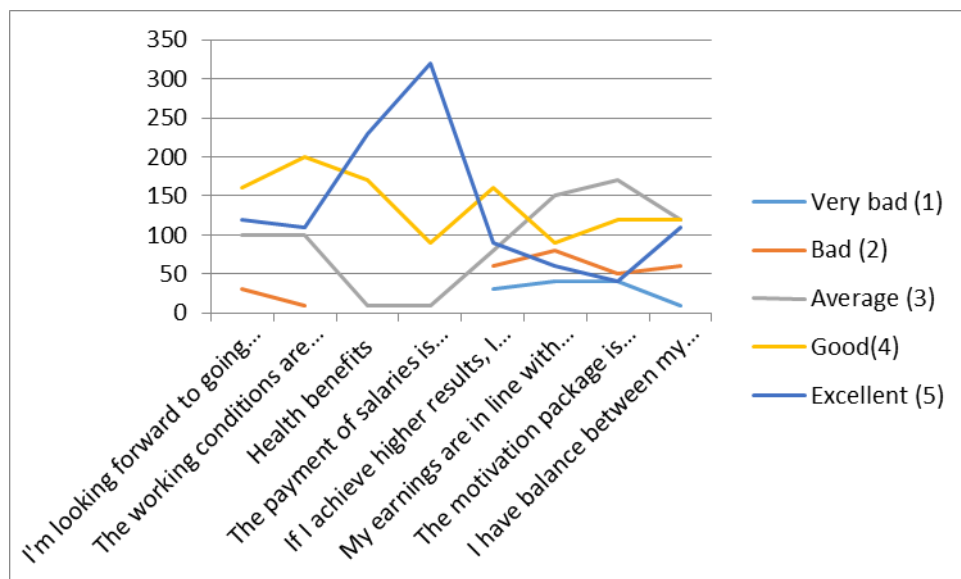
Questions/Answers	Very bad (1)	Bad (2)	Average (3)	Good(4)	Excellent (5)
<i>I'm looking forward to going to work</i>	10	30	100	160	120
<i>The working conditions are good</i>		10	100	200	110
<i>Health benefits</i>	10		10	170	230
<i>The payment of salaries is regular</i>			10	90	320
<i>If I achieve higher results, I can expect to increase my earnings in line with them</i>	30	60	80	160	90
<i>My earnings are in line with my results</i>	40	80	150	90	60
<i>The motivation package is satisfactory</i>	40	50	170	120	40
<i>I have balance between my personal and professional life</i>	10	60	120	120	110

Source: Author's research

Based on the analysis of the results presented in Table 4: Terms and Conditions, where employees gave grades from 1 (one) to 5 (five), the average grades are:

1. I'm looking forward to going to work – 3,83
2. The working conditions are good – 3,98
3. Health benefits – 4,45
4. The payment of salaries is regular – 4,74
5. If I achieve higher results, I can expect to increase my earnings in line with them – 3,52
6. My earnings are in line with my results – 3,12
7. The motivation package is satisfactory – 3,17
8. I have balance between my personal and professional life – 3,62

Figure 4. Satisfaction with Terms and Conditions



Source: Author's research

Detailed analysis of all responses represents the average score of employee satisfaction with terms and conditions is **3.81**.

This analysis of the results of this Survey, we learned the attitudes of employees – respondents in the agricultural sector, about the key factors of internal and external motivation as well as material and non-material compensation (Pouliakas, 2010).

In this sense, the open answers are also interesting - the recommendations given by the respondents as a proposal for improving the working atmosphere, interpersonal relationships and working conditions, and they are: Bonuses with an emphasis on

additional health insurance, including dental care; They need clear definitions and responsibilities; Strengthening team spirit through continuous education through various types of courses with course proposals and abroad; Organization of team building through recreational gatherings; Material stimulation; More days off in sales facilities; A greater number of programs for advancement; Quality of the workplace and equipment of the facility of sale/ambulance/station; Quality of service through improved communication with service users and feedback; Clearer hierarchy and responsibility of individuals; Listen to the suggestions of employees from the managers of specific sales facilities/ambulances and stations, etc.

We can conclude that the Survey, which was conducted on a sample of 420 employees – respondents, pointed out to us the attitudes of employees on general satisfaction and average employee satisfaction.

Dissatisfaction is indicated by a score of 1(one)-2(two), ambivalence is indicated by a score of 3(three), while job satisfaction is indicated by a score of 4(four)-5(five).

Partial employee satisfaction shown in tables 1 (one) to 4 (four), give results on the basis of which we conclude that partial satisfaction with management is **3.94**; partial employee satisfaction with communication at the workplace **3.71**; partial satisfaction possibility of advancement **3.94**; and partial satisfaction of employees with working conditions **3.81**.

The average overall employee satisfaction is **3.85**. A score of 3.85 is closer to job satisfaction than ambivalence, so we believe that employees are satisfied with their jobs.

Of the partial indicators of work, employees are most satisfied with management and the possibility of promotion, followed by working conditions and communication.

The results indicate general job satisfaction as well as satisfaction with all partial indicators.

The Economic Effects of Job Satisfaction

Managers and human resource managers in the service industry of the agrarian sector should pay special attention to employee satisfaction, because job satisfaction affects through individual performance (performance) the performance not only of the organization in which the employee works, but also of the economic results of the entire Agriculture sector.

This is indicated by the data according to which we can see that the turnover of agricultural services in million RSD from 2012 until today has almost doubled, which is shown in the next Table 5.

Table 5. Production of agricultural goods and services in million rs. in the Republic of Serbia

2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
11087	13442	15023	13813	14999	13856	15000	15313	16223	17119	20177

Source: Statistical Yearbook. 2023, 212.

In Table 6 we can see the turnover of agricultural products and food products obtained from the processing of agricultural raw materials, in million RSD during 2022.

Table 6. Turnover of agricultural raw materials and food products in 2022 in million RSD in the Republic of Serbia

<i>Agricultural Raw Materials and Live Animals</i>	330.415
<i>Food Products</i>	563.221

Source: Statistical Yearbook. 2023, 299.

All this emphasizes the importance of employees in the activity of the agricultural sector and clearly shows the importance of participation in the entire turnover.

The digital economy also brings digital human resource management in the Agriculture sector. The work and results of employees are increasingly dependent on digital tools and require “digital literacy” (Nawaz, Kundi, 2010) not only of managers but also of non-managers in the sales facilities of the agricultural sector, veterinary clinics and stations.

“Digital Human Resource Management” refers to the planning, implementation and application of digital technologies in digital human resource management, a new phenomenon known in the literature as e-human resource management. Human resource management activities such as planning, recruitment, training, compensation (Strohmeier, 2007) have undergone major changes and adaptation to the digital age.

Many positions in the production and trade of agricultural products and the provision of services in the agricultural sector, which are currently held by unskilled or poorly qualified forces, will be transformed into positions that will require a specialized workforce with special knowledge and skills due to the impact of digitization. (Amaldi, 2017)

Measuring of the success of human resource management is derived from the measurement of human capital, which can be viewed from two aspects: (Bahtijarević-Šiber, 2014)

- analysis of human capital at the level of the socio-economic community (macro-analysis), and
- analysis of the contribution of human resources management activities, which produce and develop human capital at the organizational level, to organizational performance (micro analysis).

Human capital is the producer of intellectual capital. From an economic perspective, human capital refers to the ability of individuals to create value that consumers are willing to pay for. (Slavić, Avakumović, 2018)

If we look at the value of human resources as intellectual capital, and we consider intellectual capital as the knowledge that the employee possesses, then we must bear in mind that this knowledge transforms raw materials and makes them very valuable. It is this knowledge that translates into profit (Steward, 2001).

Conclusion

It is undeniable that the most important challenges in the modern economy are globalization and digitization. Therefore, we can also say that we live and work in the age of the digital economy and digital environment.

Intangible resources – employees should be seen as a “source of value” and not as an “additional cost” in order to organize the work process in a quality, rational and efficient way (Avakumović, 2024). Each sector puts emphasis on employees who will possess knowledge and professional skills that will contribute as an employee’s performance to increasing the performance of the entire organization. In order for an employee to have a sense of “usefulness” in his workplace and in the organization in which he is employed, the management should create the possibility of training (especial in digital environment to work on modern digital platform) (Avakumovic & Avakumovic, 36, 2025), acquiring new knowledge and experience, the possibility of participating in decision-making, an adequate salary system that would evaluate quality, complexity and working conditions.

Just as there are causes of job satisfaction, so are the consequences of job satisfaction. Spector (1997, 55) emphasizes that every behavior and result of employees is a consequence of job satisfaction or dissatisfaction, and is expressed through variables that are related to work (performance and employee turnover), or variables that are not related to work (life balance).

After conducting a survey on the satisfaction of employees in the service activity of the Agriculture sector of the Republic of Serbia, on a sample of 420 employees in various sales facilities of products of the agrarian sector, veterinary clinics and veterinary stations on the territory of the Republic of Serbia, we can conclude that from partial indicators of work, employees are most satisfied with management and the possibility of promotion, then with working conditions and communication with accent on digital communication use digital platform. Partial indicators affect overall job satisfaction and in each analysis, managers or human resources managers should find a correlation between which partial indicators has the lowest score and work to improve the results in order to improve overall job satisfaction in the long term.

Conflict of interests

The authors declare no conflict of interest.

References

1. Amarasena, T. S. M., Ajward, A. R., & Ahasanul Haque, A. K. M. (2015). Does social recognition impact job satisfaction of academic faculty members of state universities in Sri Lanka. *International Journal of Recent Advances in Organizational Behaviour and Decision Sciences (IJRAOB) An Online International Research Journal*, 1(4), 540-553.
2. Amladi, P. (2017). HR's guide to the digital transformation: ten digital economy use cases for transforming human resources in manufacturing. *Strategic HR Review*, 16(2), 66-70.
3. Anderson, V. (2004). *Research methods in human resource management*. CIPD Publishing.
4. Avakumović, J., (2020), doktorska disertacija, Uticaj aktivnosti menadžmenta ljudskih resursa na zadovoljstvo zaposlenih u visokom obrazovanju Republike Srbije, Univerzitet u Novom Sadu, Ekonomski fakultet u Subotici. [In English: Avakumovic, J., (2020), PhD dissertation: The impact of HRM activities on job satisfaction in the Higher Education of the Republic Serbia, University of Novi Sad, Faculty of Economy, Subotica.]
5. Avakumović, J., (2021), monografija: Zadovoljstvo zaposlenih kroz prizmu AMO modela, Zadužbina Andrejević, Beograd. [In English: Avakumovic, J., (2021), Monograph: Job satisfaction throught the Prism of AMO Model, Zaduzbina Andrejevic, Belgrade.]
6. Avakumovic, J., Avakumovic, J. (2025), Digital Marketing and AI in Digital Environment, *Finansijski savetnik*, 1/2025, pp.7-40.
7. Avakumović, J., Avakumović, J., Milošević, D., Popović, J.: Zadovoljstvo zaposlenog nastavnog osoblja kroz prizmu AMO modela, *Akcionarstvo*, (2021). 27 (1), 107-120. [In English: Avakumovic, J., Avakumovic, J., Milosevic, D., Popovic, J., (2021) Job satisfaction of education employees throught the Prism of AMO Model, *Akcionarstvo*, 27 (1), 107-120.]
8. Avakumovic, J., The Job Satisfaction of Academic Staff: view through AMO Model, presented in English at the International Multidisciplinary Scientific Conference CCHE held in Kopaonik, Serbia, from January 29th to February 3rd, 2024 and published in the CCHE 2024 Book of Proceedings. pp. 284-291.
9. Bahtijarević-Šiber F, *Strateški menadžment ljudskih potencijala*, Školska knjiga, Zagreb, 2014.[In English: Bahtijarevic-Siber, F. (2014), *Strategy of HRM*, Skolska knjiga, Zagreb]
10. Bahtijarević-Šiber, F. (1999). *Management ljudskih potencijala*. Zagreb: Golden marketing. [In English: Bahtijarevic-Siber, F. (1999), *Human resource management*, Skolska knjiga, Zagreb]

11. Đorđević, B., Ivanović-Đukić, M., Lepojević, V. (2018). Vpliv spola in starosti na zaznavanje organizacijske pravičnosti v podjetjih v Republiki Srbiji. *Revija za ekonomske in poslovne vede*, 1. [In English: Djordjevic, B., Ivanovic-Djukic, M., Lepojevic, V., (2018), The impact of gender and age on the perception of organization justice in companies in the Republic Serbia, *Journale of Economic and Business Science*]
12. Hadžić, O., Nedeljković, M. (2010). *Motivacija za rad i zadovoljstvo poslom u organizaciji*. Novi Sad: Tehnički fakultet. [In English: Hadzic, O, Nedeljkovic, M., (2010), Work motivation and job satisfaction in organization, Novi Sad, Faculty of Technical Science]
13. Ivanović-Đukić, M., Đorđević, B., Lepojević, V. (2018). Mediating effects of educational level on job related characteristics: Job satisfaction relationship. *Strategic Management*, 23(2), 13-21.
14. Jakšić, N., Zekić, M. (2025). Punishment as a type of offense sanction. *The Journal Law Review of Public Sector*, 5(2), 25-51. <https://rpjs-journal.com/index.php/rpjs/article/view/3>
15. Kusku, F. (2001). Dimensions of employee satisfaction: A state university example. *METU Studies in Development*, 28(3/4), 399-430.
16. Levy, P.E. (2003). *Industrial/Organizational Psychology: Understanding The Workplace*. New York: Houghton Mifflin Company.
17. Milojević, I., Milanović, A. (2025). Applications of macroeconomic indicators in determining the predisposition to environmental threat, *Održivi razvoj*, 7(1), 77-86. <https://doi.org/10.5937/OdrRaz2501077M>
18. Mirković, S. (2025). The role of information technology in modern business, *ITB - Informatics, Technology and Business*, 3(1), 7-23. <https://itb-journal.com/index.php/itb/article/view/1>
19. Nawaz, A. and Kundi, G.M. (2010), "Digital literacy: an analysis of the contemporary paradigms", *Journal of Science and Technology Education Research*, Vol. 1 No. 2, pp. 19-29
20. Newstrom, J. W. (2007). *Organizational Behavior 12th edition*. Tata McGraw.
21. Noé, N. (2004). A dolgozó munkával való elégedettsége. *Marketing es Menedzsment*, 38(5), 13-23. [In English: Noe, N. (2004), Job satisfaction of employees, *Marketing and Management*, 38(5), 13-23.]
22. Pouliakas, K. (2010). Pay enough, don't pay too much or don't pay at all? The impact of bonus intensity on job satisfaction. *Kyklos*, 63(4), 597-626.
23. Radić, N. (2015). Uticaj motivacije zaposlenih na performanse organizacije. In *Synthesis 2015-International Scientific Conference of IT and Business-Related Research*, 353-358. Singidunum University. [In English: Radic, N. (2015), Influence of employees motivation on performance of organization, In *Synthesis 2015-International Scientific Conference of IT and Business-Related Research*, University Singidunum, 353-358.]
24. Robbins, S. P., Judge, T. (2013). *A Organizational Behavior Fifteenth Edition*. Essex: Pearson Edu.

25. Rodić, S. (2020). Zadovoljstvo poslom i apsentizam zaposlenih. *Zbornik radova Fakulteta tehničkih nauka u Novom Sadu*, 35(2), 300-303. [In English: Rodic, S., (2020), Job Satisfaction and employee apseteesem, Faculty of Technical Science, University of Novi Sad, 35(2), 300-303.]
26. Saba, I. (2011). Measuring the job satisfaction level of the academic staff in Bahawalpur colleges. *International Journal of Academic Research in Business and Social Sciences*, 1(1), 1-8.
27. Slavić, A., Avakumović, J. (2018). Evaluacija i merenje uspešnosti aktivnosti menadžmenta ljudskih resursa u eri digitalne transformacije, XXIII Internacionalni skup Strategijski menadžment i sistemi podrške odlučivanju u stratejskom menadžmentu, April 26-27, Subotica, Srbija. [Slavic, A., Avakumovic, J. (2018), Evaluation and measuring HRM activities in the Age of digital transformation, XXIII International Simposium of Strategic Management and decision support systems in Strategic Management, April 26-27, Subotica, Serbia]
28. Slavić, A., Avakumović, J., Berber, N. (2019). Job satisfaction of Academic Staff in the Higher Education System of Serbia: A pilot study. *Facta Universitatis, Series: Economics and Organization*, 429-442.
29. Spector, P. E. (1985). Measurement of human service staff satisfaction: Development of the Job Satisfaction Survey. *American journal of community psychology*, 13(6), 693-713.
30. Stankovska, G., Angelkoska, S., Osmani, F., Grncarovska, S. P. (2017). Job Motivation and Job Satisfaction among Academic Staff in Higher Education. *Bulgarian Comparative Education Society*.
31. *Statistički godišnjak* (2023). Beograd: Republički zavod za statistiku Republike Srbije. [In English: Statistical Yearlybook, (2023), Republic Institute for Statistics]
32. Stefan Strohmeier, Ruediger Kabst, (2014) "Configurations of e-HRM – an empirical exploration", *Employee Relations*, 36 (4), 333-353.
33. Steward, T.A. (2001), *the Wealth of Knowledge: Intellectual Capital and the Twenty-First Century Organization*, London, Nicholas Brealey.
34. Stojković, A., Kocić, S. (2024). Analiza stresnih poremećaja i javnog nastupa. *Finansijski savetnik*, 29(1), 27-38. [In English: Stojkovic, A., Kocic, S. (2024). Analitics of stress disorders and public speaking, *Financial Advisor*, 29(1), 27-38.]
35. Šušnjar, G. i Zimanji V. (2005). *Organizaciono ponašanje*. Ekonomski fakultet, Subotica. [Susnjar, G., Zimanji, V. (2005). *Organization behavior*, Faculty of Economy, Subotica]

**PAPER TITLE – USE CAPITAL LETTERS, CENTER, BOLD, TIMES
NEW ROMAN, SIZE 12**

First Author Name (10pt italic, center align)¹, First Co-Author Name (10pt italic, center align)², Second Co-Author Name (10pt italic, center align)³

**Corresponding author E-mail: (10pt italic, center align)*

ARTICLE INFO	ABSTRACT
Original/Review Article	The abstract should contain a maximum of 150 words.
Received: <i>xx May 2018</i>	The abstracts should avoid any abbreviations and mathematical formulas.
Accepted: <i>xx September 2018</i>	The abstract is a summarization of the full report, written in one paragraph, and should include next elements:
doi:xxx	
UDC xxx	1. Purpose
	2. Methodology
Keywords:	3. Results
<i>should include 4-6 key words that summarize the contents of the paper /Times New Roman, Italic, 10/</i>	4. Conclusions
	5. Recommendations
JEL: (www.aeaweb.org/jel/jel_class_system.php) /Times New Roman, Italic, 10/	6. Additional data
	/Times New Roman, 10/
	.

Introduction

Page setup: Paper size: width 170 mm x height 240 mm; Margins: top/bottom 20 mm, left/right 18 mm; Layout: header 1,25cm, footer 1,25cm; Orientation: Portrait.

Articles should be written only in English. It is advisable to write the article in the third-person singular or plural with the use of active form. Before paper submission, please check grammatical and spelling mistakes by the spellchecker for the English language.

Paper volume up to 30.000 characters (without spaces) or 15 full pages including the text, figures, tables, references list and appendices. Articles should not be shorter than 10 pages. Depending on papers' quality, Editorial Board could also accept longer articles. Article has to be prepared electronically (on computer), in program MS Word 2003 or some later version of this program.

-
- 1 Name, academic position, institution, address, phone number, e-mail, ORCID ID (<https://orcid.org/>)
 - 2 Name, academic position, institution, address, phone number, e-mail, ORCID ID (<https://orcid.org/>)
 - 3 Name, academic position, institution, address, phone number, e-mail, ORCID ID (<https://orcid.org/>)

Introduction is the first section of an IMRAD paper. Its purpose is to state clearly the problem investigated and to provide the reader with relevant background information. State the objectives of the work and provide an adequate background, avoiding a detailed literature survey or a summary of the results.

The purpose of the Introduction should be to supply sufficient background information to allow the reader to understand and evaluate the results of the present study without needing to refer to previous publications on the topic. Much of the Introduction should be written in the present tense. /Times New Roman, 11/

Please define abbreviations and acronyms during their first occurrence within the text, even in case that they were previously defined in article summary. Do not use abbreviations in article title, unless they can not be avoided.

Sub-headings should be written by font **Times New Roman, font size 11, bold, centred**, only first letter capital, interspace between sub-heading and paragraph above 6 pt (**before 6 pt**), and interspace between sub-heading and paragraph below 6 pt (**after 6 pt**). Please use the writing style presented in this template.

Materials and methods

Materials and methods are the second section of an IMRAD paper. Its purpose is to describe the experiment in such detail that a competent colleague could repeat the experiment and obtain the same or equivalent results. Provide sufficient detail to allow the work to be reproduced. Methods already published should be indicated by a reference: only relevant modifications should be described.

For equations and formulas use the Microsoft Equation Editor or addition for equations writing MathType (www.mathtype.com). Use of built-in equation editor within the program Word 2007 is not recommended. Please check if all symbols within the equations/formulas are defined (forthwith after equation/formula). The equations are written using Microsoft Word (MathType); they are consecutively numbered and centered.

Results

Results are the third section of an IMRAD paper. Its purpose is to present the new information gained in the study being reported. It should be clear and concise. The Results are core of the paper. You shouldn't start the Results section by describing methods that you inadvertently omitted from the Materials and Methods section. The Results must be written in past tense.

Discussions

The final section of an IMRAD paper. Its purpose is to fit the results from the current study into the preexisting fabric of knowledge. The important points will be expressed as conclusions. This should explore the significance of the results of the work, not repeat them. A combined *Results and Discussion* section is often appropriate. Avoid extensive citations and discussion of published literature.

Many papers are rejected by journal editors because of a fault Discussion.

Conclusions

The main conclusions of the study may be presented in a short Conclusions section, which may stand alone or form a subsection of a *Discussion* or *Results and Discussion* section. Conclusions should provide a summary of important findings and their implications to the area of research that is the focus of the article.

Acknowledgements

Collate acknowledgements in a separate section at the end of the article before the references and do not, therefore, include them on the title page, as a footnote to the title or otherwise. List here those individuals who provided help during the research (e.g., providing language help, writing assistance or proof reading the article, etc.). They should be brief.

Conflict of interests

The authors declare no conflict of interest.

References

All manuscripts should be formatted using the [American Psychological Association](#) (APA) citation style. For additional examples, consult the most recent edition of the Publication Manual of the American Psychological Association.

Reference (author(s) of quotes) has to be entered directly in the text of article in next form (Petrović, 2012; or Petrović, Marković, 2012; or Mirković et al., 2012). Please do not write them as indexes in square brackets [3] or in footnote. Try to use a footnote only in the case of closer explanation of certain terms, or clarification of real and hypothetical situations. ***Do not numerate the pages.***

Reference list should only include works that have been published or accepted for publication. Unpublished works should be only mentioned in the text. Reference list should be with the bibliographic details of the cited books, book chapters, or journal articles.

References in not-English languages should be translated in English, and the English language has to be mentioned in brackets, for example: Максимовић, Г., Секулић, Д., Петровић, А., & Драгићевић, Д. (2017), Савремени трендови и нове стратегије конкурентности у хотелијерству, *Менаџмент у хотелијерству и туризму*, 5(2), 27-35. [in English: Maksimović, G., Sekulić, D., Petrović, A., & Dragičević, D. (2017). Contemporary trends and new competitiveness strategies in hotel industry. *Hotel and Tourism Management*, 5(2), 27-35.].

Literature units have to be written in font TNR, font size 11, alignment Justified, with mutual interspace of 3 pt - before/after. In all literature units only surnames are written as a whole, while all authors' names have to be shortened on to initial (initials have to

be set after surnames). Please, write surnames of all authors (do not use the style Petrović et al.). Do not combine literature units (under each ordinal number can be only one literature unit) and always write complete titles of used literature units. If used/cited literature was taken over from the internet publication, after adequate writing of literature unit, in brackets has to be note complete link from which material was taken over (available at: www.fao.org).

Citation of Books

Author's surname Initial(s) of the given name(s). (Year of Publication) *Title of Book*, Volume number (if relevant), edition (if relevant). Publisher, Place of Publication

Citation of Articles

Author's surname Initial(s) of the given name(s). (Year of publication) Title of article. *Journal Volume number* (and issue number if issues within a volume number are not consecutively paginated): Number of first and last page of article, DOI

If the cited paper is given a DOI number, it should also be included.

Citation of Websites

Author's surname Initial(s) of the given name(s). (if known) title, type of document (if relevant), date of issue (if available), web address and date of access, if the document or the website may be subject to change.

Citing a journal article found online

Author, A. (Publication Year). Article title. Periodical Title, Volume(Issue), pp.-pp. DOI:XX.XXXXX or Retrieved from journal URL

Example:

1. Cvijanović, D., Trandafilović, S., & Imamović, N. (2013). Marketing concept in terms of agricultural enterprises development in transitional countries. *Economics of Agriculture*, 60(1), 113-122.
2. Hjalager, A. M., & Richards, G. (Eds.). (2003). *Tourism and gastronomy*. Routledge, London.
3. Mićović, A. (2017). Tourism Development and Evolution of Tourism Related Rules, *2nd International Scientific Conference – Thematic Proceedings II*, Faculty of Hotel Management and Tourism, Vrnjačka Banja, 181-202. Retrieved from http://www.hit-vb.kg.ac.rs/conference/images/thematic_proceedings/2017_II.pdf
4. Stošić, L., & Stošić, I. (2013). Diffusion of innovation in modern school. *International Journal Of Cognitive Research In Science, Engineering And Education (IJCRSEE)*, 1(1), 12-24.

5. Domanović, V., Vujičić, M., & Ristić, L. (2018), Profitability of food industry companies in the Republic of Serbia, *Economic of Agriculture*, 65(1), 11-32. doi:10.5937/ekoPolj1801011D
6. The Food and Agriculture Organization of the United Nations (FAO), Retrieved from <http://www.fao.org> (July 31, 2018)

TABLES AND FIGURES

All tables are to be numbered using Arabic numerals.

Tables have to be created within the text of article, not taken in the form of images from other documents. Tables should be numerated according to order of their appearance. Titles of the tables have to be given immediately above the table to which they relate. Please use following style during their formatting. Title of the table should be set with the interspace 6 pt - before and 3pt - after, in font TNR, font **size 10**, alignment **Centered**. Text within the table should be written in the font TNR, font size 9. Bold the text in the heading. Start with next paragraph at the interspace of 6 pt from the table source or note (after). During the article writing please mark in the main text all calls to a certain table (*Table 5.*). Try to fit all tables in article within the specified format of the page (Table properties – preferred width – max 97% - alignment: center). Complete text within the table cells has to be entered in next form (paragraph - spacing: before/after 0 pt, line spacing: single). In case when table breaks on next page, broken part of the table on next page has to be accompanied by a table header.

Identify any previously published material by giving the original source in the form of a reference at the end of the table caption.

Footnotes to tables should be indicated by superscript lower-case letters (or asterisks for significance values and other statistical data) and included beneath the table body.

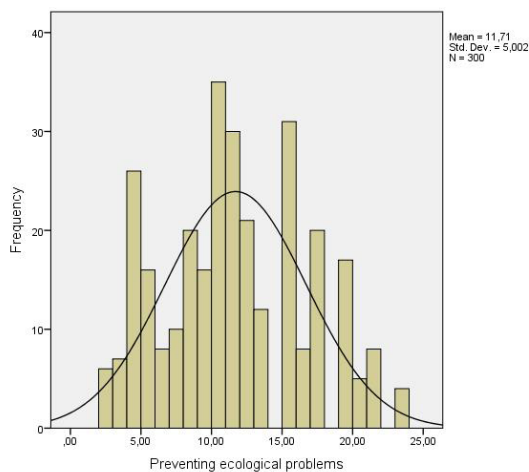
For the best quality final product, it is highly recommended that you submit all of your artwork – photographs, line drawings, etc. – in an electronic format.

Example:**Table 1.** The distribution cost of packaged goods from Subotica to retail-store objects

Indicators	Period			Total
	Month 1	Month 2	Month 3	
Distance crossed (km)	12.926	11.295	13.208	37.429
Fuel consumption (litre)	3.231	2.823	3.302	9.356
Value of fuel consumption (RSD)	242.378	211.790	247.653	701.821
Total time spend on touring (hour)	314	266	417	997
Value of total time spend on touring (RSD)	47.048	39.890	62.570	149.508
Number of tours	98	77	102	277
Toll value (RSD)	0	0	0	0
Number of pallets transported (piece)	1.179	976	1358	3.513
Total weight transported (kg)	602.600	429.225	711.116	1.742.941
Vehicle maintenance costs (RSD)	203.858	164.970	224.806	593.634
Lease costs (RSD)	480.938	454.214	565.784	1.500.936
Total sum (RSD)	974.222	870.864	1.100.813	2.945.899

Source: Petrović, 2012

All illustrations whether diagrams, photographs or charts are referred to as Figures.
The name and number of figures should be centered on the line above a figure.

Figure 1. Agriculture, value added (% of GDP)

Source: Authors' calculations

Technical preparation, prepress and printing:

DIS PUBLIC D.O.O., Braće Jerković 111-25, Belgrade, phone/fax: 011/39-79-789

Number of copies:

300 copies



The Balkan Scientific Association of Agrarian Economists, Belgrade, Serbia, Institute of Agricultural Economics, Belgrade, Serbia and Academy of Economic Studies, Bucharest, Romania is pleased to announce that journal **ECONOMICS OF AGRICULTURE** has been accepted for indexing in the *Emerging Sources Citation Index (ESCI)*, a new edition of Web of Science.

Content in ESCI is under consideration by Clarivate Analytics, the owner of Web of Science, for additional indexing on the platform, including for the Science Citation Index Expanded, the Social Sciences Citation Index, and the Arts & Humanities Citation Index.

The quality and depth of content Web of Science offers to researchers, authors, publishers, and institutions sets it apart from other research databases. The inclusion of **ECONOMICS OF AGRICULTURE** in the Emerging Sources Citation Index demonstrates our dedication to providing the most relevant and influential **economics of agriculture** content to our community.

You may find necessary information on the following link:

<http://mjl.clarivate.com/cgi-bin/jrnlst/jlresults.cgi?PC=MASTER&ISSN=0352-3462>

Published quarterly

Journal is registered in major scientific databases:

- Web of Science (Clarivate Analytics)
 - Emerging Sources Citation Index (ESCI)
- EBSCO
- DOAJ
- ERIH PLUS
- AgEcon Search
- Social Science Research Network (SSRN)
- ProQuest
- Library of Congress E-Resources Online Catalog
- Ingenta Connect
- Ulrich's Periodicals Directory
- CABI
- J-Gate
- The World Wide Web Virtual Library for European Integration
- SCIndeks
- The digital repository of the National Library of Serbia
- doiSerbia
- EconLit
- WorldCat
- Mendeley
- CyberLeninka
- Google Scholar
- CNKI (China National Knowledge Infrastructure)
- ERIH PLUS by Dimensions
- Agora
- Publons
- Internet Archive

EconLit Journal is indexed in major scientific databases:

- Index Copernicus Journals Master List (ICV2013: 5,22).

CIP - Каталогизација у публикацији
Народна библиотека Србије, Београд
33:63(497.11)

ЕКОНОМИКА пољопривреде = Economics of
Agriculture / editor-in-chief Drago
Свијановић. - Год. 26, бр. 5 (1979)- . -
Београд : Научно друштво аграрних економиста
Балкана : Институт за економику пољопривреде
; Букурешт : Академија економских наука,
1979- (Belgrade : Dis Public). - 24 cm

Тромесечно. - Је наставак: Економика
производње хране = ISSN 0352-3454. - Друго
издање на другом медијуму: Економика
пољопривреде (Online) = ISSN 2334-8453
ISSN 0352-3462 = Економика пољопривреде
(1979)
COBISS.SR-ID 27671

The Ministry of Science, Technological Development and Innovation of the Government of the Republic of Serbia provides financial support for the publication of the quarterly journal
ECONOMICS OF AGRICULTURE

