

56. HRVATSKI I 56<sup>th</sup> CROATIAN AND  
16. MEĐUNARODNI 16<sup>th</sup> INTERNATIONAL  
SIMPOZIJ SYMPOSIUM ON  
AGRONOMA AGRICULTURE

5. – 10. rujna 2021. | Vodice | Hrvatska

September 5 – 10, 2021 | Vodice | Croatia

**ZBORNİK RADOVA**

**PROCEEDINGS**

Izdavač | Published by **Fakultet agrobiotehničkih znanosti Osijek**  
**Sveučilišta Josipa Jurja Strossmayera u Osijeku**  
**Faculty of Agrobiotechnical Sciences Osijek**  
**University Josip Juraj Strossmayer in Osijek**

Za izdavača | Publisher **Krunoslav Zmaić**

Glavni urednici | Editors in Chief **Vlatka Rozman**  
**Zvonko Antunović**

Oblikovanje | Design by **Ras Lužaić**

Tisak | Print by **VIN Grafika**

ISSN **2459-5543**

## **Fakultet agrobiotehničkih znanosti Osijek, Sveučilište Josipa Jurja Strossmayera u Osijeku**

### **Agronomski fakultet Sveučilišta u Zagrebu**

Agronomski i prehrambeno-tehnološki fakultet Sveučilišta u Mostaru, Bosna i Hercegovina

Akademija poljoprivrednih znanosti

Association for European Life Science Universities (ICA)

Balkan Environmental Association (B.EN.A)

Biotehniška fakulteta Univerze v Ljubljani, Slovenija

European Hygienic Engineering&Design Group (EHEDG), Germany

European Society of Agricultural Engineers (EurAgEng)

Fakulteta za kmetijstvo in biosistemske vede, Univerza v Mariboru, Slovenija

Hrvatska agronomska komora

Hrvatsko agronomsko društvo

Prehrambeno-tehnološki fakultet Osijek

Sveučilište Josipa Jurja Strossmayera u Osijeku

Sveučilište u Slavonskom Brodu

Veterinarski fakultet Sveučilišta u Zagrebu

### **pod pokroviteljstvom**

Ministarstva znanosti i obrazovanja Republike Hrvatske

Ministarstva poljoprivrede Republike Hrvatske

Ministarstva gospodarstva i održivog razvoja Republike Hrvatske

### **u suradnji s**

Bc Institutom za oplemenjivanje i proizvodnju bilja, Zagreb

Brodsko-posavskom županijom

Društvom agronoma Osijek

Gradom Osijekom

Gradom Požegom

Gradom Slavonskim Brodom

Gradom Vinkovcima

Gradom Vodicama

Hrvatskim lovačkim savezom, Zagreb

Hrvatskom agencijom za poljoprivredu i hranu, Osijek

Hrvatskom gospodarskom komorom, Zagreb

Hrvatskom poljoprivrednom agencijom, Križevci

Institutom za jadranske kulture i melioraciju krša, Split

Institutom za poljoprivredu i turizam, Poreč

Osječko-baranjskom županijom

Poljoprivrednim institutom Osijek

Sveučilištem u Splitu

Turističkom zajednicom Osječko-baranjske županije

Veleučilištem u Požegi

Visokim gospodarskim učilištem u Križevcima

Vukovarsko-srijemskom županijom

### **organiziraju**

## **56. hrvatski i 16. međunarodni simpozij agronoma**

**5. do 10. rujna 2021., Vodice, Hrvatska**



**Faculty of Agrobiotechnical Sciences Osijek, Josip Juraj Strossmayer University of Osijek  
and**

**Faculty of Agriculture University of Zagreb**

Academy of Agricultural Sciences

Association for European Life Science Universities (ICA)

Balkan Environmental Association (B.EN.A)

Biotechnical Faculty, University of Ljubljana, Slovenia

Croatian Chamber of Agronomists

Croatian Society of Agronomy

European Hygienic Engineering&Design Group (EHEDG), Germany

European Society of Agricultural Engineers (EurAgEng)

Faculty of Agriculture and Food Technology, University of Mostar, Bosnia and Herzegovina

Faculty of Agriculture and Life Sciences, University of Maribor, Slovenia

Faculty of Food Technology Osijek, Croatia

Faculty of Veterinary Medicine University of Zagreb

Josip Juraj Strossmayer University of Osijek

University of Slavonski Brod

**under the auspices of the**

Ministry of Science and Education of the Republic of Croatia

Ministry of Agriculture of the Republic of Croatia

Ministry of Economy and Sustainable Development of the Republic of Croatia

**in collaboration with**

Agricultural Institute Osijek

Bc Institute for Breeding and Production of Field Crops, Zagreb

Brod-Posavina County

City of Osijek

City of Požega

City of Slavonski Brod

City of Vinkovci

City of Vodice

College of Agriculture in Križevci

College of Slavonski Brod

Croatian Agency for Agriculture and Food, Osijek

Croatian Agricultural Agency, Križevci

Croatian Chamber of Economy

Croatian Hunting Federation

Institute for Adriatic Crops and Karsts Reclamation, Split

Institute of Agriculture and Tourism, Poreč

Osijek-Baranya County

Polytechnic in Požega

Society of Agronomy, Osijek

University of Split

Vukovar-Srijem County

**organize**

**56<sup>th</sup> Croatian & 16<sup>th</sup> International Symposium on Agriculture**

**September 5 - 10, 2021, Vodice, Croatia**



## **Organizacijski odbor Organizing Committee**

### **Predsjednik | Chairman**

Krunoslav Zmaić, Croatia

### **Članovi | Members**

Zoran Grgić, Croatia  
Ivan Ostojić, Bosnia and Herzegovina  
Franjo Tomić, Croatia  
Arthur Mol, Netherlands  
Mariana Golumbeanu, Romania  
Nataša Poklar Ulrih, Slovenia  
Ludvig Josefsberg, Germany  
Peter Groot Koerkamp, Netherlands  
Branko Kramberger, Slovenia  
Josip Haramija, Croatia  
Jurislav Babić, Croatia  
Vlado Guberac, Croatia  
Ivan Samardžić, Croatia  
Nenad Turk, Croatia  
Radovan Fuch, Croatia  
Marija Vučković, Croatia  
Ivica Ikić, Croatia  
Danijel Marušić, Croatia  
Romeo Jukić, Croatia  
Ivan Radić, Croatia  
Željko Glavić, Croatia  
Mirko Duspara, Croatia  
Ivan Bosančić, Croatia  
Ante Cukrov, Croatia  
Đuro Dečak, Croatia  
Darja Sokolić, Croatia  
Luka Burilović, Croatia  
Katja Žanić, Croatia  
Dean Ban, Croatia  
Ivan Anušić, Croatia  
Zvonimir Zdunić, Croatia  
Dragan Ljutić, Croatia  
Ivana Jurić, Croatia  
Borislav Miličević, Croatia  
Marijana Ivanek-Martinčić, Croatia  
Damir Dekanić, Croatia

## **Znanstveni odbor Scientific Committee**

### **Predsjednici | Chairmans**

Vlatka Rozman, Croatia

Zvonko Antunović, Croatia

### **Članovi | Members**

Nikola Bilandžija, Croatia  
Ivica Bošković, Croatia  
Anita Bošnjak Mihovilović, Croatia  
Mato Drenjančević, Croatia  
Jelena Gadže, Croatia  
Goran Jukić, Croatia  
Željko Jukić, Croatia  
Nikolina Kelava Ugarković, Croatia  
Dario Iljkić, Croatia  
Antonis K. Kokkinakis, Greece  
Jelena Kristić, Croatia  
Zvezdana Marković, Croatia  
Ornella Mikuš, Croatia  
Josip Novoselec, Croatia  
Aleksandra Perčin, Croatia  
Sonja Petrović, Croatia  
Maria Popa, Romania  
Sanja Radman, Croatia  
Irena Rapčan, Croatia  
Lidija Svečnjak, Croatia  
Tomislav Vinković, Croatia  
Vladimir Zebec, Croatia

### **Tajnik | Secretary**

Tihomir Florijančić, Croatia

## Key stakeholder groups for digital innovation of agriculture in Croatia

Larisa Hrustek<sup>1</sup>, Martina Tomičić Furjan<sup>1</sup>, Alen Džidić<sup>2</sup>, Dragica Šalamon<sup>2</sup>, Filip Varga<sup>2,4</sup>, Bastiaan van Loenen<sup>3</sup>

<sup>1</sup>*Faculty of Organization and Informatics, University of Zagreb, Pavlinska 2, Varaždin, Croatia (lhrustek@foi.unizg.hr)*

<sup>2</sup>*Faculty of Agriculture, University of Zagreb, Svetošimunska cesta 25, Zagreb, Croatia*

<sup>3</sup>*Faculty of Architecture and the Built Environment, Delft University of Technology, Julianalaan 134, BL Delft, The Netherlands*

<sup>4</sup>*Centre of Excellence for Biodiversity and Molecular Plant Breeding, Svetošimunska 25, Zagreb, Croatia*

### Abstract

The current readiness of the agricultural sector in Croatia to transform is limited. Creating and using an open data ecosystem in which data truly is the main force of the innovation process offers an opportunity to strengthen cooperation in this sector. The stakeholders of the agricultural data ecosystem in Croatia were not investigated until now. The main goal of this paper was to identify key stakeholder groups in the Croatian agricultural data ecosystem using a complex query. Five groups of stakeholders with different roles were identified. Their needs are focused on greater cooperation in the sector and they all strive for the economic, environmental, and social sustainability.

**Key words:** innovation trends, agricultural ecosystem, stakeholder groups, open data

### Introduction

The agricultural sector faces significant challenges that require drastic changes in the sector's everyday operations. One of the most significant challenges is related to climate change and global warming. A second challenge are the daily varying market conditions, and rapidly changing consumer preferences and expectations. Third, new environmental policies and recommendations, as well as food quality and safety, affect the way agricultural systems can and should be managed (Meinke, 2019). The roles and responsibilities of agricultural stakeholders expanded significantly in terms of expectations in response to successfully facing these complex challenges, and digital disruptors stand out as the main force, i.e. innovations based on digital technologies and new concepts (Trivelli et al., 2019). Innovations in the agriculture sector can be classified into three categories, namely (1) political issues and forces aimed at creating and adopting innovations, (2) distinguishing between innovations of products and innovation of processes, and (3) their impact on economic operators, the market (Bucci et al., 2019), and ultimately on society.

In Croatia, the share of agriculture, forestry and fisheries in total GDP has declined in recent years and amounts to slightly less than 3 % (Croatian Bureau of Statistics, 2019). This might be the result of a minimal readiness of the agricultural sector in Croatia to transform, due to a lack of investments in infrastructure capacity, the adoption of new technologies and forms of business and competitiveness of local products on the European market. The establishment of “smart agriculture” in Croatia should increase the innovation readiness of the sector. Smart agriculture is based on the incorporation of digital technologies into machinery, equipment, and sensors in agricultural production systems, and enables the collection of large amounts of data and information generated by the gradual application of process automation (Orsini et al., 2019). Use and re-use of open data in agriculture has the

potential to improve production efficiency. However, the issue of creating a single information space for agriculture remains open (Shamin et al., 2019; European Commission, 2020). The implementation of the common data space depends on the extent to which different stakeholders provide support using relevant data collected from heterogeneous data sources (Aydin and Aydin, 2020). Therefore, open data in agriculture, generated in the agricultural production also on the basis of implemented digital technologies, are most important in innovation processes in the sector. In order to create an ecosystem in which data is truly the main force of the innovation process, the cooperation and collaboration of all stakeholders in the agriculture data ecosystem is needed. For this reason, the main goal of this paper is to present key stakeholder groups in the agricultural data ecosystem, map these stakeholder groups onto the Croatian ecosystem, and explore and define, for each stakeholder group, the basic features, roles and needs, considering the underlying data usage and management in the agricultural sector.

### Material and methods

In order to obtain a generic categorisation of stakeholders in agriculture we searched the Scopus and the Web of Science platforms using the following complex query: "stakeholder" OR "persons" OR "actors" AND "agriculture" OR "agriculture business" OR "farms" OR "agriculture sector" OR "agriculture area" OR "agriculture field" AND "open data". This complex query was searched by topic: the title, abstract, and keywords were included in the search. Given the results obtained, i.e. the number of articles on the topic and the year of publication, there were no special restrictions in this search. Based on the analysis of the literature, stakeholders' groups in the agricultural data ecosystem were identified. After that, based on the union of all stakeholders, stakeholder groups in the agricultural data ecosystem of Croatia were defined and their roles and needs were presented.

### Results and discussion

In the Scopus database we found 17 articles, and 15 articles were available for analysis. The same search of the WoS platform resulted in 3 articles. After reviewing the articles found on the WoS, there are referenced also in Scopus. This resulted in a total of 17 articles for further analysis, of which 15 were available.

The stakeholders within the literature were identified as follows (Table 1). Based on the literature analysis, the union of all identified stakeholders has given stakeholder groups defined as follows: agricultural producers/ farmers, management and support organisations, consumer organisations/ consumers, researchers and scientists and suppliers.

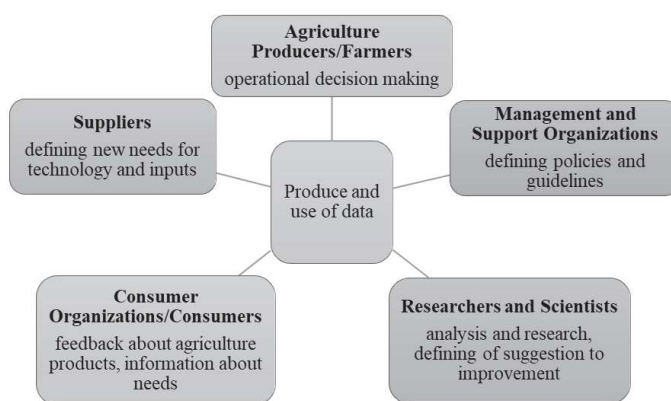
Table 1. Identified stakeholder within the literature

Stakeholders	Source
Public administration, Farmers and companies, Environmentalist group	Gautreau and Vélez, 2011
Contractors, Advisers, Industry, Research, Government, Business Associates and other Service Providers	Pesonen et al., 2013
Farmers, Researchers, Policy makers, Businesses, Advisors	Charvat et al., 2014
Agri-food industry, Consumers, Public administrations and Communities	Reznik et al., 2015
Community of data providers, Partners, Users	Celli et al., 2015
Farmers, Input and Technology Suppliers, Government, Participants in supply chains	Wolfert et al., 2017
Scientists and Societal actors	Ardila et al., 2018
Governments, Researchers, Farmers, International Organizations, Smallholder Farmers, Citizens, Service providers, SMEs, Multinationals	Musker and Schaap, 2018
Academic and Research Community, Industry, Standardization Bodies	Vučinić et al., 2018

Farmers, Researchers, Businesses, Analysts, and Experts	Aydin et al., 2018
Government, Private sector, Civil society groups, Consumers	Yuyanto and Liawatimena, 2018
Managers, Agriculture Business, Society, Support Scientists, End Users	Caballero et al., 2019
Farmers, Experts, Researchers, Domain Experts, Analysts	Aydin and Aydin, 2020
Farmers, Researchers, Analysts, Domain Experts and Exporters	Aydin and Aydin, 2020
Farmers, Extension agents, Researchers	Tonnang et al., 2020

### Stakeholder groups roles and needs in the agriculture ecosystem of Croatia

In order for the agricultural economy to sustainably operate, the ecosystem needs to be based on knowledge, new business concepts, and technological innovations, and key stakeholders in the agricultural sector need to be strengthened around their sphere of activity. Identifying stakeholders (Picture 1) is the first step in understanding the needs and quality of the sector, and the second step is to determine the relevance of their role and needs and the cooperative and incentive role in the sector. For identification of roles and needs, a blueprint of the national Strategy of the agriculture in Croatia was used (Ministry of Agriculture, 2020), given its detailed view of past, current and future needs of the agricultural sector, considering thereby only those related to data usage and management in the agricultural sector.



Picture 1. Key stakeholder groups for use of open data in the agricultural sector

Agricultural producers/ farmers simultaneously act as suppliers who offer their products, but also as members of the local community, procuring raw materials and supplies from other companies. These stakeholders are the main investors in their own rural community and play a vital role in the sustainability of the community itself, but also in the sustainability of the value chain and food system. They are expected to produce a sufficient amount of healthy, tasty, and fresh food that meets the prescribed quality standards. Data needs of agricultural producers/farmers are related to business investment, infrastructure and work capacity, business support through policies and recommendations, and most importantly, the availability of data for operational decisions and fair competition in the market.

Management and support organizations should strengthen farmers to invest responsibly, and improve their access to inputs, advisory, specialized financial services, special education, targeted training, and access to final consumers. The roles of the identified stakeholders of this group are somewhat different, however, their activities are aimed at encouraging the development and growth of the agricultural sector through policies, professional assistance, and financial support. Data needs of this group are aimed at building a business culture focused on sustainable development, encouraging all other stakeholders to cooperate and develop the sector through compliance with recommendations and policies, and support in building transparent business models through the availability of information by other stakeholders.



Researchers and scientists are important for performing different research analyses and for suggesting improvements. This group of stakeholders plays an important role in the implementation of scientific, professional, and project research, where the results of the research are input for the development of the agricultural sector through guidelines, recommendations, proposals, discovery of new methods, models, concepts, or products. The needs of this group in the ecosystem are related to greater involvement and cooperation in agricultural practice, availability of data necessary for conducting quality research, and a better understanding of the needs of all stakeholders in the agricultural ecosystem in Croatia and accordingly greater scientific contribution through research results. Consumers are buyers and users of finished agricultural products, and consumer organizations buy agricultural products for further production. The needs of consumers are related to the purchase of healthy and fresh food at reasonable prices and appropriate availability, while the needs of consumer organizations relate to the procurement of inputs needed in food processing and production. Suppliers of input raw materials and technology must play a role in providing appropriate production and technological inputs to farmers. Their need for data is significant due to the discovery of hidden needs in the market and the development of new, quality solutions tailored to the production needs of farmers.

## **Conclusions**

Five groups of stakeholders have been identified in the agricultural ecosystem: agricultural producers/ farmers, management and support organisations, consumer organisations/ consumers, researchers and scientists and suppliers. Their roles generally differ, but they all strive for the economic, environmental, and social sustainability of the agricultural sector. Their needs are focused on greater cooperation of all the stakeholders in the ecosystem. The presented overview will serve for further research on the introduction of new concepts for ecosystem development in the agricultural sector. A limitation in this paper is the search based on a complex query conducted in the Scopus and WoS database, which should be extended to additional professional databases in the field of agriculture and national databases as this article explores the open data agricultural ecosystem in Croatia. Future research will focus on additional and detailed search of stakeholders in professional and national databases, so additional categorization of stakeholders and analysis of their needs for open data can be made.

## **Acknowledgement**

The paper has been prepared in the context of the Twinning Open Data Operational (TODO) project which has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement Number 857592 – TODO.

## **References**

- Ardila A.M., Rebscher A., Hack J. (2018). An open-data based assessment of expected changes in land use and water availability as a result of the construction of the west segment of the Nicaragua interoceanic canal. In *Environments – MDPI*. 5 (1) 14: 1-17.
- Aydin S., Aydin M.N. (2020). A Sustainable Multi-layered Open Data Processing Model for Agriculture: IoT Based Case Study Using Semantic Web for Hazelnut Fields. *Advances in Science. Technology and Engineering Systems Journal*. 5 (2): 309-319.
- Aydin S., Aydin M.N. (2020). Ontology-based data acquisition model development for agricultural open data platforms and implementation of OWL2MVC tool. *Computers and Electronics in Agriculture*. 175: 105589.

- Aydin S., Ünal U., Nafiz Aydin M. (2018). Open Data in Agriculture: Sustainable Model Development for Hazelnut farms using semantics. 6th International Conference on Control Engineering & Information Technology (CEIT), Istanbul, Turkey.
- Bucci G., Bentivoglio D., Finco A., Belletti M., Bentivoglio D. (2019). Exploring the impact of innovation adoption in agriculture: How and where Precision Agriculture Technologies can be suitable for the Italian farm system? IOP Conf. Series Earth Environ. Sci., 275.
- Caballero I., Ruiz J., Navarro G. (2019). Sentinel-2 Satellites Provide Near-Real Time Evaluation of Catastrophic Floods in the West Mediterranean. *Water*. 11 (12): 2499.
- Charvat K., Esbrí Palomares M.A., Mayer W., Charvat J.K., Campos A.M., Palma R., Krivanek Z. (2014). FOODIE - Open Data for Agriculture. IST-Africa 2014 Conference Proceedings, Mauritius.
- Celli F., Malapela T., Wegner K., Subirats I., Kokoliou E., Keizer J. (2015). AGRIS: Providing access to agricultural research data exploiting open data on the web. *F1000 Research*. 4:110.
- Croatian Bureau of Statistics (2019). Gross Domestic Product - Annual Calculation. Available from: [https://www.dzs.hr/Hrv\\_Eng/Pokazatelj/Bruto%20domaci%20proizvod%20Godisnji.xls](https://www.dzs.hr/Hrv_Eng/Pokazatelj/Bruto%20domaci%20proizvod%20Godisnji.xls)
- European Commission (2020). A European strategy for data. COM (2020) 66 final. Available from: <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52020DC0066>
- Gautreau P., Vélez E. (2011). Strategies of environmental knowledge production facing land use changes: Insights from the silvicultural zoning plan conflict in the Brazilian state of Rio grande do sul. *CyberGeo* 2011.
- Meinke H. (2019). The role of modeling and systems thinking in contemporary agriculture. In *Sustainable Food Supply Chains: Planning, Design, and Control through Interdisciplinary Methodologies*. Bologna, Italy: Elsevier.
- Ministry of Agriculture (2020). Draft agricultural strategy, Croatia 2020-2030. Available from: [https://poljoprivreda.gov.hr/UserDocsImages/dokumenti/novosti/Nacrt\\_strategije\\_poljoprivrede\\_2020\\_2030\\_.pdf](https://poljoprivreda.gov.hr/UserDocsImages/dokumenti/novosti/Nacrt_strategije_poljoprivrede_2020_2030_.pdf)
- Musker R., Schaap B. (2018). Global Open Data in Agriculture and Nutrition (GODAN) initiative partner network analysis. *F1000Research* 2018.
- Orsini R., Basil D., Belletti M., Bentivoglio D., Bozzi C.A., et al. (2019). Setting of a precision farming robotic laboratory for cropping system sustainability and food safety and security: Preliminary results. IOP Conf. Series Earth Environ. Sci., 275.
- Pesonen, L.A., Teye F.K.-W., Ronkainen A.K., Koistinen M.O., Kaivosoja J.J., Suomi P.F., Linkolehto R.O. (2013). Cropinfra e An Internet-based service infrastructure to support crop production in future farms. *Biosystems Engineering*. 120.
- Řezník T., Lukas V., Charvát K., Horáková Š., Charvát J.K. (2015). Towards Farm-Oriented Open Data in Europe: the Scope and Pilots of the European Project "FOODIE". *Agris On-line Papers in Economics and Informatics*. VII (1): 51-58.
- Shamin A., Frolova O., Makarychev V., Yashkova N., Kornilova L., Akimov A. (2019). Digital transformation of agricultural industry. IOP Conf. Series Earth Environ. Sci., 346.
- Trivelli L., Apicella A., Chiarello F., Rana R., Fantoni G., Tarabella, A. (2019). Unveiling technological connections in the agrifood sector. *British Food Journal*. 121: 1730-1743.
- Tonnang H.E.Z., Balemi T., Masuki K.F., Mohammed I., Adewopo J., Adnan A.A., Mudereri B.T., Vanlauwe B., Craufurd P. (2020). Rapid Acquisition, Management, and Analysis of Spatial Maize (*Zea mays* L.) Phenological Data-Towards 'Big Data' for Agronomy Transformation in Africa. *Agronomy*. 10 (9): 1-12.
- Vučinić M., Pejanovic-Djurisic M., Watteyne T. (2018). SODA: 6TiSCH Open Data Action. Workshop on Benchmarking Cyber-Physical Networks and Systems, Porto, Portugal.
- Wolfert S., Ge L., Verdouwa C., Bogaardt M.J. (2017). Big Data in Smart Farming - A review. *Agricultural Systems*. 153: 69-80.
- Yuyanto and Liawatimena S. (2018). Implementation of Data Collecting Platform Over Distributed Sensors for Global Open Data for Agriculture and Nutrition. 6<sup>th</sup> International Conference on Cyber and IT Service Management (CITSM 2018), Medan, Indonesia.

## Promoting digital innovation: Identifying the key elements in agricultural open data ecosystem in Croatia

Dragica Šalamon<sup>1</sup>, Martina Tomičić Furjan<sup>2</sup>, Alen Džidić<sup>1</sup>, Filip Varga<sup>1,3</sup>, Larisa Hrustek<sup>2</sup>, Bastiaan van Loenen<sup>4</sup>

<sup>1</sup>*Faculty of Agriculture, University of Zagreb, Svetošimunska 25, Zagreb, Croatia, (dsalamon@agr.hr)*

<sup>2</sup>*Faculty of Organization and Informatics, University of Zagreb, Pavlinska 2, Varaždin, Croatia*

<sup>3</sup>*Centre of Excellence for Biodiversity and Molecular Plant Breeding, Svetošimunska 25, Zagreb, Croatia*

<sup>4</sup>*Faculty of Architecture and the Built Environment, Knowledge Centre Open Data, Delft University of Technology, Julianalaan 134, Delft, Netherlands*

### Abstract

Open data is critical for digital innovation in the sector of agriculture. We aimed to identify the four key elements of the open data ecosystem for the agricultural domain in Croatia. 357 data files available via the Croatian Open data portal, the internet pages of the Ministry of agriculture, the Croatian agency for agriculture and food, as well as the Paying Agency for Agriculture, Fisheries and Rural Development were analysed. The main G2B publishers of the agriculture domain have not yet reached their potential in opening data. There are still many raw and aggregated datasets not openly available. The published data lack a suitable format for data linking and information on licencing.

**Key words:** open data, agriculture, ecosystem elements, publisher, dataset

### Introduction

As the basis of digital transformation, access to more comprehensive data with broad usage capabilities enables innovation for the progress of the European economy and the betterment of citizens (Davies, 2012). European and Croatian strategic logistics and legislation for the opening and reuse of data as an institutional framework for the implementation of open data policy has been developing intensively since 2013 (Musa et al., 2018). In 2018, a code of conduct was developed for the exchange of agricultural data under the contract, and in 2019, EU Member States signed a declaration of cooperation "A smart and sustainable digital future for European agriculture and rural areas", which recognises the potential of digital technologies for the agricultural sector and rural areas and supports the establishment of data spaces.

Given the projected global increase from 33 zettabytes of open data in 2018 to 175 zettabytes of open data in 2025 (Gens et al., 2017) the current European Data Strategy predicts a near doubling in the number of data experts in the EU since 2018 (to 10.9 million), as well as an increase in the population with basic digital skills from 57% to 65%. The value of the data economy in the EU is estimated at EUR 829 billion Euro in 2025, representing almost a triple from 2018 (EC, 2020). The expected reversal of the processing and analysis of data from centralized computing infrastructure to network-edged computing by 2025 (Panetta, 2016) will provide additional opportunities for data manufacturers to manage the data generated and a new perspective for the development of SMEs' and MMEs' products and services. For this reason, a significant impact on the way production, consumption and life is expected from rationalized energy consumption, better traceability of products, materials

and food, to a healthier life. The strategy highlights the importance of SMEs, and increasing the functionality of G2B ("government to business") and B2G ("business to government") and B2B ("business to business") data exchange (EC, 2020). Innovation based on open access to data and open use and reuse of data between sectors will also contribute to the European Green Plan.

The priority sector for addressing issues such as connectivity, data processing and storage, computing power and cybersecurity is precisely the European agricultural information space within which a European neutral platform for the exchange and assembly of agricultural data is planned into repositories, including private and public data. The role of sector data spaces is to foster the development of an open data ecosystem (businesses, civil society and individuals) where new products and services are created on the basis of more accessible data. For the precise and tailored application of production approaches at farm level, it is necessary to strengthen digital, in particular data, literacy in the sector (EC, 2020; Šalamon et al., 2021). The flow of production data, in particular in use with other data from agricultural but other sectoral data sources is essential for agricultural production. For the agriculture sector, they include socio-economic, legislative and administrative, environmental and natural resources data (Šalamon, 2019).

As technologies and innovations arise on the basis of open data, not the other way around (Musa et al., 2018), the limiting factor in the early development of the open data ecosystem in the agriculture sector is the amount of open data and repositories. With a focus on the G2B principle, we decided to identify key elements of the open data ecosystem (Zuiderwijk et al., 2014) of the agricultural sector in Croatia and to assess their status in order to provide input to the next steps towards an open data ecosystem in the agriculture sector in Croatia.

## **Material and methods**

The very definition of the open data ecosystem as a functional whole and cyclically sustainable system of people, practices, values and technologies, which make up the infrastructure of open data within a narrower context is still in development (Zuiderwijk et al., 2014; van Loenen et al., 2018). Therefore we decided to focus on the four key elements of the open data ecosystem according to Zuiderwijk et al. (2014): (i) open online data repositories; (ii) search, assessment, review of data and licences; (iii) cleaning, analysis, enrichment and visualisation of data; (iv) interpretation, discussion and feedback to the data provider and other stakeholders.

From the G2B perspective, the data sets of the agricultural sector were analysed, in a narrow sense and without the analysis of policy acts, heralds and proceedings, available through the following repositories: (i) the Open Data Portal of the Republic of Croatia (<https://data.gov.hr/>) in the thematic field of Agriculture, forestry and fisheries; (ii) the website of the Ministry of Agriculture (<https://poljoprivreda.gov.hr/>); (iii) the website of the Croatian Agriculture and Food Agency (<https://www.hapih.hr/>), and (iv) the website of the Paying Agency for Agriculture, Fisheries and Rural Development (<https://www.apprrr.hr/>), in relation to the number of documents available and the publishers of datasets.

The search, assessment and review element of data and licenses includes: (i) an analysis of access options; (ii) information on the data format (raw or aggregated; and the format and size of the files). The third element is the purification of raw data, analysis, enrichment, visualization and connectivity. For the fourth key element of the ecosystem, the ability to provide feedback to a publisher that publishes a particular set of data has been analysed.

---

## Results and discussion

A total of 357 files (5.95 GB) available from four publishers were analysed, and over ten databases and related applications from these publishers were listed. On its website, the largest number of files are provided by the Ministry of Agriculture of the Republic of Croatia (202 analysed), while the Payment Agency offers the largest amount of data open through downloadable files on the account of spatial data (5.1 GB). In addition to the Ministry, the Croatian Agency for Agriculture and Food, and the Agency for Payments in Agriculture, Fisheries and Rural Development make central public publishers of open data in the agricultural ecosystem in Croatia. According to the number of open files, the most common format is .pdf (not considered to be an open format), followed by .xlsx and .aspx (Graph 1). Almost no dataset was published in an open format (.csv). Additional data sets are opened by the National Bureau of Statistics, as the only publisher of agricultural data that also references its data through the Open Data Portal of the Republic of Croatia.

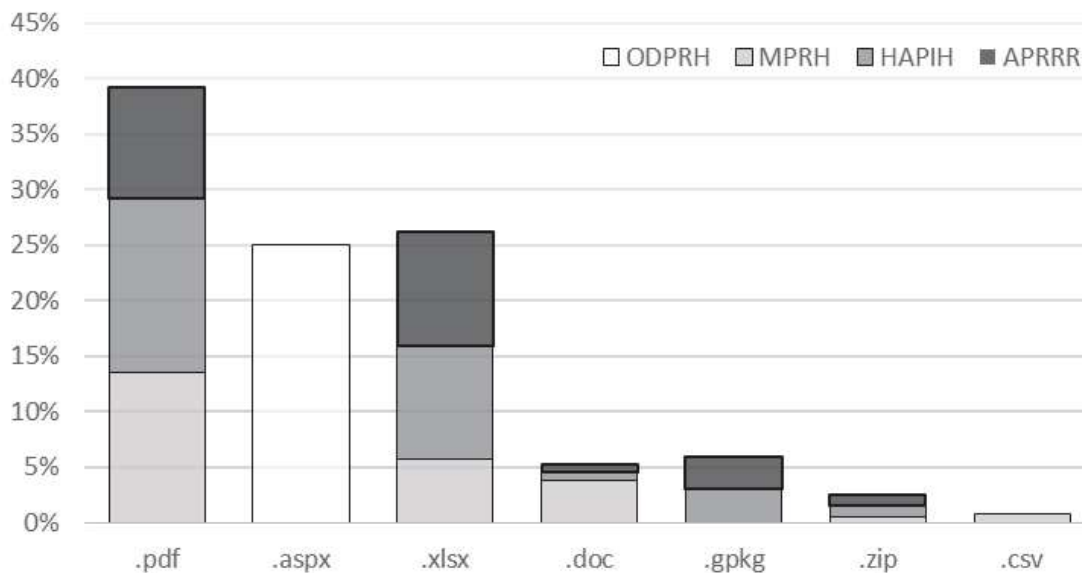
In addition to the publication of open documents, the Ministry of Agriculture of the Republic of Croatia (see <https://poljoprivreda.gov.hr/>) also creates databases for different target groups (for consumers, or narrower professional communities). These are Food bank, Hagrid, SVIS, Lysacan, VetIS, Owner, Honey of the Croatian apiaries, Eggs of the Croatian farms, KOLK-VETI and By-products. They are available through the eponymous or other (e.g. e-donations, eDPZ) web or installation applications of the Ministry. Access to databases is possible with registration, but there is no information on how users are registered. The databases Honey of the Croatian apiaries, and Eggs of the Croatian farms offer limited search options for users that did not register. Feedback is enabled through the user system by contacting the person in charge of each application for both registered users and the ones not registered.

Access to open data sets of the Ministry was analysed based on 202 data sets available through documents in .xlsx, .csv, .doc, .html, .png, .zip, and .pdf formats (0.33 GB) (Graph 1). Predominantly .pdf files, which are not considered to be an open format, that contain aggregated data with certain map visualisations are shared (Graph 1). Animal information is available in the form of data aggregated by cities, without the specification of the animal species. The farm registry is listed, but there is no access to that data. The assessment of breeding values in Croatia is only available for cattle in .html form, and milk control and management of cattle are available through the Owner web application. Breeding associations or similar address books have different levels of availability. Some are open in .html form and others accessible only through applications with registered users. For some address books, visualization is also enabled on the interactive map. Gene bank collections offer aggregated information on the number of samples of reproductive tissues or genomic collections, without the possibility of searching. Individual data sets are available in multiple formats, e.g. .csv, .xlsx and .pdf. For some, the download format information is wrong. Feedback is possible for individual thematic data groups, while information on how to use the data or licenses are generally not available.

The Croatian Agriculture and Food Agency offers the possibility to access information on demand using defined application forms for: access to data; re-use of the data, and supplement or clean the data. Some information from this publisher is freely available on the website <https://www.hapih.hr/>. 36 documents (0.13 GB) were analysed with data related to seed and planting, plant protection, soil, food safety, livestock production, quality control of livestock products, viticulture, fruit growing and vegetable growing that this publisher opens through its website. Predominantly open .pdf files contain mostly aggregated data with

individual map views (Graph 1). In addition to the files freely available on the publisher's website, an additional 14 sets of data were analysed in .xlsx documents (0.17 GB) consisting of raw data related to livestock production provided on demand for scientific and educational purposes. Files that are freely available are not linked, there is no information about licenses, are predominantly of simple structures, while the raw data provided can be purified for different purposes. Visualizations are limited to aggregated data in annual reports.

For the publisher Paying Agency for Agriculture, Fisheries and Rural Development (APRRR) (<https://www.aprrr.hr/>) 75 files out of a total of 5.32 GB were analysed. Most data can be accessed without registration, but some data is available through the Arkod portal, Agronet and Portal ponuda, which require registration. The Arkod portal allows visualization on an interactive map, while Agronet and Portal ponuda allow for data browsing. Terms of use of Arkod spatial information are available on request. The ability to feedback on data is not directly obvious.



Graph 1. Shares of used formats of the number of analyzed files published by central public publishers of open agriculture data in Croatia.

ODPRH – Open dana portal (agriculture); MPRH – Ministry of agriculture; HAPIH – Croatian Agency for Agriculture and Food (Internet documents and documents on demand); APRRR – Paying agency.

The prevailing file types available from this publisher are .pdf and .xlsx, fewer sets are .gpkg files, while exceptional data is present in .doc files, and several archived sets of information are available in compressed .zip files (Table 1). The file format does not provide related data, the license information is generally not present, the data is predominantly aggregated and of simple structure.

Through the Open Data Portal of the Republic of Croatia in the thematic area Agriculture, forestry and fisheries, 30 sets of data were analysed, of which 29 were published by the State Bureau of Statistics and one by APRRR. The National Bureau of Statistics issues aggregated sets of .aspx format data with metadata, and all (sub)selected data can be downloaded in .htm, .json, and various .csv, .xls format options. Each set of data has the specified source, responsible service, contacts of responsible persons and copyright. The APRRR data set lists aggregated farm register statistics and the register published in 2015, but the link is not valid.

Although complementary owners of public data in the agricultural sector from a G2B perspective, such as peripheral public services (cities, counties, municipalities), centres of excellence (Varga et al, in press) and the research and scientific community in this survey are not covered, four data sets sources, i.e. the four data publishers researched, are currently responsible for the fundament of the open agricultural sector ecosystem in Croatia. Step-ups in opening potential are databases, applications and interactive visualizations of the Ministry of Agriculture and APRRR. The additional potential of data in food production in Croatia is carried by non-governmental organisations (LAGs or breeders' associations, etc.) from a B2G perspective. The large representation of .pdf file formats with aggregated data does not currently allow for database and G2G ("government to government") interoperability and efficiency in data usage.

For the final assessment of this ecosystem, in addition to the estimated key elements, an additional three elements should be analysed: user trajectories clarifying the routes of use of open data sets (Walker et al., 2020); the data quality management system; and different types of metadata that can be linked to ecosystem elements (Zuiderwijk et al., 2014). The first step in further evaluation of the system is a stakeholder analyses (Hrustek et al., in press) and the social elements of the open data ecosystem, as well as infrastructure and technological elements and tools for working with open data in this sector. Additional value provides a link to the data space of the agricultural sector, namely the availability of socio-economic, legislative and administrative, environmental and natural resources data with application in the agricultural sector (Šalamon, 2019).

## Conclusions

Although there are steps in the sector to open up the potential of open data in the form of databases, applications and interactive visualisations, central agricultural sector publishers can improve the amount and quality of published open data significantly. The lack of raw data hinders faster access to the consolidated versions of the data, and the opening of predominantly aggregated data prevents the faster development of new knowledge and conclusions from the large amount of information aggregated by central public authorities in the sector. Predominantly used formats are not open and unsuitable for data connectivity, and the lack of licensing information restricts the proper use of open data. Education, data literacy and systematic investment of human capacity and knowledge within the agricultural sector are crucial in enabling the publication of open data and the reuse of such data from central sources, but also for incentivizing peripheral publishers.

## Note

This work was created as a product of the Twinning Open Data Operational (TODO) project funded by the EU Horizon 2020 Research and Innovation Programme (GA: 857592 – TODO).

## References

- Davies T. (2012). Open Data: Infrastructures and ecosystems. ACM Web Science Conference 2012: 1-6.
- EC (2020). A European strategy for data. European Commission, Brussels.
- Gens F., Del Prete C., Lundstrom S., Fearnley B., Nakamura T., Turner V., Carter P., Carvalho L., Fitzgerald S., Gillen A., Matsumoto S., Mohan D., Newmark E., Ng S., Parker R., Schubmehl D., Vesset D., Tom Mainelli T., Rick Villars R., Sutherland H. (2017). Worldwide IT Industry 2018 Predictions. IDC FutureScape, Doc # US43171317.

- Hrustek L., Tomičić Furjan M., Džidić A., Šalamon D., Varga F., van Loenen B. (2021). Key stakeholder groups for digital innovation of agriculture in Croatia. Proceedings of 55th Croatian & 15th International Symposium on Agriculture (in press).
- Musa A., Bevandić D., Herak D., Jadrijević L., Kovačić M., Lukša Z., Vrčec N. (2018). Priručnik o ponovnoj uporabi informacija za tijela javne vlasti: otvoreni podaci za sve. Musa A. (ed.), 59. Zagreb, Hrvatska: Povjerenik za informiranje, Hrvatska.
- Panetta C. (2016). Gartner's Top 10 Strategic Technology Trends for 2017. Smarter with Gartner. Gartner.
- Šalamon D. (2019). Overview of open data in Croatia available for use in the sector of agriculture. Book of Abstracts of the International Conference Innovations: Guarantee for Future of Agribusiness in Croatia. Svržnjak K. (ur.). Zagreb: Hrvatsko agroekonomsko društvo, 31-32.
- Šalamon D., Džidić A., Varga F., Čavrak I., Bosnić I. (2021). Data literacy in sector of Croatia- Learning about and with open data. Book of Abstracts of the International Conference Innovations: Innovation in education. Hrvatsko agroekonomsko društvo (in press).
- Varga F., Grdiša M., Nikolić T., Guberović E., Bosnić I., Welle Donker F., Šalamon D. (2021). Dalmatian pyrethrum spatial records quality from Croatian Open Databases. Proceedings of 55th Croatian & 15th International Symposium on Agriculture (in press).
- van Loenen, B., Vancauwenberghe, G., Cromptvoets, J., Dalla Corte, L. (2018). Open Data Exposed. In: Van Loenen B., Vancauwenberghe G., Cromptvoets J. (eds.). The Hague: TMC Asser Press, 1-10 (Information Technology and Law Series; vol. 30).
- Walker J., Thuermer G., Simperl E., Carr L. (2020). Smart rural: The open data gap. In *The Conference: Data for Policy 2020*, Data for Policy community platform on Zenodo.
- Zuiderwijk A, Janssen M, Davis C (2014). Innovation with open data: essential elements of open data ecosystems, Information Polity 19 (1-2): 17-33.