Towards digital innovation

Stakeholder interactions in agricultural data ecosystems in Croatia

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TOWARDS DIGITAL INNOVATION: STAKEHOLDER INTERACTIONS IN AGRICULTURAL DATA ECOSYSTEM IN CROATIA*

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ABSTRACT

The successful adoption of digital innovations in agricultural production systems is based on the proactive participation of all stakeholders and represents an important step in establishing resilient agri-food chains and creating sustainable value. The key tool for the creation of sustainable value is integrating the nine aspects of the business process (cooperation; inclusion; financing; diversification; communication; policies; knowledge with entrepreneurship; and production) by re-using of open governmental and public endeavours data as well as by the contractual sharing. The objectives of this research are to identify stakeholders in the Croatian agricultural system, and to explore their roles and their potential for data supply and needs for data uptake. Open access repositories were queried to identify stakeholders. Direct observation methods and semi-structured conservational qualitative interviews were used for stakeholder characterisation and data flow detection. Stakeholder importance with respect to current data supply was analysed. Underdeveloped data flow relationships in the agricultural data ecosystem in Croatia could be built in a spontaneous process following the data opening of the Research and Consumer group of stakeholders and promoting data sharing initiatives of the early adopters in the Supplier group. In that way, data opening would be the driver of the effective cooperation creation required for sustainable value creation but also the adoption of the best management practices, sustainable solutions and digital development.

KEY WORDS

agriculture data ecosystem, open data, stakeholder analysis, sustainable value

CLASSIFICATION

JEL: O13, Q01, Q15, Q16

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INTRODUCTION

The agricultural sector plays a significant role in global and regional development. However, despite its strategic importance, too little attention is still paid to building the key elements in creating value and establishing sustainable practices in business processes [1]. The key elements of strategic planning, decision-making, and management in complex systems such as agriculture are (i) using and integrating the emerging digital technologies; (ii) the circular approach and participation; (iii) transferring the knowledge and the appropriate policies into agricultural business process practices [1-6]. An approach that combines these key features improves the business performance [5] but also creates sustainable agricultural value [1].

The framework for sustainable value creation in the agricultural sector [1] focuses on activities creating value currently and in the future, and it includes maintaining the internal environment but also emphasizes simultaneous interaction with the external surrounding. Therefore, the integration of the following nine aspects: cooperation; inclusion; financing; diversification; communication; policies; knowledge with entrepreneurship; and production enables the creation of sustainable values. The key tool for the integration of these aspects is the data sharing (either as re-using of the open data or as contractual sharing), enabled by the effective data governance [7-14].

Sustainable data-based value creation is a common approach that allows different stakeholders to influence decisions at different governmental levels of a complex structure [2]. In this research, we focused the circular perspective of the agricultural data ecosystem on the cooperation of all stakeholders and investigated data sharing needs based on the key characteristics and role of individual stakeholders in the sector and their role in the supply and demand for data.

Cooperation and collaboration between the stakeholders in the agricultural sector through engagement, motivation and capacity to act together enables economic opportunities and ensures equal access to information and resources. It also contributes to the promotion of best management practices, the ones crucial for sustainable development and promoting effective resource management [3-5, 14, 15-17]. However, despite the focus on joint planning and management in agricultural operations, at the moment the effective cooperation remains limited [2]. The reasons are the complexity of the agricultural system, the large number of stakeholders with different perspectives, interests, values and concerns regarding business processes [2] which operate in an ecosystem where data and information exchange is lacking or is decentralized [6].

The open data ecosystem is a concept developed by emerging governments to encourage sharing and reuse of data, and as such includes key components which are policies for legal context, standards for interoperability, and an access network available for all stakeholders in the ecosystem [18, 19]. Open data ecosystem performance can be observed through three types of output indicators, namely data supply, data governance and user characteristics [18]. Open governmental data is an important part of the agricultural data ecosystem, however, creating value in this sector requires also a significant portion of different contractual data sharing [14].

This research contributes to the usage and value elucidation of open and shared data in the agricultural data ecosystem by defining and prioritizing the stakeholders through queries of open source databases, by discovering the data needs based on the stakeholder groups and alliances as well as the assigning the level of influence for the data supply in this data rich sector. The revealing of the potential for the development of data supply, taking into account stakeholder relations, will enable the development of a more resilient and sustainable ecosystem for agricultural data sharing in Croatia.

In the Croatian agricultural sector, data are often vague, scattered or not easily accessible [20], and in many cases when farmers (SMEs) are to obtain management, market or other information, they rely on informal channels such as a personal network of agricultural contacts (personal account and spoken-information). The farmers' associations, governmental and business advisory services do not yet recognize the valuable potential of the data, therefore, it is important to understand the groups of stakeholders and their relationships in the agricultural open data ecosystem in order to address the needs and problems of the data and information exchange and to formulate strategies and recommendations for further sector development.

The objectives of this research are as follows:

1) to identify all present and potential stakeholders in the agricultural open data ecosystem in Croatia and categorize them into key groups,
2) to define data sharing in this ecosystem, based on relationships between stakeholders and their role in the supply and demand for data,
3) to add to the knowledge of the key elements of the agricultural open data ecosystem in Croatia and prioritize further research.

METHODOLOGY AND MATERIALS

Stakeholder analysis (SA) is an approach used to define and understand a complex network of actors focusing on identifying key stakeholders, assessing their interests and needs, and clarifying how they can impact sustainability and improve processes in a particular research field [21, 22]. This research is based on the stakeholder methodology approach developed by Grimle and Chan [22, 23], where they consider the stakeholder analysis as a powerful tool for analysing the situation of the field, formulating policies, and developing programs based on an approach of understanding the observed system, changing it, identifying key actors or stakeholders and assessing their interests in the system. Lelea et al. conducted a transdisciplinary study in the field of agricultural and food systems where they developed a methodology for stakeholder analysis [24].

Figure 1 shows the four steps of the information collection, classification and validation analysis used for stakeholder analysis in the agricultural data sharing ecosystem in Croatia. In our research we have focused on the selecting of an activity system in agricultural sector and centering the issue to be addressed to data sharing. In the stakeholder's analysis we have focused to identify and characterize the actors based on the initial categorization of the stakeholder groups (Figure 2): (i) Agricultural producers/ farmers; (ii) Management and support organisations; (iii) Consumer organisations/ consumers; (iv) Researchers and scientists and (v) Suppliers. These groups were the basis for selecting the participants for our research [24]. Identification of stakeholders in key groups was made based on the on-line queries. Stakeholder characterisation and the research of their roles in data supply and demand in the sector, as well as a proposal for integration and their potential contribution to the development of a collaborative network and data sharing model, were obtained from the queries, direct observations and interviews. Stakeholder interviews were conducted as an important source of qualitative information in this stakeholder analysis [25]. Validation of stakeholders as data providers was carried out by this research group based on information collected from interviews and direct observation.

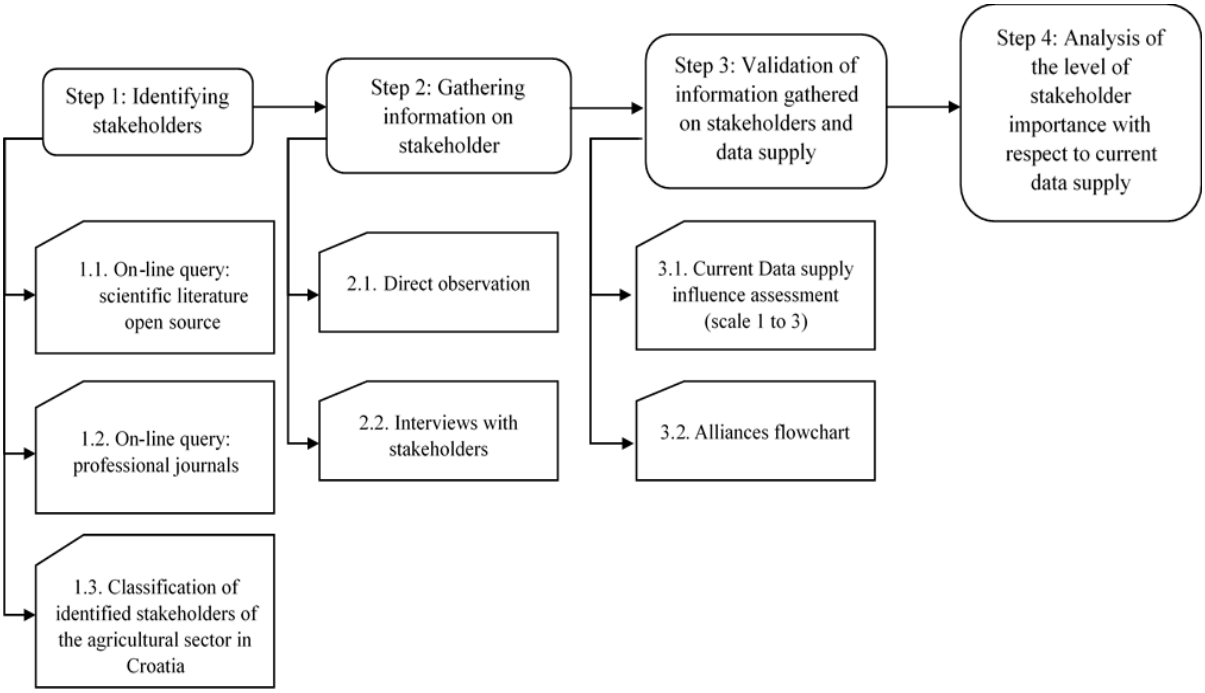

Figure 1. The four steps of agricultural stakeholder mapping in the context of data sharing ecosystem in Croatia.

Step 1: Identifying stakeholders

Open access repositories of scientific and professional publications were chosen for the initial stakeholder identification. Digital Academic Archives and Repositories (Dabar) and the Portal of Croatian scientific and professional journals – Hrčak were queried for scientific publications. Professional journals from Hrčak were searched by field, focusing on the journals in the field of agriculture (section: "agronomy").

The complex query: "stakeholder" OR "persons" OR "actors" OR "agriculture" OR "agriculture business" OR "farms" OR "agriculture sector" OR "agriculture area" OR "agriculture field" AND "open data" was used for search of the national databases Hrčak and Dabar [26]. As shown in Table 1, a search based on a complex query in the Hrčak database resulted in a total of 63 literature sources. This query did not yield a result in the Dabar database, i.e. it resulted in 0 articles found. Therefore, a simplified query was used in Dabar with the keywords "agriculture" and "stakeholders" and resulted in 18 literature sources. In the Hrčak database, a search of professional journals resulted in 24 journals in the field of agriculture.

An important aspect of stakeholder analysis is based on differentiating and classifying stakeholders according to their roles in the ecosystem. This form of categorization enables the grouping of stakeholders according to similar characteristics in order to identify those of strategic importance [9]. Identification of relationships between all stakeholders can help determine how stakeholders could engage in an open data ecosystem for policy implementation, support the decision-making of sustainable development, and manage business processes. Building on the defined basic categorization of stakeholder groups in the agricultural sector in Croatia [26] the stakeholders identified in the queries were classified and the new grouping was used in further data supply influence assessment and alliance flow chart production encompassing also the data demand side, as well as for the final prioritization (Figure 2).

Table 1. Number of articles and journals in national databases.

Research goal	Research query/field	Database	Results
Additional categorization of stakeholders in agriculture open data ecosystem in Croatia	agriculture OR agriculture sector OR agronomy OR farming OR smart farming OR smart agriculture OR precision agriculture OR agriculture field AND open data	Hrčak	63
	agriculture AND stakeholders	Dabar	18
	Professional journals; field Agriculture (Agronomy)	Hrčak	24

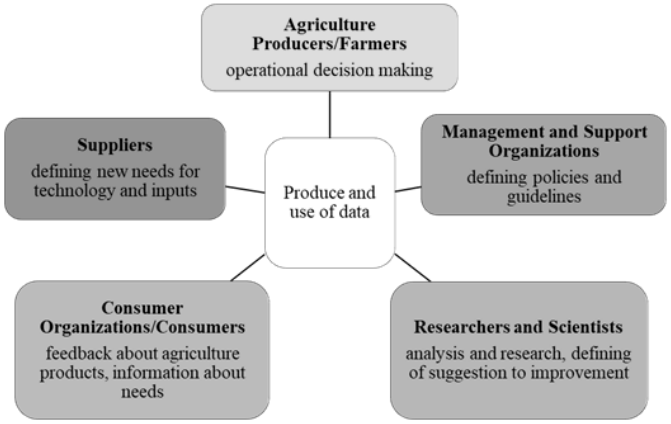

Figure 2. Preliminary key stakeholder groups of agricultural open data ecosystem in Croatia used for the classification of the open access sources query results [26].

Step 2: Gathering information on stakeholder connections and data supply influence

To identify the basic characteristics and roles of individual stakeholders in the agricultural data ecosystem, to investigate their data requirements, as well as the data that are the result of their work, field research was performed including direct observation and semi-structured interviews with the following questions (in Croatian):

1) What is your role, as a stakeholder, in the agricultural sector?
2) Which of the 5 stakeholder groups do you have the most cooperation and interaction with? Can you specify?
3) Do you share your management/business/product data with any of the 5 stakeholder groups? Can you specify to whom and how?
4) From the stakeholders identified in question 2, do you require/use any data sets and can you specify? Would it be useful to you to get some data for your business from some other entity you are currently not cooperating with?

A breakdown of the main stakeholder groups (Figure 2) provided the structure for interviewing the representatives of the five stakeholder groups. In total, 24 interviews were used for validation: 5 interviews per group of stakeholders were performed with representatives of Agriculture producers/Farmers, the group of Suppliers and the group of Customer Organization/Consumer; and 3 interviews per group of stakeholders were performed

with representatives of Management and Support Organizations, as well as the Researchers/Scientists from the field of agricultural sciences. The additional 3 representatives were interviewed from the group of other stakeholders after the classification of the query results.

Characteristics and roles of stakeholders were additionally supplemented with 15 sets of direct observations for the 10 of the interviewed stakeholders (3 from Management and Support Organizations, 3 from Suppliers, 2 from Researchers/Scientists, and 2 from Agriculture producers/Farmers) and the randomly selected 5 additional representatives from each of the stakeholder groups. All available sources, including official web sites and on-line available documents, were reviewed for (i) the data needs, (ii) data sharing and (iii) data sharing possibilities.

Step 3: Validation of information gathered on stakeholders and data supply and demand

Qualitative data from the interviews were used to extract the information on data needs and data sharing of the stakeholders and stakeholder groups. Also for the data opening and sharing supply assessment and to formulate the alliance's flowchart. The alliances flowchart contains information on the stakeholder group relevance in the system, the data supply influence and the alliances derived from the interviews, direct observation and the query results.

Current data supply influence assessment was estimated on a scale of 1 to 3, where (i) 1 is considered as stakeholder data openness or sharing not known or exceptional; (ii) 2 is considered as stakeholder data known to share, some data known to be open; (iii) 3 is considered as stakeholder relevant open data supplier or data sharer. The interview results and the direct observation from the previous research step were used for this assessment according to this research group's judgment. Scoring results were included in the alliances flowchart to distinguish the groups assessed as relevant data suppliers, as well as to distinguish a specific stakeholder relevant in the stakeholder group, but scoring low as data supplier.

Query results provided the number of the references in common for specific stakeholders and stakeholder groups. This information was used as an indicator of the stakeholder interactions and supplemented the interview and observation information for the final alliances flowchart. The level of importance of each stakeholder and stakeholder group used for the alliances flowchart was derived from the frequencies of the queried references shown in Table 2. Based on the collected data, the relations between stakeholders were constructed [27, 28, 29].

Step 4: Analysis of the level of the stakeholder importance with respect to current data supply

Finally, to discover the relevant priority groups for further focus in open data ecosystem maturation, we have imposed the level of the stakeholder importance (derived from the number of the query references) to the level of the stakeholder influence to the data supply [24].

RESULTS

Key stakeholders in Croatia

The content of the found articles was analysed, and special emphasis has been placed on identifying specific stakeholders operating in or in relation to the agriculture sector. All stakeholders identified in the articles are classified to the key stakeholder groups as shown in Table 2. Additional group (Others) was formed containing the stakeholders that could not be classified to the one of the initial five stakeholder groups at all, or exclusively.

Table 2. Identified stakeholders in the agricultural data ecosystem in Croatia (continued on p.197).

Agriculture producers/Farmers	owners of agricultural land [30, 31] milk producers [32] animal breeders, cattle breeders [33] meat producers [34, 35] vegetable producers [36] forestry entrepreneurs [37] fish farmers, fishermen [38] producers of organic agriculture products [39] flower producers [40] wine and winery producers [41] energy plantations [42] family farms, local farms, rural holdings [39, 43] processors of agricultural products (milk, meat, fruits, vegetables) [44] mushroom growing [45]
Suppliers	manufacturers of technological solutions and mechanization in agriculture [46] hatcheries, rearing parent stock [47] seed growers [45, 47] seedling growers [48] manufacturers of plant protection products [45, 48] agriculture machinery market [49] agricultural cooperatives [49] forest owners [31] landowners [31]
Management and Support Organization	Ministry of Agriculture; Croatian Agency for Agriculture and Food; Agency for Payments in Agriculture, Fisheries and Rural Development [50, 51] Croatian Agricultural Advisory Service [52] national training providers in the agricultural sector [37] agriculture local action groups [41] developed agencies in rural development and agriculture [41] independent consultants in agriculture [41] agriculture producers cooperatives and local partnerships [39, 41] creators of agricultural programs [53] issuers of certificates in agriculture [54] Croatian Meteorological and Hydrological Service [55] meteorological stations [56] the institutional Animal Care and Ethics Committee [50] State Geodetic Administration [57] Croatian Veterinary Institute, veterinary institute [58] Croatian Agricultural Society [48, 59], Croatian Society of Plant Sciences [45]
Consumer Organizations/Consumers	business entities in tourism [60] private accommodation, hotels [61] organized gastronomic events [62] local population, household [39] buyers of agricultural products [49]

Table 2. Identified stakeholders in the agricultural data ecosystem in Croatia (continuation from p.196).

Researches and Scientists	educational institutions [34, 39]: Faculty of Agriculture [45, 49], Faculty of Agrobiotechnical Sciences [45] editorial boards of professional journals students of agriculture and agronomy [46] laboratory centres [58] researchers [51], research organizations [63], multidisciplinary research teams [64] forestry experts [37] organizers of educational programs [39]
Others	owners of organic gardens and ecovillages [39] hunting and hunting tourist centres [65] botanical gardens [66, 67] school gardens [48] media: agricultural portals, web pages [39] employees in agriculture [54]

The group of Agricultural Producers and Farmers includes all stakeholders who are primarily engaged in the production of any agricultural product, processing of agricultural lands, or animal husbandry. Only those producers who offer final agricultural product for further processing or sale are included in this group of stakeholders. Some of the agricultural producers in the agricultural data ecosystem are producers of milk and dairy products, meat, fruits, vegetables, flowers, and agricultural organic products. This group includes animal breeders who resell their breeding, but also grain producers, owners of agricultural land who grow various crops for food purposes. Also included are sustainable users of wild populations (e.g. fishermen and forest owners who sell their timber resources, and mushroom pickers), fish farmers and wineries. Apart from the type of agricultural activity they perform, Agricultural Producers and Farmers also differ in size, so in this division in Croatia, there are family agriculture farms, as well as small, medium and large agriculture businesses.

Suppliers are all those stakeholders who supply agricultural producers and farmers with all the necessary resources for work such as machinery and other technological solutions, plant protection products, re-selling seeds and seedlings, feed, flocks of animals, and more. These include producers of agricultural machinery and technological solutions for agriculture, hatcheries, producers of seeds and seedlings, producers of plant protection products, owners of land and forests who rent out their land.

Management and Support Organizations include all stakeholders who provide any form of support to farmers and enable the functioning and operations of all stakeholders in the ecosystem. Identified stakeholders can be divided by levels. The highest level representative is the Ministry of Agriculture and it oversees some of the lower level stakeholders. Agricultural advisory services operate at the local level but under the authority of the Ministry. National training providers in the agricultural sector and issuers of certificates in agriculture who provide support to farmers in terms of education, also operate under the authority of the Ministry. Furthermore, various agencies and consultants with advisory capacity operate at the local and regional levels. In addition to all the above, support in agriculture is provided by some organizations from related other disciplines such as the State Geodetic Administration, the Croatian Veterinary Institute, the Croatian Meteorological, and Hydrological Service, and others.

Consumer Organizations and Consumers are all stakeholders who buy and use agricultural products, produced exclusively by agricultural producers or farmers. These are households, private and business entities, organized events and companies that process agricultural products, and direct consumers.

The group of Researches and Scientists includes faculties and all educational institutions in the field of agriculture in Croatia. Educational institutions usually include research groups and laboratories, multidisciplinary teams, project teams, and experts in the field of agriculture. Students of agriculture are included in this group.

Finally, to the five basic stakeholder groups, the category of other stakeholders was added. This group includes stakeholders who cannot be included in any of the previously described groups. This group includes owners of organic gardens and ecovillages, botanical gardens, school gardens, and hunting and hunting tourist centres. Employees in agriculture and households that produce food for their own needs belong to this group. In addition to them, there are also media that cover agricultural activity and events related to it.

The role of stakeholders in the agriculture data ecosystem

From the agricultural producers and farmers group, the interview was attended by family agriculture farms and small agriculture businesses, who have less than 10 employees (Figure 3). They unanimously agreed that their role in the ecosystem is to produce and supply food and drink to the community. For the producers, the most important group of stakeholders are the suppliers who supply them with production resources. The management and support organizations are in charge of controlling food production and enabling support for the agriculture production. All of the agricultural producers mentioned that they have specific certificates from the field in which they operate and that they have acquired most of them through organized training of the Ministry of Agriculture and the Advisory Service. Some of the producers mentioned that they cooperate with consultants, i.e. organizations that prepare projects for them co-financed from European Union funds. Also, all of them are in communication with the Agency for Payments in Agriculture, Fisheries, and Rural Development, which takes care of the operational implementation of direct support measures and rural development measures. All farmers stated that they have no contact with researchers, scientists, and educational institutions.

The data needs of agricultural producers are diverse and depend on the type of activity they are engaged in. For example, the vegetable producer pointed out that the most important data for him are data about current protection products and substitute protection products, and data about demand and prices on the market. Meat producers stated that they need data on the quantities and prices of all food resources they use to prepare food on their farms, followed by data on the quantities and prices of final products on the market, data on available production incentives, and investment opportunities. All farmers agreed, that the data they can generate is related to the parameters of agricultural production.

From the supplier group of stakeholders, a regional representative of a company engaged in the sale of seeds, plant protection products, and the purchase of mercantile cultivation, an employee in an agricultural market, and a landowner who rents out his land were interviewed (Figure 4). The regional representative of the agricultural corporation stated that their business is based on cooperation with large and small agricultural producers who buy from them seeds, plant protection products, and mineral fertilizers, as well as redeem mercantile goods and lend for further production. An employee of the agricultural shop stated that they supply the local population and households with resources for agricultural production, and cooperate with larger farmers as agreed. The owner of the land pointed out that he does not cultivate the land, but rents it to an agricultural farm.

The regional representative emphasized the wide range of stakeholder partners: large and small agricultural producers, buyers of mercantile goods, large agricultural corporations such as feed mills, competitors, and others. An employee of an agricultural market mentioned households cultivating their gardens and small farmers as key stakeholders. The landowner, since he rents out his land, cooperates exclusively with the agricultural producer to whom he rents the land, the data flow is shown in Figure 4.

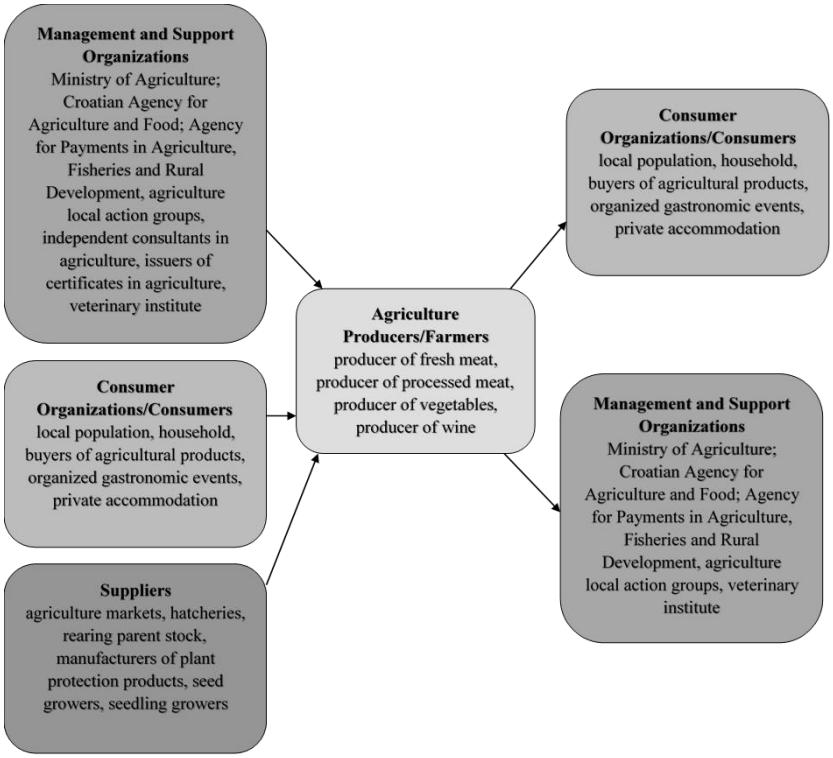

Figure 3. Primary needs of data flow as recognized in interviews with the agriculture producers.

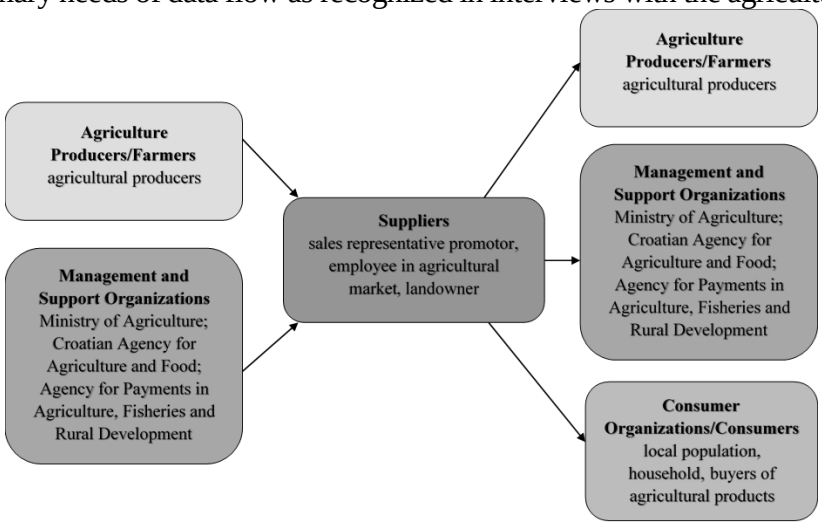

Figure 4. Primary needs of data flow as recognized in interviews with the suppliers.

The most important stakeholder representative from the group of the Management and Support Organization is the Ministry of Agriculture. The role of the Ministry is clear and refers to administrative and other affairs in the field of agriculture. From this group, an informal interview was conducted with an employee of the Advisory Service. They cooperate with farmers in the implementation of various experiments, where, based on the monitoring of agricultural production, they receive information on agricultural practices as well as the pros

and cons of agricultural production. In addition, the role of the Advisory Service is to provide assistance to farmers through advice on agricultural production and to apply for various measures and incentives. They cooperate with suppliers in conducting experiments in different agriculture fields. For example, a regional representative and a representative of the Advisory Service, together with an agricultural producer, described their cooperation in testing new seeds.

In the group of consumer organizations, a local restaurant was selected for the interview, which procures its food exclusively from agricultural producers and farmers. The owner of the restaurant stated that he has big problems when procuring fresh groceries, especially fresh meat. Mostly information about producers who offer fresh and quality meat comes by word of mouth from acquaintances. Therefore, the lack of data on agricultural producers and the lack a network of producers to whom they can turn, are a problem for him in performing his business and sometimes he cannot satisfy the entire offer in his restaurant.

The scientists and researchers group uses the data provided by different stakeholder groups, or generates the data with their research. Importance of data provided from the private sector is crucial in order to improve their scientific and research work, develop new projects or suggest better solutions to certain problems. Moreover, based on the interviews, generated data of different granularity from research is provided to the farmers/source of the data often only upon the specific request and there is no obligation or channel for the direct feedback to source of the data.

Data availability is also important for the group of Other stakeholders. The media inform the wider community about the current state of the sector and individual activities, other stakeholders and also about agricultural products. School and kinder gardens serve to teach children from an early age about farming, especially vegetables. The Botanical Garden serves as a centre where it is possible to be educated and introduced of the wider community to the cultivation of plants of different species.

Alliances of the stakeholders in the agricultural data sharing ecosystem in Croatia are shown in the Figure 5. The most striking result is the perceived lack of data and information feedback of the Research group to the group of Agriculture producers / Farmers, which is in this research limited to smallholders. Additional lack of data sharing alliances is evidenced between the groups of the Suppliers and the Researchers. The group of Consumer Organisations and consumers does not have any detected data sharing relations with the Management and support group using our methods. The group of Agriculture producers / Farmers shares data with the Other stakeholders as was recognised from the interviews and direct observations.

Stakeholder importance with respect to current data supply

The stakeholder group matrix in Figure 6 emphasizes the two stakeholder groups distinguished from the others in the quadrant of the estimated high level of importance in the agricultural data sharing ecosystem in Croatia and the low estimated data supply for that ecosystem. Surprisingly, one of the groups is the Research and scientists and the other are the Suppliers.

Management and Support Organizations are recognized as the group of the significant importance and influence in data supply in the agricultural data sharing ecosystem in Croatia. The other stakeholder group in the same high influence and high data supply sector are the Agriculture producers and Farmers.

Consumer Organizations/Consumers and others, as stakeholders not directly involved in agricultural activities, have less importance and influence in the agriculture data ecosystem.

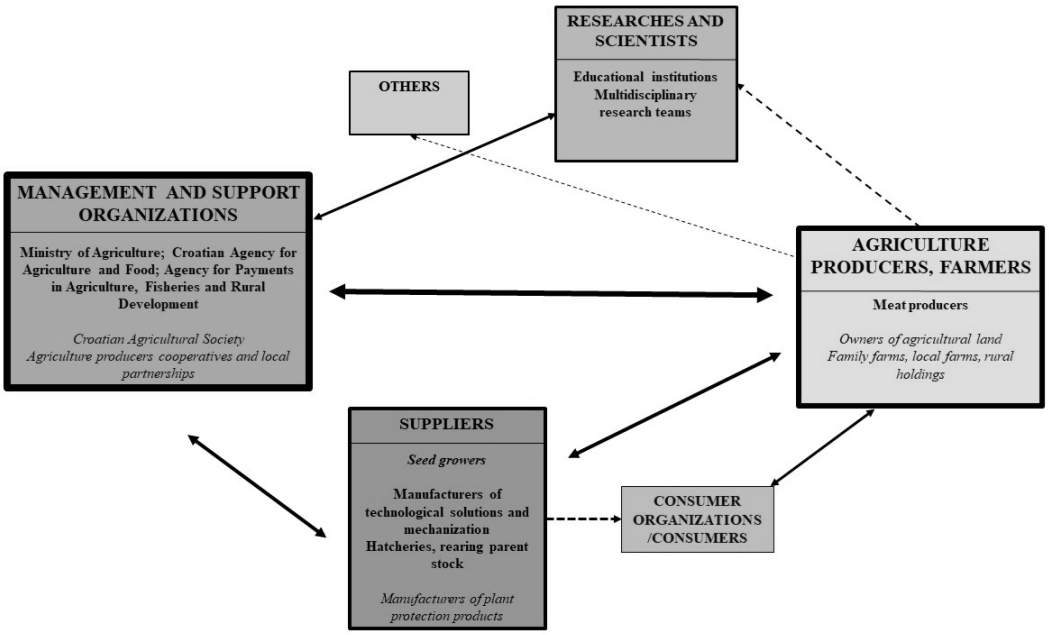

Figure 5. Alliances of the stakeholders in the agricultural data sharing ecosystem in Croatia.

However, the low level of data from that stakeholder was found to be concerning in the interviews where the group of Agriculture Producers and Farmers emphasized their need to know the market prices and market demand.

The shape size represents the assessed level of importance of the stakeholder group. The thickness of the shape border indicates relevant data suppliers. Two-headed arrows are data sharing alliances derived from the queried references and one-headed arrows are derived from the interviews and direct observations. The thickness of the arrow indicates the estimated relevance of the communication. Stakeholders with estimated high importance and low influence in data sharing are shown in italic and the stakeholders with high importance and influence are shown in bold font.

Distinguished stakeholders, when superimposing importance in the agricultural data sharing ecosystem in Croatia to the data sharing contribution, were examined from each group of the

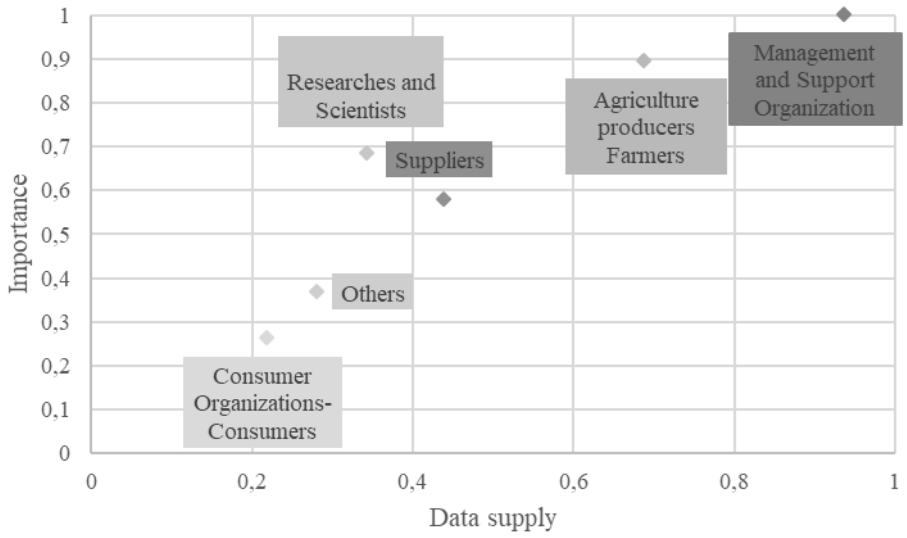

Figure 6. A stakeholder map matrix in the agriculture data ecosystem.

stakeholders (shown in the Figure 5). In the Agriculture Producers/Farmers group none of the stakeholders assessed as important have an average share in the data sharing. A high level of importance, but a low impact on the data supply was recorded for the owners of agricultural land, meat producers and family farms, local farms and rural holdings. Milk producers, producers of organic agriculture products and processors of agricultural products (milk, meat, fruits, vegetables) scored high in the group for data supply, but are assessed as less important.

In the group of Suppliers, the stakeholders that stand out with high assessed importance and low impact to data supply are the manufacturers of plant protection products. The seed growers are assessed as important and sharing their data. Manufacturers of technological solutions and mechanization in agriculture, hatcheries, seedling growers, and agricultural cooperatives scored high in the group for data supply, but are assessed as less important.

As expected, the Management and Support Organization records the highest level of importance, but also a high level of influence in the agriculture data ecosystem as well as data supply. The Ministry of Agriculture scored the highest together with the Croatian Agency for Agriculture, Croatian Agricultural Advisory Service and Food and Agency for Payments in Agriculture, Fisheries and Rural Development. Agriculture producer's cooperatives and local partnerships and the Croatian Agricultural Society were assessed as important stakeholders, but sharing less data then the other stakeholders in the group.

In the group of Researches and Scientists educational institutions (i.e. Faculty of Agriculture Faculty of Agrobiotechnical Sciences) and researchers (research organizations and multidisciplinary research teams) are distinguished as important and sharing more data than the other stakeholders in the group.

All stakeholders of high importance had high data influence in the Others group. In the Consumer Organizations/Consumers all stakeholders were assessed to be equally important and most of the data sharing in this group of stakeholders comes from the business entities in tourism and the organized gastronomic events.

DISSCUSION AND FUTURE WORK

The analysis of key stakeholder groups in the Croatian agriculture data ecosystem provided identification and characterisation of stakeholders and their relationships inside the agriculture business processes, with several relevant outside connections in the group of Management and support. Our analysis included different perspectives in gathering the data, and only further participatory approach in stakeholder analysis would add valuable qualitative and quantitative data and aspect contribution if more stakeholder details are required [24].

This stakeholder analysis results should prove valuable in developing collaboration, joint projects, or policies, but also in solving sectoral business problems where the participatory approach is required [24]. In the further maturation of the agricultural data ecosystem in Croatia, both for the open governmental data and the data of the public endeavours as well as with developing the contractual sharing and the effective data governance, the critical findings of the underdeveloped relationships, need for better data supply should be taken into account [7-14]. Despite numerous initiatives for cooperation and data sharing between stakeholders in public and private sector at different levels, limited impact to sustainable value creation has been achieved in industries including agriculture, and unsustainable practices persist [14, 68, 69]. Expanding on the initiatives of open data ecosystem readiness and the ability to identify the different ways in which stakeholders share data, build sustainable practices and systems is crucial to the successful adoption and implementation of innovation. Successful integration of sustainability aspects into innovation requires the

collective participation of different stakeholders, matching objectives among stakeholders, and also their expertise as well as specialized roles for clear transfer of added value within the ecosystem [68, 70, 71].

In order to abandon unsustainable practices and to adapt to new digital agricultural practices it is important that the Research and scientist as well as the Supplier group of stakeholders promote their data governance and commit to data opening and sharing in the agriculture data sector in Croatia. It is concerning no data flow was indicated in this research results between the Research and Supplier groups. Additional emphasis to importance of opening up the stakeholders mapped to the Research and scientist group in the agricultural sector in Croatia are the results of the interviews showing limited data flow from those stakeholders to the group of Agriculture producers and Farmers, as seen from the perspective of the interviewed smallholders. Especially when considering smallholders are the ones actually feeding the population [72]. Aside from the food production, the smallholders are the source of a large amount of high-value data for all other stakeholders in the agricultural data ecosystem in Croatia. In addition, their data needs, according to the interviews, are increasing given the persistent disruptions in the agricultural sector due to environmental, economic, and social global challenges [72-74]. Market data considering the prices and the demand are the Consumer stakeholder data important to the Agriculture Producers and Farmers group that are not enough open and re-usable.

Also, group of Suppliers emphasized data needs, as they depend on market trends and the needs of agricultural producers, i.e. their survival depends on performance in the agricultural market. The data of the Croatian agricultural research sector is evidently not available to them and the contractual data sharing from the group of Agriculture producers and Farmers is evidently limited. Management and Support Organizations have/gather and open the most data according to the above results, but opening of this data is limited [20] and more care should be given to data governance research in this group in order to boost the usability of this data for solving relevant sectoral problems. The strong open data outreach responsibility of this stakeholder group is even more pronounced by the fact that the effective cooperation required for sustainable value creation is lacking in the complex business systems, such as agriculture, which operate in an data ecosystem where data and information exchange is lacking or is decentralized [6].

CONCLUSION

The agricultural sector in general is a mine of valuable data generated in agricultural processes, however, its' potential to generate value is not yet exploited in the ecosystem of agricultural data in Croatia. The concept of smart and precise agriculture often referred to as the digital agriculture includes collecting and systematizing data from agricultural business processes, integrating, monitoring, analysing, and interpreting data, enabling the development of sustainable practices. To enable the transition to digital agriculture and the data to generate the value, it is necessary to strategically invest into maturation of agricultural data ecosystem (interaction of people, infrastructure, and processes) in Croatia working on the underdeveloped alliances by opening data of the identified key stakeholders.

The Management and Support Organization group of stakeholders is recognised as the most important and most data influential one with the most responsibility in promoting open governmental data and open data of the public endeavours. The Agriculture producers/Farmers are the second most important and data influential stakeholder group providing data to and trough other stakeholder groups, primarily the corresponding ministry. The Suppliers group of stakeholders was characterized in this research as the one not connected well enough through the data flow with the other stakeholders. The group of Researches and Scientists in the agricultural sector in Croatia were characterized as not

contributing enough to the open data ecosystem. The group of consumers is not reaching the producers with the data they require. Underdeveloped data flow relationships in the agricultural data ecosystem in Croatia could be built in a spontaneous process following the data opening of the key stakeholders and promoting data sharing initiatives of the early adopters. In that way, data opening in the agricultural data ecosystem in Croatia would be the driver of the effective cooperation creation required for sustainable value creation but also the adoption of the best management practices, sustainable solutions and digital development.

Based on the emphasized requirements from the Research group for the Supply group, and all groups for the group of Agriculture producers and Farmers, as well as recorded importance of the word-of-mouth for the market information and food product availability, it is evident that the data supply of many stakeholders is underdeveloped. Future research focusing on data demands of the stakeholders could enable faster development and maturation of the agricultural data ecosystem in Croatia.

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