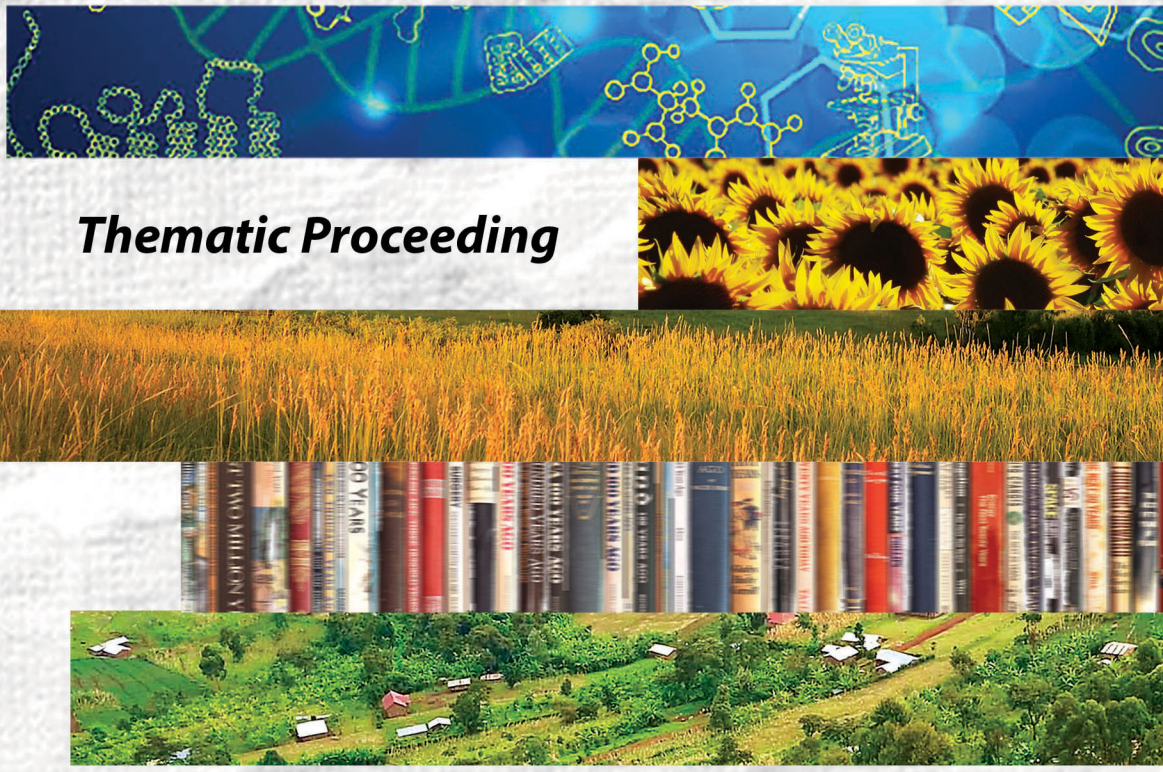
INSTITUTE OF AGRICULTURAL ECONOMICS, BELGRADE, SERBIA

SUSTAINABLE AGRICULTURE AND RURAL DEVELOPMENT



Thematic Proceeding

Belgrade, 2021

INSTITUTE OF AGRICULTURAL ECONOMICS
BELGRADE

Volgina Street no. 15, 11060 Belgrade, Serbia
Phone/Fax: +381 (0) 11 69 72 858
Phone: +381 (0) 11 69 72 848

E-mail:
office@iep.bg.ac.rs

Internet address:
www.iep.bg.ac.rs

International Scientific Conference

SUSTAINABLE AGRICULTURE AND RURAL DEVELOPMENT

THEMATIC PROCEEDING

February, 2021

Belgrade, Serbia

Publisher:

Institute of Agricultural Economics, Belgrade, Serbia

Editors:

Jonel Subić, Ph.D.
Predrag Vuković, Ph.D.
Jean Vasile Andrei, Ph.D.

Technical arrangement and printing:

SZR NS MALA KNJIGA +
Zetska Street no. 15,
21000 Novi Sad, Republic of Serbia,
Phone: +381 21 64 00 578

Technical preparation and typesetting:
Vladimir Sokolović

Number of copies: **300**

ISBN-978-86-6269-096-8
ISBN (e-book)-978-86-6269-097-5

Publishing of Thematic Proceeding was financially supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia.

Organizers

1. INSTITUTE OF AGRICULTURAL ECONOMICS, BELGRADE - SERBIA
   Prof. *Jonel Subić*, Ph.D.

Co-organizers

1. NATIONAL TEAM FOR THE REVIVAL OF SERBIAN VILLAGES, BELGRADE - SERBIA
   Milan Krkobabić, B.Sc. and Academician *Dragan Škorić*
2. CHAMBER OF COMMERCE AND INDUSTRY OF SERBIA, BELGRADE - SERBIA
   Marko Čadež, B.Sc.
3. FACULTY OF AGRICULTURE, NOVI SAD - SERBIA
   Prof. *Nedeljko Tica*, Ph.D.
4. FACULTY OF AGRICULTURE, BELGRADE - SERBIA
   Prof. *Dušan Živković*, Ph.D.
5. FACULTY OF ECONOMICS, SUBOTICA - SERBIA
   Prof. *Aleksandar Grubor*, Ph.D.
6. FACULTY OF ECONOMICS, KRAGUJEVAC - SERBIA
   Prof. *Petar Veselinović*, Ph.D.
7. FACULTY OF HOTEL MANAGEMENT AND TOURISM, UNIVERSITY OF KRAGUJEVAC, VRNJAČKA BANJA - SERBIA
   Prof. *Drago Cvijanović*, Ph.D.
8. FACULTY FOR APPLIED ECOLOGY (FUTURA), BELGRADE - SERBIA
   Prof. *Jordan Aleksić*, Ph.D.
9. FACULTY OF APPLIED MANAGEMENT, ECONOMICS AND FINANCE (MEF), BELGRADE - SERBIA
   Prof. *Tomislav Brzaković,* Ph.D.
10. FACULTY OF ECONOMICS AND ENGINEERING MANAGEMENT, UNIVERSITY BUSINESS ACADEMY, NOVI SAD - SERBIA
    Prof. *Dragan Soleša*, Ph.D.
11. FACULTY FOR BIOFARMING, MEGATREND UNIVERSITY, BAČKA TOPOLA - SERBIA
    Prof. *Gorica Cvijanović,* Ph.D.
12. UNIVERSITY "UNION – NIKOLA TESLA", BELGRADE - SERBIA
    Prof. *Nebo*ša *Zakić*, Ph.D.
13. UNIVERSITY EDUCONS, NOVI SAD - SERBIA
    Prof. *Aleksandar Andrejević,* Ph.D.
14. INSTITUTE OF ECONOMIC SCIENCES, BELGRADE - SERBIA
    Jovan Zubović, Ph.D.
15. INSTITUTE FOR SCIENCE APPLICATION IN AGRICULTURE, BELGRADE - SERBIA
    Rade Jovanović, Ph.D.

16. NOVI SAD BUSINESS SCHOOL, NOVI SAD - SERBIA
    Prof. *Jelena Damjanović*, Ph.D.
17. RAPS - DEVELOPMENT ACADEMY OF SERBIAN AGRICULTURE, BELGRADE - SERBIA
    Prof. *Mihailo Ostojić*, Ph.D.
18. BALKAN SCIENTIFIC ASSOCIATION OF AGRICULTURAL ECONOMIST, BELGRADE - SERBIA
    Prof. *Goran Maksimović*, Ph.D.
19. COOPERATIVE UNION OF SERBIA, BELGRADE - SERBIA
    Nikola Mihailović, B.Sc.
20. AGRICULTURAL EXTENSION SERVICES OF BELGRADE, BELGRADE - SERBIA
    Milica Janković, M.Sc.
21. FACULTY OF AGRO-FOOD AND ENVIRONMENTAL ECONOMICS, BUCHAREST UNIVERSITY OF ECONOMIC STUDIES, BUCHAREST - ROMANIA
    Prof. *Mirela Stoian*, Ph.D.
22. FACULTY OF SOCIAL AND CULTURAL SERVICE AND TOURISM, STAVROPOL STATE AGRARIAN UNIVERSITY, STAVROPOL - RUSSIAN FEDERATION
    Prof. *Ivan Ivanovich*, Ph.D.
23. NATIONAL INSTITUTE FOR ECONOMIC RESEARCH "COSTIN C. KIRITESCU", ROMANIAN ACADEMY, BUCHAREST - ROMANIA
    Prof. *Luminita Chivu*, Ph.D.
24. UNIVERSITY OF AGRONOMIC SCIENCES AND VETERINARY MEDICINE OF BUCHAREST (USAMV), BUCHAREST - ROMANIA
    Prof. *Sorin Mihai Cimpeanu*, Ph.D.
25. RESEARCH CENTRE FOR SUSTAINABLE RURAL DEVELOPMENT OF ROMANIA, ROMANIAN ACADEMY, TIMISOARA - ROMANIA
    Prof. *Vasile Gosa*, Ph.D.
26. FACULTY OF ECONOMICS SCIENCE, PETROLEUM - GAS UNIVERSITY OF PLOIESTI, PLOIESTI - ROMANIA
    Prof. *Irena Gabriela Rapulescu*, Ph.D.
27. FACULTY OF AGRICULTURE, UNIVERSITY OF BANJA LUKA - BOSNIA AND HERZEGOVINA
    Prof. *Zlatan Kovačević*, Ph.D.
28. UNIVERSITY OF CATANIA - ITALY
    Prof. *Loredana Cardullo*, Ph.D.
29. LEIBNIZ INSTITUTE OF AGRICULTURAL DEVELOPMENT IN TRANSITION ECONOMIES (IAMO), HALLE – GERMANY
    Prof. *Thomas Glauben*, Ph.D.
30. INSTITUTE OF AGRICULTURAL ECONOMICS, SOFIA - BULGARIA
    Prof. *Božidar Ivanov*, Ph.D.

31. NATIONAL INSTITUTE FOR ECONOMIC RESEARCH, CHISINAU - MOLDOVA
    Prof. *Alexandru Stratan*, Ph.D.
32. INSTITUTE OF AGRICULTURAL ECONOMICS, BUCHAREST - ROMANIA
    Cecilia Alexandri, Ph.D.
33. INSTITUTE FOR AGRICULTURE ECONOMICS AND RURAL DEVELOPMENT (ICEADR), BUCHAREST - ROMANIA
    Ana Ursu, Ph.D.
34. BALKAN ENVIRONMENTAL ASSOCIATION (B.EN.A.), THESSALONIKI - GREECE
    Mariana Golumbeanu, Ph.D.
35. RESEARCH NETWORK ON RESOURCES ECONOMICS AND BIOECONOMY (RebResNet), PLOIESTI - ROMANIA
    Prof. *Andrei Jean Vasile,* Ph.D.
36. UNIVERSITY OF BIJELJINA, BIJELJINA - BOSNIA AND HERZEGOVINA
    Prof. *Milena Jelikić Stankov*, Ph.D.

HONORARY BOARD

- *Branko Ružić,* M.A., Minister of Education, Science and Technological Development of the Republic of Serbia, Belgrade - Serbia.
- *Branislav Nedimović,* B.Sc., Minister of Agriculture, Forestry and Water Management of the Republic of Serbia, Belgrade - Serbia.
- *Milan Krkobabić,* B.Sc., Minister of Rural Welfare, Co-president of the National Team for the Survival of Serbian Villages, Belgrade - Serbia.
- Academician *Dragan Škorić,* President of the Academic Committee for the Village of the Serbian Academy of Sciences and Arts, Co-president of the National Team for the Revival of Serbian Villages, Belgrade - Serbia.
- Prof. *Ivan Atanov,* Ph.D., Rector of the Stavropol State Agrarian University, Stavropol - Russian Federation.
- Prof. *Nicolae Istudor*, Ph.D., Rector of the Bucharest University of Economic Studies, Bucharest – Romania.
- *Marko Čadež,* B.Sc., President of the Chamber of Commerce and Industry of Serbia, Belgrade – Serbia.
- *Mirjana Dukić Mijatović,* Ph.D. State Secretary of the Ministry of Education, Science and Technological Development of the Republic of Serbia, Belgrade – Serbia.
- *Marina Soković,* Ph.D. Assistant Minister in the Ministry of Education, Science and Technological Development of the Republic of Serbia, Belgrade – Serbia.
- *Saša Lazović,* Ph.D., Assistant Minister in the Ministry of Education, Science and Technological Development of the Republic of Serbia, Belgrade – Serbia.
- *Aleksandar Bogićević,* B.Sc., Assistant Minister in the Ministry of Agriculture, Forestry and Water Management of the Republic of Serbia, Belgrade – Serbia.
- *Nenad Katanić*, Ph.D., Assistant Minister in the Ministry of Agriculture, Forestry and Water Management of the Republic of Serbia, Belgrade – Serbia.

- Prof. *Snežana Bogosavljević Bošković*, Ph.D., Faculty of Agronomy, Čačak – Serbia.
- Prof. *Nedeljko Tica*, Ph.D., Dean of the Faculty of Agriculture, Novi Sad – Serbia.
- Prof. *Dušan Živković*, Ph.D., Dean of the Faculty of Agriculture, Belgrade – Serbia.
- Prof. *Petar Veselinović*, Ph.D., Dean of the Faculty of Economics, Kragujevac – Serbia.
- Prof. *Aleksandar Grubor*, Ph.D., Dean of the Faculty of Economics, Subotica – Serbia.
- Prof. *Zorica Vasiljević*, Ph.D., Faculty of Agriculture, Belgrade – Serbia.
- Prof. *Aleksandar Rodić*, Ph.D., Head of Robotics Department, Institute „Mihailo Pupin“, Belgrade - Serbia
- Prof. *Igor Tomašević*, Ph.D., Faculty of Agriculture, Belgrade – Serbia
- Prof. *Drago Cvijanović*, Ph.D., Dean of the Faculty of Hotel Management and Tourism, University of Kragujevac, Vrnjačka Banja – Serbia
- Prof. *Aleksandar Andrejević*, Ph.D., Rector of the University „EDUCONS“, Novi Sad – Serbia.
- Prof. *Jordan Aleksić*, Ph.D., President of the Council of the Faculty „FUTURA“, Belgrade – Serbia.
- Prof. *Gorica Cvijanović*, Ph.D., Dean of the Faculty for Biofarming, Megatrend University, Bačka Topola – Serbia.
- Prof. *Koviljko Lovre*, Ph.D., President of Serbian Association of Agricultural Economists, Belgrade – Serbia.
- Prof. *Marko Carić*, Ph.D., Rector of the University Business Academy, Novi Sad – Serbia.
- Prof. *Tomislav Brzaković*, Ph.D., Dean of the Faculty of Applied Management, Economics and Finance, Belgrade – Serbia.
- Prof. *Nebojša Zakić*, Ph.D. Rector of the University „Union – Nikola Tesla“, Belgrade, Serbia.
- Doc. *Nikola Milićević*, Ph.D., Faculty of Economics, Subotica – Serbia.
- *Jovan Zubović*, Ph.D., Director of the Institute of Economic Sciences, Belgrade – Serbia.
- *Rade Jovanović*, Ph.D., Director of the Institute for Appliance of Science in Agriculture, Belgrade – Serbia.
- *Ljubinko Rakonjac*, Ph.D., Director of the Institute of Forestry, Belgrade – Serbia.
- *Milan Lukić,* Ph.D., Director of the Institute “Dr Josif Pančić”, Belgrade – Serbia.
- Prof. *Mihailo Ostojić*, Ph.D., President of the Council of Development academy of Serbian Agriculture (RAPS), Belgrade – Serbia.
- *Mariana Golumbeanu*, Ph.D., Vice president of the Balkan Environmental Association (B.EN.A.), Thessaloniki – Greece.
- Prof. *Vasile Gosa*, Ph.D., Director of the Research Centre for Sustainable Rural Development of Romania, Romanian Academy, Timisoara – Romania.
- Prof. *Andrei Jean Vasile*, Ph.D., President of the Research Network on Resources Economics and Bioeconomy (RebResNet), Ploiesti – Romania.
- Prof. *Thomas Glauben*, Ph.D., Director of the Leibniz Institute of Agricultural Development in Transition Economies (IAMO), Halle – Germany.
- Prof. *Luminita Chivu*, Ph.D., Director of the National Institute for Economic Research “Costin C. Kiritescu”, Romanian Academy, Bucharest – Romania.

- Prof. *Irina Gabriela Radulescu*, Ph.D., Dean of the Faculty of Economics Science, Petroleum – Gas University of Ploiesti, Ploiesti – Romania.
- *Cecilia Alexandri*, Ph.D., Director of the Institute of Agricultural Economics, Bucharest – Romania.
- Prof. *Alexandru Stratan*, Ph.D., Director of the National Institute for Economic Research, Chisinau – Moldova.
- Prof. *Božidar Ivanov*, Ph.D., Director of Institute of Agricultural Economics, Sofia – Bulgaria.
- *Ana Ursu*, Ph.D., Director of Institute for Agriculture Economics and Rural Development (ICEADR), Bucharest – Romania.
- Prof. *Agatha Popescu*, Ph.D., University of Agricultural Sciences and Veterinary Medicine of Bucharest, Bucharest, Romania.
- *Jelena Damjanović*, Ph.D., Principal of Novi Sad Business School, Novi Sad – Serbia.
- Doc. *Ljiljana Tomić*, Ph.D., Founder of the University of Bijeljina, Bijeljina - Bosnia and Herzegovina.
- *Milica Janković*, M.Sc. Agricultural Extension Services of Belgrade, Belgrade – Serbia.
- *Boban Ilić*, B.Sc., Secretary General, SWG Secretariat, Skopje – Macedonia.
- *Nikola Mihailović*, B.Sc., President of the Cooperative Union of Serbia, Belgrade – Serbia.

SCIENTIFIC BOARD

- Prof. *Jonel Subić*, Ph.D., Serbia - President
- *Klaus Dieter Wagner*, Ph.D., Austria
- Prof. *Aleksandar Ostojić*, Ph.D., Bosnia and Herzegovina
- Prof. *Ferhat Ćejvanović*, Ph.D., Bosnia and Herzegovina
- Prof. *Željko Vaško*, Ph.D., Bosnia and Herzegovina
- Doc. *Boro Krstić*, Ph.D, Bosnia and Herzegovina
- Doc. *Miroslav Nedeljković*, Ph.D., Bosnia and Herzegovina
- Prof. *Albena Miteva*, Ph.D., Bulgaria
- Prof. *Julia Doitchinova*, Ph.D., Bulgaria
- Prof. *Zoran Grgić*, Ph.D., Croatia
- *Vaclav Vilhelm*, Ph.D., Czech Republic
- Prof. *Andras Nabradi*, Ph.D., Hungary
- Prof. *Donatella Privitera,* Ph.D., Italy
- Prof. *Giuseppe Castaldelli*, Ph.D., Italy
- Prof. *Marco Platania*, Ph.D., Italy
- Prof. *Margaret Loseby,* Ph.D., Italy
- Prof. *Matteo Vittuari*, Ph.D., Italy
- Prof. *Micol Mastrocicco*, Ph.D., Italy
- Prof. *Blagica Sekovska*, Ph.D., Macedonia
- Prof. *Jorde Jakimovski*, Ph.D., Macedonia
- *Dori Pavloska Gjorgjieska,* Ph.D., Macedonia
- Prof. *Alexandru Stratan*, Ph.D., Moldova
- *Ion Certan*, Ph.D., Moldova
- Prof. *Aleksandra Despotović*, Ph.D., Montenegro
- Prof. *Eirik Romstad*, Ph.D., Norway
- Prof. *Marian Podstawka*, Ph.D., Poland
- Prof. *Adam Wasilewski*, Ph.D., Poland
- *Barbara Wieliczko,* Ph.D., Poland
- *Marek Wigier*, Ph.D., Poland
- *Pawel Chmielinski,* Ph.D., Poland
- Prof. *Agnieszka Wrzochalska*, Ph.D., Poland
- *Zbigniew Floriańczyk*, Ph.D., Poland
- Prof. *Adrian Stancu*, Ph.D., Romania
- Prof. *Andreica Marin*, Ph.D., Romania
- Prof. *Claudiu Cicea*, Ph.D., Romania
- Prof. *Cosmin Salasan*, Ph.D., Romania

- Prof. *Dan Boboc*, Ph.D., Romania
- Prof. *Dorel Dusmanescu*, Ph.D., Romania
- Prof. *Florentina Constantin*, Ph.D., Romania
- Prof. *Gabriel Popescu*, Ph.D., Romania
- Prof. *Irina Gostin*, Ph.D., Romania
- Prof. *Irina Petrescu*, Ph.D., Romania
- Prof. *Jean Vasile Andrei*, Ph.D., Romania
- Prof. *Mariana Eftimie*, Ph.D., Romania
- Prof. *Mirela Stoian*, Ph.D., Romania
- Prof. *Raluca Ignat*, PhD., Romania
- Prof. *Raluca Ion*, Ph.D., Romania
- Prof. *Raluca Ladaru*, Ph.D., Romania
- *Bogdan Bazga*, Ph.D., Romania
- *Marius Voicilas*, Ph.D., Romania
- *Monica Tudor,* Ph.D., Romania
- Prof. *Anna Ivolga*, Ph.D., Russia
- Prof. *Marina Leshcheva*, Ph.D., Russia
- Prof. *Natalia Bannikova,* Ph.D., Russia
- Prof. *Vasily Erokhin*, Ph.D., Russia
- Prof. *Richard Simmons*, Ph.D., Scotland
- *Maja Kožar,* Ph.D., Slovenia
- Prof. *Aleksandar Rodić*, Ph.D., Serbia
- Prof. *Boris Kuzman*, Ph.D., Serbia
- Prof. *Branislav Vlahović*, Ph.D., Serbia
- Prof. *Božo Drašković*, Ph.D., Serbia
- Prof. *Danijela Despotović*, Ph.D., Serbia
- Prof. *Dejan Janković*, Ph.D., Serbia
- Prof. *Dragan Soleša*, Ph.D., Novi Sad, Serbia
- Prof. *Gojko Rikalović*, Ph.D., Beograd, Serbia
- Prof. *Gordana Dozet*, Ph.D., Serbia
- Prof. *Igor Tomašević*, Ph.D., Serbia
- Prof. *Ilija Brčeski,* Ph.D., Serbia
- Prof. *Ivan Bošnjak*, Ph.D., Serbia
- Prof. *Jugoslav Aničić*, Ph.D. Serbia
- Prof. *Koviljko Lovre*, Ph.D., Serbia
- Prof. *Lela Ristić*, Ph.D., Serbia
- Prof. *Ljubinko Jovanović*, Ph.D., Serbia
- Prof. *Marija Kostić*, Ph.D., Serbia
- Prof. *Marija Lakićević*, Ph.D., Serbia
- Prof. *Marija Mandarić*, Ph.D., Serbia
- Prof. *Mića Mladenović*, Ph.D., Serbia
- Prof. *Mihajlo Ostojić*, Ph.D., Serbia
- Prof. *Mihajlo Ratknić*, Ph.D., Serbia
- Prof. *Miljana Barjaktarović*, Ph.D., Serbia
- Prof. *Miodrag Brzaković*, Ph.D., Serbia
- Prof. *Natalija Bogdanov*, Ph.D., Serbia
- Prof. *Rade Popović*, Ph.D., Serbia
- Prof. *Radovan Pejanović*, Ph.D., Serbia
- Prof. *Sanjin Ivanović*, Ph.D., Serbia
- Prof. *Sanja Mrazovac Kurilić*, Ph.D., Serbia
- Prof. *Slađan Rašić*, Ph.D., Serbia
- Prof. *Snežana Janković*, Ph.D., Serbia
- Prof. *Sreten Jelić*, Ph.D., Serbia
- Prof. *Stanislav Zekić*, Ph.D., Serbia
- Pof. *Tanja Stanišić*, Ph.D., Serbia
- Pof. *Tatjana Jovanić*, Ph.D., Serbia
- Pof. *Tatjana Ratknnić*, Ph.D., Serbia
- Prof. *Todor Marković*, Ph.D., Serbia
- Prof. *Veljko Vukoje*, Ph.D., Serbia
- Prof. *Vesna Rodić*, Ph.D., Serbia
- Prof. *Vlade Zarić*, Ph.D., Serbia
- Prof. *Vladimir Zakić*, Ph.D., Serbia
- Prof. *Vladislav Zekić*, Ph.D., Serbia
- Prof. *Žaklina Stojanović*, Ph.D., Serbia
- Prof. *Zoran Njegovan*, PhD., Serbia
- Prof. *Zoran Rajić*, Ph.D., Serbia
- Prof. *Zorica Sredojević*, Ph.D., Serbia
- Prof. *Zorica Vasiljević*, Ph.D., Serbia
- Prof. *Željko Dolijanović*, Ph.D., Serbia
- Doc. *Andreja Andrejević*, Ph.D., Serbia
- Doc. *Dejan Sekulić*, Ph.D., Serbia
- Doc. *Dragan Milić*, Ph.D., Serbia
- Doc. *Gordana Radović*, Ph.D., Serbia
- Doc. *Irena Janković*, Ph.D., Serbia

- Doc. *Marija Nikolić*, Ph.D., Serbia
- Doc. *Mirela Tomaš*, PhD., Serbia
- Doc. *Nemanja Berber*, Ph.D., Serbia
- Doc. *Nikola Ćurčić*, Ph.D., Serbia
- Doc. *Nikola Milićević*, Ph.D., Serbia
- Doc. *Radivoj Prodanović*, Ph.D., Serbia
- Doc. *Tatjana Papić Brankov*, Ph.D., Serbia
- Doc. *Vera Mirović*, Ph.D., Serbia
- *Aleksandar Lučić,* Ph.D., Serbia
- *Anton Puškarić*, Ph.D., Serbia
- *Biljana Grujić Vučkovski*, Ph.D., Serbia
- *Branko Mihailović*, Ph.D., Serbia
- *Danica Mićanović,* Ph.D., Serbia
- *Divna Simić,* Ph.D., Serbia
- *Jovan Zubović*, Ph.D., Serbia
- *Lana Nastić,* Ph.D., Serbia
- *Ljiljana Rajnović*, Ph.D., Serbia
- *Marko Jeločnik*, Ph.D., Serbia
- *Mihajlo Ratknić,* Ph.D., Serbia
- *Nataša Cecić Kljajić*, Ph.D., Serbia
- *Predrag Vuković*, Ph.D., Serbia
- *Slađan Stanković*, Ph.D., Serbia
- *Slavica Arsić,* Ph.D., Serbia
- *Slavica Čolić,* Ph.D., Serbia
- *Slavica Stevanović,* Ph.D., Serbia
- *Svetlana Nikolić Roljević*, Ph.D., Serbia
- *Vesna Paraušić*, Ph.D., Serbia
- *Vesna Popović*, Ph.D., Serbia
- *Vladan Ugrenović*, Ph.D., Serbia
- *Vladimir Filipović*, Ph.D., Serbia
- *Vlado Kovačević*, Ph.D., Serbia
- *Zoran Simonović*, Ph.D., Serbia
- *Željko Despotović,* Ph.D., Serbia

ORGANIZATIONAL BOARD

- *Predrag Vuković*, Ph.D. – President
- Prof. *Jonel Subić,* Ph.D.
- *Marko Jeločnik*, Ph.D.
- *Ljiljana Rajnović,* Ph.D.
- *Nada Mijajlović*, M.Sc.
- *Velibor Potrebić*, M.A.
- *Marijana Jovanović Todorović*, B.Sc.
- *Bojana Bekić Šarić,* B.Sc.
- *Ivana Vučetić*
- *Milena Marinković*
- *Vesna Stajčić*
- *Boban Zarić*

Table of Contents

PLENARY SECTION

THEMATIC PROCEEDING

PROTEIN CONTENT IN BEAN GRAIN GROWN ACCORDING TO SUSTANABLE ECOLOGICAL PRINCIPLES

Gordana Dozet[1], Marijana Jovanović Todorović[2], Mirjana Vasić[3], Vojin Đukić[4], Marija Cvijanović[5], Zlatica Miladinov[6], Gorica Cvijanović[7]

Abstract

The research has been conducted during a three-year period in order to determine the protein content in bean grains grown by organic principles and to choose more suitable variety for farming in organic production. The field experiment was set by a split-plot design in 4 repetitions on calcareous chernozem. The large plots were cropped with varieties Maksa and Zlatko, while control subplot was treated by agro-technical treatments permitted in organic production. In the research, the starting hypothesis was that the protein content in bean grains will depend on variety and applied agro-technics in organic bean growing technology. The protein content in bean grain was statistically significantly dependent on agro-ecological conditions during the production year, variety and applied agro-technics. For the production of bean by organic principles, Maksa variety is recommended. It is possible to achieve high protein content in beans grown in accordance with the principles of sustainable ecological development.

Key words: *sustainable ecological development, beans, protein content.*

Introduction

Beans occupy an important place in the diet of our population, as a protein plant, but also in agricultural production, as an economically viable plant species and

1 Gordana Dozet, Ph.D., Associate Professor, Megatrend University, Faculty of Biofarming, Maršala Tita no. 39, 24300 Bačka Topola, Phone: +381 24 712 209, E-mail: gdozet@biofarming.edu.rs

2 Marijana Jovanović Todorović, M.Sc., Researcher Associate, Institute of Agricultural Economics, Volgina no. 15, 11060 Belgrade, Serbia, Phone: +381 60 484 80 41, E-mail: mairjana_j@iep.bg.ac.rs

3 Mirjana Vasić, Ph.D., Principal Research Fellow, Institute for crops and vegetables, Maksima Gorkog no. 30, 21101 Novi Sad, Serbia, Phone: +381 69 181 63 19, E-mail: mirjana.vasic@nsseme.com

4 Vojin Đukić, Ph.D., Senior Research Associate, Institute for crops and vegetables, Maksima Gorkog no. 30, 21101 Novi Sad, Serbia, Phone: +381 64 820 57 51, E-mail: vojin.djukic@nsseme.com

5 Marija Cvijanović, Ph.D., Assistant Professor, University Bijeljina, Pavlovića put bb, 76300 Bijeljina, Bosnia and Hercegovina, Phone: +381 63 885 81 85, E-mail: marijacvijanovic@yahoo.com

6 Zlatica Miladinov, Ph.D., Researcher Associate, Institute for crops and vegetables, Maksima Gorkog no. 30, 21101 Novi Sad, Serbia, Phone: +381 64 398 63 87, E-mail: zlaticamiladinov@gmail.com

7 Gorica Cvijanović, Ph.D, Full Professor, Megatrend University, Faculty of Biofarming, Maršala Tita no. 39, 24300 Bačka Topola, Serbia, Phone: +381 24 712 209, E-mail: cvijagor@yahoo.com

a good pre-crop. Due to its adaptability, it can be successfully grown in different agro-ecological conditions. It is one of the vegetables with the richest nutrients, primarily due to its high protein content.

Using the principles of organic agriculture, they combine the traditional way of production with the use of scientific innovations, all with the aim of promoting correct relations and a good quality of life within the environment. It is very important to choose the right variety that will be grown according to ecological principles (Vasić, 2016).

Modern agriculture is returning to organic agro-technical methods and the application of organic fertilizers. Guanito is a fertilizer based on bat droppings and part of seabirds. Contains all the macro and micro elements required by plants in their natural form. Declared organic fertilizers include Guanito, which contains 13% nitrogen, 8% phosphorus, 2% potassium and 11 trace minerals (Lazić and Šikoparija, 2011). It is an extraordinary organic fertilizer that has a beneficial effect on the positive balance of nutrients in the soil. It exhibits fungicidal and nematicidal properties (Shrinidhi et al., 2013).

Guanito faster mineralized itself, and plants get quickly available biogenic elements necessary to achieve planned and economically viable yields. Replacement of nitrogen from mineral fertilizers with organic and biological nitrogen has an ecological effect and has a positive effect on the physical properties of the soil.

Liquid preparation with effective microorganisms (EM aktiv) is applied before sowing for soil treatment and foliar. It promotes seed germination, lush roots, flowers and fruits and improves soil fertility (Szymanski et al., 2003). The tendency is to introduce into production varieties that are tolerant to diseases and pests, especially in the organic system of cultivation.

The implementation and maintenance of all the principles of organic cultivation technology implies the use of fertilizers for plant nutrition that are allowed in organic plant production. There are microorganisms that have a defensive role, but also a stimulating effect on plants. One of those organisms are fungi of genus Trichoderma spp. This fungi performes possitive effect on growth, development of plants, but also manifest preventive protection in case of pathogens attack (Harman et al., 2004).

Based on this research, we try to make a harmonized agricultural technique, especially in the organic system of cultivation. According to ressearch we can give a recommendation to target group of producers, in order to contribute to

increasing the area under beans in the Republic of Serbia, as well as achieving stable yields with satisfying quality.

The aim of performed research is possibility to determine which variety is more adaptable to the conditions of organic sustainable production and which applied agrotechnics is better, but also the interaction between the examined factors that are determined on the protein content in bean grain. Also, the influence of weather conditions (years), different varieties and applied treatments on the organic pelleted fertilizer Guanita, *Trichoderma atroviride* (Tffi) and the microbiological preparation EM aktiv on the protein content in bean grain was observed.

Materials and Methods

Two beans varieties created on the Institute of Field and Vegetable Crops in Novi Sad, has been used as material in the field experiment. Used variety in experiment are variety's Maksa and Zlatko and both are of determinable growth. Organic pelleted fertilizer (Guanito) was used with the formulation of nutritive elements N:P:K = 6:15:3 + 10Ca + 2Mg. Effective microorganisms (EM-aktiv) and *Trichoderma atroviride* (preparation Tiffi) were applied. EM-aktiv is a liquid concentrate that holds main antibiotic organisms which can be found naturally in soil (more than 80 strains). The preparation contains firm body of aerobic and anaerobic microorganisms, without any traces of genetically modified microorganisms. *Trichoderma atroviride* represents an integral part of the commercial bio preparation Tiffi which serves to control pathogenic fungi.

The field experiment in dry vegetable farming was set on calcareous chernozem in the period of 2014-2016 in Bajša, municipality of Bačka Topola, by split-plot design in four repetitions. The preceding crop was onion. The first factor of examination was the year of research, the second (large plots) were varieties (Zlatko and Maksa), and the third factor (subplots) was fertilization with 5 treatments: 1 – control, 2 – treatment of soil using the EM-aktiv (7 days prior to sowing), 3 – treatment of soil using the *Trichoderma atroviride* (Tiffi) (7 days prior to sowing), 4 – treatment of soil with pelleted organic fertilizer Guanito + EM-aktiv (7 days prior to sowing) during the bean's blossoming and 5 – treatment of bean seeds immediately before sowing with *Trichoderma atroviride* (Tiffi).

After soil treatment by raking were fertilizer and preparations inserted into the sowing layer depth. Bean was manually sown in four five-meter-long rows. The first and the fourth row were used for isolation, and the two middle rows were used for sample collection of plants for further analysis. The size of the elementary plot was 10 m^2.

In their physiological maturity, the plants from the middle rows were cut underneath the cotyledonal scar with vineyard scissors, carefully tied in bundles and the grains were manually detached from pods for determining the yield. A mass of 100 g was submitted to the Institute of Field and Vegetable Crops to determine the protein content of beans. The results were processed in Statistica 12 for the split-plot experiment design, by using the variance analysis, until the average values were tested using t - test with significance level of 5% and 1%.

Weather conditions

Temperature and precipitation data were obtained from the valid meteorological station of the Agricultural Administrative and Professional Service Bačka Topola from Bačka Topola.

Temperatures for the bean's vegetation period have deviated from the perennial average – more than 1°C in the year 2015 and 0.8°C in in the year 2016, but in the year 2014, the temperature was below average for the same period when compared with the perennial average. Precipitation in 2014 was highest during the bean's vegetation period and it amounted to 371.2 mm, which was higher when compared with other examined years and the perennial average.

When compared with 2015, it was 208.3% higher, and when compared with 2016 it was 99.6% higher, while when compared with the perennial average it was 48.5% higher (Tab.1). On that basis, it was concluded that the year 2014 was the most favorable among the three examined years for bean growing without irrigation.

Tabele 1. Weather conditions during the vegetation period of bean

Precipitation/Temperature	Vegetetion period				
	May	June	July	August	Sum/ Average
Precipitation 2014	168.0	48.0	88.2	67.0	371.2
Precipitation 2015	18.4	20.4	15.0	66.6	120.4
Precipitation 2016	31.2	66.4	26.6	61.8	186.0
Perennial precipitation average (1962-2016)	65.4	69.4	61.6	53.6	250.0
Temperature 2014	15.6	20.0	21.9	20.7	19.6
Temperature 2015	17.4	20.6	24.1	23.8	21.5
Temperature 2016	17.1	22.2	23.9	21.7	21.2
Perennial temperature average (1962-2016)	17.2	20.5	22.2	21.6	20.4

Source: Meteorological yearbook - climatological data (2014-2016); Republic Hydrometeorological Service of Serbia; *- expressed in mm; **- expressed in °C

Research results with discussion

The average protein content in the research period 2014-2016 was 20.56% (Tab. 2), with the highest recorded protein content being 23.56% in 2014 for the variety Maksa in variant 5, and the lowest 17.03% in 2015 for varieties Zlatko in the control variant.

The highest protein content was in 2014 (22.47%), and the lowest in 2015 (18.79%), while in 2016 it was 20.42%. All differences in protein content measured in bean grain in the years of research were at the level of high ($p < 0.01$) statistical significance (Tab. 2). In the examined varieties, there were differences in the protein content in the bean grain. The Maksa variety had a significantly higher protein content (21.05%) compared to the Zlatko variety (20.07%). That was 4.88% more.

In the control variant, a lower protein content was measured (19.37%), which was statistically very significant ($p < 0.01$) compared to other variants used (20.95%, 20.84%, 20.56%), 21.08%), while between the applied variants from 2 to 5 there were no statistically significant differences in the mentioned measurement property.

The BxC interaction was significant, insofar as in both tested cultivars the lowest protein content was in the control, and the highest in variant 5.

The CxB interaction was significant only in the control variant, because the Zlatko cultivar had a significantly lower protein content compared to the Maksa cultivar.

Table 2. Influence of research factors on grain protein content (%)

Year (A)	Variety (B)	Fertilization (C)						$\bar{x}$A
		1	2	3	4	5	$\bar{x}$AB	
2014	Zlatko	20.37	22.42	22.47	21.89	22.51	21.93	22.47
	Maksa	21.97	23.38	23.08	23.03	23.56	23.00	
	$\bar{x}$AC	21.17	22.90	22.78	22.46	23.03		
2015	Zlatko	17.03	18.75	18.79	18.31	18.82	18.34	18.79
	Maksa	18.37	19.55	19.31	19.26	19.70	19.24	
	$\bar{x}$AC	17.70	19.15	19.05	18.79	19.26		
2016	Zlatko	18.52	20.38	20.43	19.90	20.46	19.94	20.42
	Maksa	19.97	21.25	20.99	20.94	21.42	20.91	
	$\bar{x}$AC	19.24	20.82	20.71	20.42	20.94	$\bar{x}$B	
$\bar{x}$BC	Zlatko	18.64	20.52	20.56	20.03	20.60	20.07	
	Maksa	20.10	21.39	21.12	21.08	21.56	21.05	

Year (A)	Variety (B)	Fertilization (C)						x̄A
		1	2	3	4	5	x̄AB	
	x̄C	19.37	20.95	20.84	20.56	21.08		
Average 2014 -2016								20.56
LSD		Faktor						
A		B	C	AxB	AxC	BxC	AxBxC	
p<0.05		0.09	0.57	0.66	0.69	1.02	0.95	1.54
p<0.01		0.15	0.86	0.88	1.04	1.36	1.27	2.06

Source: Current research results

The protein content is influenced by the weather conditions that characterized the production year for beans, the choice of variety, but also the application of specific agricultural techniques (certain treatments) before sowing and during the growing season. Similar results state Dozet (2006, 2009), Cvijanović et.al. (2016), Dozet et al. (2020). In 2014, when there was the most precipitation and when the highest yield per hectare was, then the highest protein content in bean grain was measured, by 11.86%, respectively 10.04%, compared to 2015 and 2016. Differences between cultivars existed, which indicates that the property of protein content is also defined by genetic influence. Such results in the examination of protein content in soy are reported by Dozet (2009). According, in a three-year study, the protein content was higher in the grain of the Maksa variety, which also had a higher yield compared to the Zlatko variety. In their research in Argentina, Sammán et al. (1999) have come to similar results, and found differences in the protein content between different varieties of beans in the interval from 18 to 22%. Different protein content between cultivars was also found in soybeans by Đukić et al. (2018). Similar results in a study of 106 wild and 99 primitive varieties of beans are reported by Gepts et al. (1986). The positive impact of microbiological preparations in their research is stated by Dozet et al. (2015, 2016).

Conclusions

Based on the examination of the influence of the year of the variety, organic fertilizer and microbiological preparations on the protein content in beans (*Phaseolus vulgaris* L.) grown according to ecological principles, the following can be concluded:

- The protein content was very significantly influenced by the examined factors, years, variety and application of Guanite, EM aktiv and Trichoderma.

- The interactions that were significant were BxC and CxB, while the others were not statistically significant.
- The average protein content in the research period 2014-2015 was 20.56%, with the highest recorded protein content being 23.56% and the lowest 17.03%. The highest protein content was in 2014 (22.47%) and the lowest in 2015 (18.79%).
- All differences between the years were at a level of high statistical significance. - In the control and the other 4 variants, there were very significant differences between the examined varieties with the correct trend, because in all variants the Maksa variety achieved higher protein content in the grain compared to the Zlatko variety.

Modern agriculture is returning to organic agrotechnical methods and the application of organic fertilizers, which includes Guanito fertilizer.

To determine the most optimal period for production, it is necessary to use the findings on the impact of climate change on the behavior of cultivated plants in the initial stages of growth, as well as on the quality of the obtained grain. In that way, it will be possible to adapt to the new conditions, as well as production in the months with the smallest moisture deficit.

For the determination of efficient agricultural system is crucial to understanding the agroecosystem. The future in the production of healthy food lies in the application of agronomic and environmental performance, while preserving water and the environment, as well as protecting the environment.

The key for determined most efficient farming systems lies in understanding how agroecosystems works. For the future production of healthy food it is necessary to perform ecological principles and that is produced according to ecological principles and unequivocally affects the protection of water, the environment, as well as the environment and humanity. It is possible to achieve high protein content in beans grown according to the principles of sustainable ecological development.

Literature

1. Cvijanović M., Dozet G., Cvijanović G., Đukić V., Vasić M., Popović V., Jakšić S. (2016): *Yield of Bean (Phaseolus vulgaris) in ecological production according to environment conservation*. VI Balkan Symposium on Vegetables and Potatoes (September 29, 2014 - October 2, 2014) - Acta Horticulturale 1142_4, 25-30.

2. Dozet Gordana (2006): *Prnos i kvalitet soje u zavisnosti od međurednog razmaka i grupe zrenja u uslovima navodnjavanja*. Magistarska teza. Poljoprivredni fakultet, Univerziteta u Novom Sadu, str. 73.
3. Dozet Gordana (2009): *Uticaj đubrenja predkulture azotom i primene Co i Mo na prinos i osobine zrna soje*. Doktorska disertacija. Fakultet za biofarming, Megatrend univerziteta, Beograd, str. 154.
4. Dozet G**.**, Cvijanovic G., Vasic M., Djuric N., Jaksic S., Djukic V., (2015): *Effect of microbial fertilizer application on yield of bean (Phaseolus vulgaris L.) in organic production system*. Proceedings of XXIII International Conference »Ecological Truth«, 17-20 June 2015, Kopaonik, Serbia, 105-107.
5. Dozet G**.**, Cvijanovic G, Jaksic S., Djukic V., Kaludjerovic D., Miladinov Z. (2016): *Impact of Trichoderma atroviride and effective microorganisms the yield of pepper (Capsicum annuum L.) in the greenhause.* Symposium proceedings 2nd International Symposium for Agriculture and Food ISAF 2015, Org. Fac. Of Agricultural Sciences and Food Ss "Cyril and Methodius" University in Skopje Rep. of Macedonia Ohrid, Republic of Macedonia. 7-9 October 2015, 295-300.
6. Dozet Gordana, Mirjana Vasić, Gorica Cvijanović, Vojin Đukić, Zlatica Miladinov, Nenad Đurić and Vladan Ugrenović (2020): *Effect of variety on bean yield in organic production*. Of GEA (Geo Eco-Eco Agro) International Conference - Book of Proceedings, 28-29 May 2020, Podgorica, Montenegro, 380-386.
7. Đukić V., Stojanović Danijela, Miladinov Zlatica, Miladinbović J., Balešević-Tubić Svetlana, Dozet Gordana, Merkulov-Popadić Larisa (2018): *Sadržaj proteina i ulja u novim NS sortama soje*, Zbornik radova 59. Savetovanje Proizvodnja i prerada uljarica, 17-22.
8. Gepts P., Osborn T.C., Raska K. Bliss F.A. (1986): *Phaseolin protein variability in wild forms and landraces, of the common (Phaseolys vulgaris L): Evidence for multiple centres of domestication*. Econ. Bot., 40: 451-468.
9. Harman G.E., Howell C.R., Viterbo A., Chet I., Lorito M. (2004): *Trichoderma species-opportunistic avirulent plant symbionts*. Nature Reviews Microbiology 2 (1): 43–56.
10. Lazić Branka i Šikoparija Dobrila (2011): *BIO-BAŠTA za Vas*. Centar za organsku proizvodnju, Selenča; Zelena mreža Vojvodine, Novi Sad, 92 i 96.

11. Sammán N, Maldonado S, Alfaro M.E, Farfán N., Gutierrez J. (1999): *Composition of different bean varieties (Phaseolus vulgaris) of North-western Argentina (Region NOA): cultivation zone influence*. J Agric Food Chem. 1999 Jul;47(7):2685-9.
12. Shrinidhi Shetty K.S., Sreepada Rama Bhat (2013): *Effect of bat guano on the growth of Vigna radiata L*. International Journal of Scientific and Research Publications, Volume 3, Issue 3, 1-8.
13. Szymanski N., Patterson Robert A. (2003): *Effective microorganisms (EM) and wastewater systems*, New England: University of New England (http://www.envismadrasuniv.org/pdf/effective%20microorganisms%20and%20waste%20water.pdf 06.09.2020, 16:10h).
14. Vasić M. (2016): *Sorte pasulja u različitim sistemima gajenja*. 50. Savetovanje agronoma i poljoprivrednika, 24.01. – 30.01.2016., Zlatibor (https://www.ifvcns.rs/wp-content/uploads/2016/03/17-Sorte-pasulja-u-razlicitim-sistemima-gajenja.pdf, 06.09.2020, 17:20h)