



THE ATTITUDES OF AGRICULTURAL RESEARCHERS TOWARDS DATA SHARING: CASE STUDY OF THE REPUBLIC OF MOLDOVA

Viorica Lupu
Technical University of Moldova
viorica.lupu@lib.utm.md

Rodica Cujba
Technical University of Moldova;
Information Society Development
Institute
rodica.cujba@idsi.md
rodica.cujba@adm.utm.md

Vera Sobetchi
Technical University of Moldova
vera.sobetchi@lib.utm.md

ABSTRACT

The implementation of information and communication technologies in research leads to a big data flow that needs efficient management. In the context of the Open Science movement and following FAIR principles, sharing of research data became an important issue for all research disciplines. In this work we focus on data sharing in agricultural sciences due to the significance of this field for every person, every country and even for the whole humanity. The paper is focused on data produced in agricultural sciences and provides information about types of data produced, on understanding the benefits from open data, provides perception and attitude of scholars towards sharing and reusing research data. The perceptions of agricultural researchers to data sharing are generally positive, but respondents reported a number of fears including lack of time, data security and losing control over intellectual property, possible misinterpretation and misuse of data. They also mentioned the interest in library assistance and the need of training in research data management.

CCS CONCEPTS

- **Applied computing** → Computers in other domains; Agriculture; Computers in other domains; Digital libraries and archives;
- **Information systems** → Data management systems;
- **Social and professional topics** → Computing / technology policy; Intellectual property; Digital rights management.

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1 INTRODUCTION

Open Science (OS) is becoming an important concept in performing research. The main idea of OS is that sharing of knowledge and data in the research system in the shortest possible time and the participation of all key social actors (industry, authorities, citizens,

etc.) in the research process ensures greater creativity, scientific productivity, trust in science and the use of research results in society [1].

Because science has become increasingly data driven, open data plays a key role in enabling and promoting open science. Open data has a positive impact on science via preventing duplication of data collection, and thus freeing up resources to gather a more varied array of data [2]. At the same time, planning for, acquiring and preparing datasets for sharing is time-consuming and requires a serious effort from researchers [3].

Open data are crucial also to many aspects of agro-food production, as they have the potential to transform the agricultural sector, helping to limit food loss and waste, eradicate hunger and improve food security. Lots of studies show that data sharing in the field of agriculture allows a better understanding of existing problems and the identification of new solutions for the sustainable development of the field [4] [5] [6].

Thus, agriculture represents a significant sector and area of big interest that should be investigated due to its broad and evolving scope and the central role of agriculture in the human experience [7].

In the Republic of Moldova, as in other parts of the world, agriculture is going through a period of accelerated and profound transformation. This is being affected by global climate change, population exodus, extreme weather conditions such as drought, floods and other exceptional situations, as well as by the pandemic situation in recent years and the war in the neighboring Ukraine.

Researchers from the Republic of Moldova are committed to establishing ways to implement more efficient, resilient and sustainable agricultural and food systems that increase productivity, protect the environment, strengthen the capacities to adapt to climate change and contribute to improving the quality of life. Agricultural research aims to accelerate the pace of achieving the Sustainable Development Goals of the 2030 Agenda [8], adapted and correlated with national agricultural needs and priorities.

Although open research data is gaining more and more resonance in the scientific community, there are still differences in researchers' approaches and attitudes, especially among researchers from different disciplines. In the Republic of Moldova, little is known about the attitude of agricultural researchers towards opening and sharing research data. Farther studies were needed to assess researchers' approach on open data and to review and track the changes of these attitudes over time.

Considering the fact that the agriculture plays a central role in the economy of the Republic of Moldova and there have been no studies

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focused exclusively on the opinions of agricultural researchers, it was decided to carry out the investigation on determining the level of involvement in data sharing and better understanding of needs of scholars in agriculture.

1.1 BACKGROUND

In different countries, including the Republic of Moldova, several studies have been carried out to better understand the attitudes and perceptions of researchers regarding the openness and sharing of research data.

The first attempts in the Republic of Moldova to study the attitudes of researchers regarding scientific data were carried out by the Information Society Development Institute in 2015. The survey referred to the inventory of the existing digital scientific content and the assessment of the need to transpose the national scientific content in the digital format [9]. However, this study was not entirely dedicated to research data, but included a series of questions regarding the use, storage, preservation and sharing of scientific data. This research focused mainly on studying the opinions of leaders of research institutions and managers of national research projects.

The research highlighted some respondents' concerns about the situation regarding the preservation and use of scientific data. They reported several problems, such as: insufficient national strategies/policies on access to scientific data, lack of funds for the development and maintenance of the scientific data infrastructures, insufficient credits given to researchers providing access to research data, lack of data management requirements in research projects, etc. [10].

As open research data represent an important element of Open Science, it became the subject of another extensive study „Attitudes towards Open Science” carried out between October 25 - December 6, 2021, within the national project 21.70105.40SD „Stimulating the commitment of the Republic of Moldova in Open Science: methodological and applicative support”. Although this study did not focus exclusively on research data, Moldovan researchers' perceptions on opening and sharing data were studied in depth. Open access to research data was mentioned as a relevant and a key aspect of Open Science policies at any level (institutional, national and international) by more than 80% of respondents. The respondents stressed the advantages of open data. Although they report some uncertainty and concern, most respondents recognize that open data increases the chances of citation and their reuse. These considerations are also complemented by the possible influence of open data on the success of accepting one's own papers in a high-quality scientific journal. At the same time, open data enables other researchers to do improved evaluation and verification of research results [11].

Until now, two studies devoted to research data have been carried out in the Republic of Moldova. The first one was conducted in 2018 by the Information Society Development Institute and focused on the mapping of the scientific data ecosystem in the Republic of Moldova in general. The survey aimed to identify the needs of the scientific community related to the life cycle of research data management. With reference to the sharing of research data, 31% of respondents answered that they provide access to data,

and 60.1% of researchers share their research data according to the requirements of the funding agency. However, the researchers noted certain restrictions that limit the sharing of research data, such as: intellectual property, legal provisions, data security, imposed embargo period or self-embargo [10].

The second study was performed in 2021 by the “Nicolae Testemitanu” State University of Medicine and Pharmacy of the Republic of Moldova in order to study the perception of medical researchers regarding the openness and sharing data. The study revealed the strategic importance of open data in research and innovation in the field of medicine. Medical researchers believe that data from publicly funded research should be findable, accessible, interoperable and reusable, yet data sharing and use practices are still limited [12].

The both studies carried out in the Republic of Moldova showed that the majority of researchers opt for data openness, accept and are ready to provide access to their research data, but they have concerns about the loss of property rights and the violation of copyright. They also voice fears that the data can be interpreted incorrectly or used in ways other than intended and they will not receive appropriate acknowledgment and recognition from those who will reuse their data.

In recent years, a growing number of studies have been conducted worldwide on the attitudes and perceptions of agricultural science researchers on the management, openness and sharing of research data.

The Ithaka S+R Research Support Services program conducts in-depth qualitative analyzes of research practices and support needs of researchers to better understand changing research methods and practices. Over time, the attitudes of researchers from various disciplines have been studied and analyzed. One of these studies involved agricultural researchers from the United States [7]. It demonstrated that this field produces a wide variety of data types, stored in multiple formats and in various locations, that are often difficult to manage. Most researchers reported that they lack adequate training, policies and infrastructures for data management, and a key challenge for them remains who should be responsible for monitoring and coordinating this process. In terms of data findability, some respondents noted that it lags behind the discovery of other forms of content. As major barriers to data access they reported state budgetary constraints leading to reductions in the data collected and made available to researchers, data produced by private companies that cannot be accessed by researchers or the public, the high cost of purchasing access licenses etc. Participants in the Ithaka S+R study also mentioned that they face considerable barriers to data sharing, citing the following reasons for not sharing their data: the data would not be meaningful to others, the data would be difficult to prepare for sharing, lack of rewards or recognition, lack of time and necessary knowledge [13].

A study conducted in Germany in 2020 [14] proves the diversity of the research data landscape in the agricultural sciences. This causes problems, uncertainties and hinders the effective sharing, access and reuse of valuable data in the agricultural scientists' community. Exploring the ways of data sharing, the study found out that a rather low number of researchers store their research data in institutional and discipline-specific repositories accessible to the public, using local storage in most cases. Regarding sharing data, a

quarter of respondents mentioned that they provide data directly to their colleagues. More than half of surveyed researchers partially share their data in the context of a research collaboration or make their data available as part of an independent publication. The study concluded that in order to improve the situation of agricultural researchers in data management, the level of awareness towards the need for good data management should be increased, while distributed data management services should be brought together by common standards [14].

In the majority of studies, researchers are increasingly aware of the need to share their data.

The study conducted in Turkey [15] highlighted other reasons why academics may be more reluctant to do so. An important factor in this regard is the feeling of mistrust in data sharing. The closed network style of the Turkish academic system makes researchers more protective of their data.

Life sciences researchers, like researchers in other fields, are willing to share research data, but they face a lot of issues related to data storage: selection of a storage space (e.g., laboratory computers, external hard drives, institutional or specialized repositories, etc.), application of metadata, continuous short-term and long-term access to data [16].

The motivations, but also the constraints of sharing scientific data, have also been investigated in specific disciplines of the agricultural field, which generate data in an ever-increasing volume.

A study carried out in Canada by the Plant Phenotyping Center at the University of Saskatchewan [17] explored the sharing of agricultural research results among researchers with a focus on digital data. The results of the study showed that researchers share data mainly through direct personal requests based on trusting relationships but are willing to share their data openly based on institutional policy and incentives.

Problems and challenges in collecting, sharing and using data are faced not only by researchers but also by farmers, especially those implementing smart agricultural technologies. They are greatly affected by the absence of legal and regulatory framework on agricultural data management, the lack of transparency and clarity in data ownership, portability, confidentiality, trust and accountability in business relationships that govern smart agriculture [18].

1.2 THE AIM AND OBJECTIVES OF STUDY

The study aims to analyze the perceptions and attitudes of Moldovan researchers in agricultural sciences towards sharing research data, by using survey method. The specific objectives of the survey were as follows:

- to study the attitudes of agricultural researchers on open research data,
- to provide some recommendations regarding the application of research data sharing practices,
- to identify the training needs of researchers in this topic.

2 METHODOLOGY

The presented results in this work are based on the survey performed from October to December 2022. The survey was completed by respondents using the online tool Google Forms. Closed-ended questions (with multiple choice, multiple answers allowed, with

rating scales, gradation of the answer for more nuanced questions) and questions with open answers were formulated. Open questions offered the respondents the opportunity to express their point of view on the problems and challenges they face in the data exchange process. The Likert scale [19] was used in a number of statements for nuanced answers and graded according to the level of agreement or disagreement.

The questionnaire comprised 22 questions divided in five parts:

- sociodemographic characteristics (gender dimension, age, research area, position / function);
- importance and benefits of open research data (the importance and the necessity of research data for the development of agriculture, benefits from opening/sharing research data);
- data produced / collected / used / stored (types and categories of research data produced, collect, used, data storage);
- willingness and barriers for data sharing (data publishing, the availability of produced or collected research data, motivations or obligations to publish data in open access, barriers to share research data);
- library support on research data management (the level of researchers' interest in library assistance with data management, training topics).

A wide range of communication channels were used to reach researchers. An initial e-mail invitation was sent to all potential participants from the faculties of the Technical University of Moldova related to agricultural sciences. Emails were also sent to researchers from agricultural research institutions of the Republic of Moldova. The emails sent included information regarding the purpose of the study with a link to the online survey.

Most difficulties related to the surveying process were encountered during the data collection stage: the respondents were quite reluctant to complete the questionnaire. Thus, it was necessary not only to send the questionnaire by e-mail, but also to contact a large number of respondents by phone in order to encourage them to participate in this survey.

2.1 TARGET POPULATION AND SAMPLE SIZE

The target population for this study was the research community in the field of agricultural sciences of the Republic of Moldova: researchers, teaching staff, administration and management staff of units with agricultural profile. According to the national statistics for research [20], in 2022 there were 375 researchers in the field of agricultural sciences in the Republic of Moldova. Setting up 90% for the confidence interval and 5.0% for margin of error, it was calculated that the sample size should be 158 respondents.

A total of 131 respondents ($n=131$) fulfilled the online survey, that represents 6% margin of error for 90% of the confidence interval and 60% population proportion.

2.2 ETHICAL CONSIDERATION

In order to ensure confidentiality and anonymity, personal data was not requested. The only personal information requested was the age, gender and position within the affiliated organization.

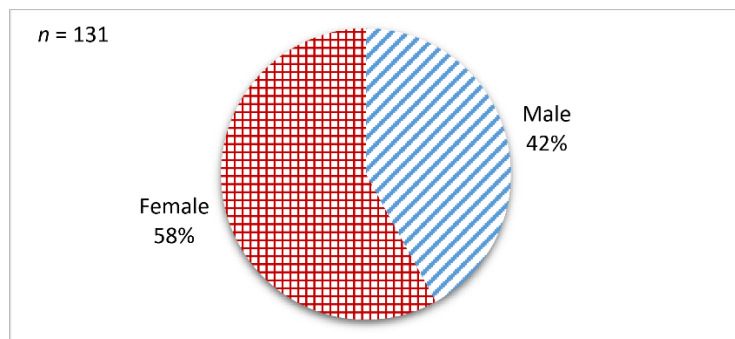


Figure 1: Gender dimension of the respondents

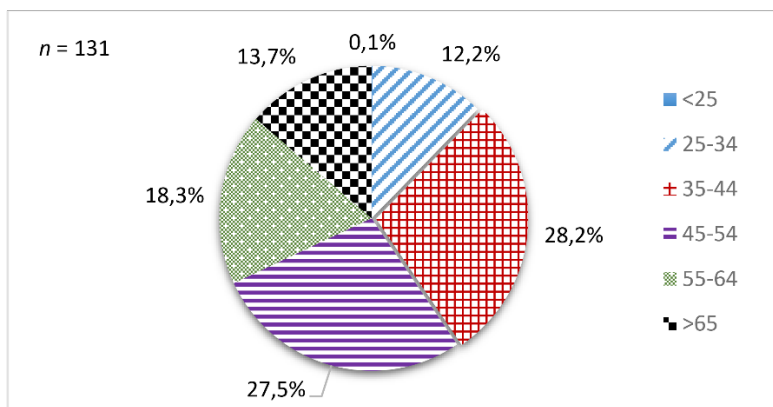


Figure 2: Distribution of the respondents by age

Table 1: Distribution of respondents by their position within the affiliated organization

Position	No of respondents	Share of total
Scientific and didactic staff	56	42.7%
Research staff	40	30.5%
Doctoral / postdoctoral student	18	13.7%
Management / administrative staff	11	8.4%
Veterinarian	2	1.6%
Other	4	3.1%

3 RESULTS AND DISCUSSIONS

3.1 SOCIODEMOGRAPHIC CHARACTERISTICS

In the context of gender dimension, participants included 58% females and 42% males (Figure 1). Taking into consideration that on national level the distribution of researchers in agricultural sciences by gender represent 50,4% females and 49,6% males [20], women were more receptive to the invitation to fulfill the survey.

The distribution of respondents by age shows that more than half or 55.7% (35-44 years old – 28.2%, 45-54 years old – 27.5%) are researchers of the most productive age (Figure 2).

As shown in Table 1, most respondents are employed as scientific and didactic staff or research staff (42.7% and 30.5% respectively),

13.5% representing doctoral or postdoctoral students. A total of 8.4% held managerial or administrative positions.

3.2 THE IMPORTANCE AND BENEFITS OF OPEN RESEARCH DATA

Figure 3 presents the views of researchers on the level of importance of research data for the development of agriculture. The Likert Scale [19] was used for answers: Very important; Important; Slightly important; Not important; Don't know. Thus, the overwhelming majority of researchers considers that research data are very important (109 of 131) and important (21 of 131) for research, which is 99% of the respondents in total.

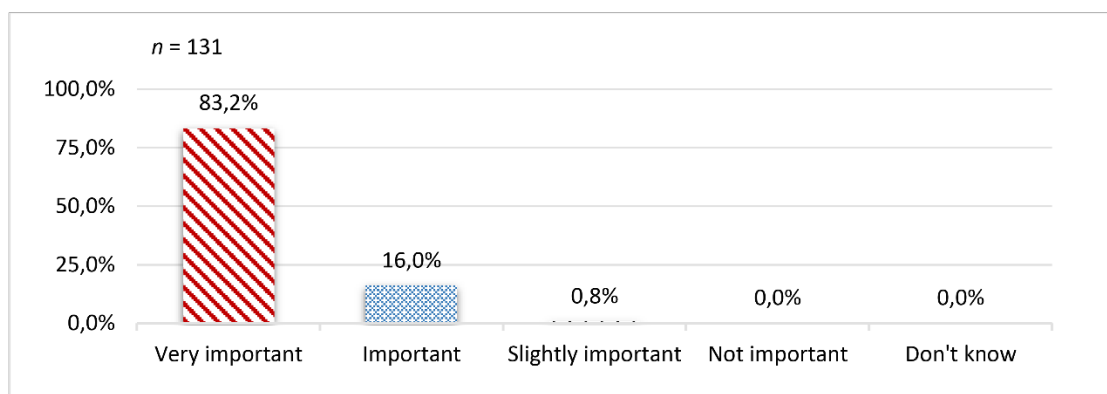


Figure 3: Opinions of respondents on importance of research data for the development of agriculture

Table 2: Responses on the necessity of open research data in agriculture

Why open research data are needed in agriculture? Open research data would allow to / help to:	No of responses	Share of total
Adapt to climate change in agriculture	111	84.7%
Enhance the management of plant pests and diseases	94	71.8%
Efficient use of fertilizers	82	62.6%
Plan the planting season	77	58.8%
Reduce the risk of frost or drought affecting crops	73	55.7%
Inform consumers about food contamination	66	50.4%
Optimize the irrigation system	65	49.6%
Avoid price crises	51	38.9%

Researchers were requested to answer why there is a need in open research data in agriculture. Multiple answer options were possible. According to answers presented in Table 2, one hundred eleven scholars or almost 85% of respondents consider that open research data in agriculture are needed for adaptation to climate change. Over 70% or 94 respondents believe that open data would enhance the management of plant pests and diseases. At the same time, 62.6% of researchers think that open research data can lead to more efficient use of fertilizers. The importance of open data in the planning of planting dates was mentioned by 58.8% of researchers. Also, more than 50% of respondents mentioned that open data can help in reducing frosts and droughts risks affecting crops (55.7%) and awareness of consumers about contamination of food.

The respondents were asked to highlight the benefits from opening/sharing research data (multiple answers). The evidence presented in Table 3 reveals that researchers perceive as the main benefits of open data growing the visibility of research (74% of respondents), transparency of the research process (68.7%), new opportunities for collaboration (68.7%). Between 50% and 60% of researchers consider that open data accelerates development of science (57.3%), help to avoid duplication of research effort (55%), improve researcher’s profile (53.4%) and increase the number of citations (51.1%).

3.3 DATA PRODUCED / COLLECTED / USED

Being asked about types of research data produced or used (multiple answers), agricultural scholars believe that agronomical data (60.3%), productivity data (57.3%) and pedology data (45%) are the most produced/used (Table 4). Researchers also produce and use meteorological data (34.4%), data on social-economic situation (29.0%), marketing data (22.1%) and animal husbandry data (20.6%). Less than 1/5 of respondents mentioned production and usage of data related to land fund (19.1%), infrastructure (13.0%), forest fund (11.5%), hydrology (9.9%).

The respondents were asked to select the category of data they produce and collect (multiple answers). According to gathered responses, statistical data (84.7% of responses), experimental measurements (77.9% of answers) and tables/charts (59.5% of responses) are the most produced or collected (Table 5).

3.4 WILLINGNESS AND BARRIERS FOR DATA SHARING

Respondents were asked if they agree to publish their research results obtained within projects funded by the Government in open access. The answers show that 129 researchers or 98.5% replied affirmatively (56.5% of respondents strongly agree and 42% agree), and only 2 researchers or 1.5% do not know (Figure 4).

Table 3: Responses on benefits of open research data in agriculture

What are the benefits of opening / sharing research data?	No of responses	Share of total
Increasing the visibility of research	97	74.0%
Transparency of the research process	90	68.7%
New opportunities for collaboration	90	68.7%
Accelerating the pace of science	75	57.3%
Avoiding duplication of effort	72	55.0%
Improving researcher's profile	70	53.4%
Increasing the number of citations	67	51.1%
Recognition for the data produced	56	42.7%
Facilitating research reproducibility	49	37.4%

Table 4: Responses on data types produced or used

What types of research data do you produce or use?	No of responses	Share of total
Agronomical data	79	60.3%
Productivity data	75	57.3%
Pedology data	59	45.0%
Meteorological data	45	34.4%
Social-economic data	38	29.0%
Marketing data	29	22.1%
Animal husbandry data	27	20.6%
Land fund data	25	19.1%
Infrastructure data	17	13.0%
Forest fund data	15	11.5%
Hydrological data	13	9.9%

Table 5: Responses on data categories produced or used

What categories of data you produce and collect?	No of responses	Share of total
Statistical data	111	84.7%
Experimental observations	102	77.9%
Tables, charts	78	59.5%
Databases, simulation software, data files	55	42.0%
Field notes	46	35.1%
Lab notes	45	34.4%
Photos, videos, slides	44	33.6%
Instrumental measurements	42	32.1%
Research notebooks, registers	38	29.0%
Spreadsheets	27	20.6%
Methodologies and workflows	23	17.6%
Maps	21	16.0%
Procedures and standard operational protocols (SOPs)	20	15.3%
Models, algorithms, scripts	18	13.7%
Questionnaires, transcripts, code books	15	11.5%
Catalogued specimens	7	5.3%

Researchers were asked if they have the experience and making publicly available produced or collected research data. Overwhelming majority of the respondents ($n = 108$ or 82.4%) answered affirmatively, 7 or 5.3% answered negatively and 16 or 12.2% are not sure (Figure 5).

Another question referred to the level of access that researchers would give to their research data. The evidence shows that most of researchers (85 respondents or 64.9%) are ready to open access to research data to everyone. Twenty-three respondents or 17.6% believe that research data should be shared only with their research

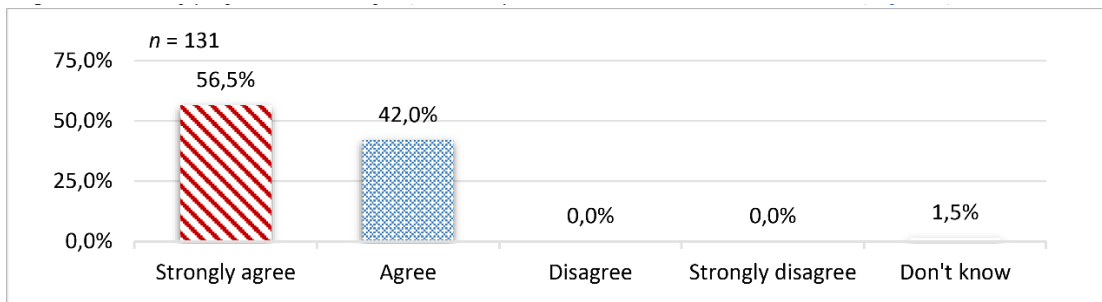


Figure 4: The level of agreement to publish in open access research results funded by Government

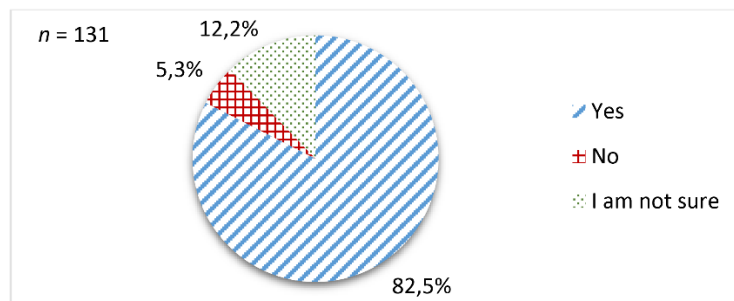


Figure 5: The availability of produced or collected research data

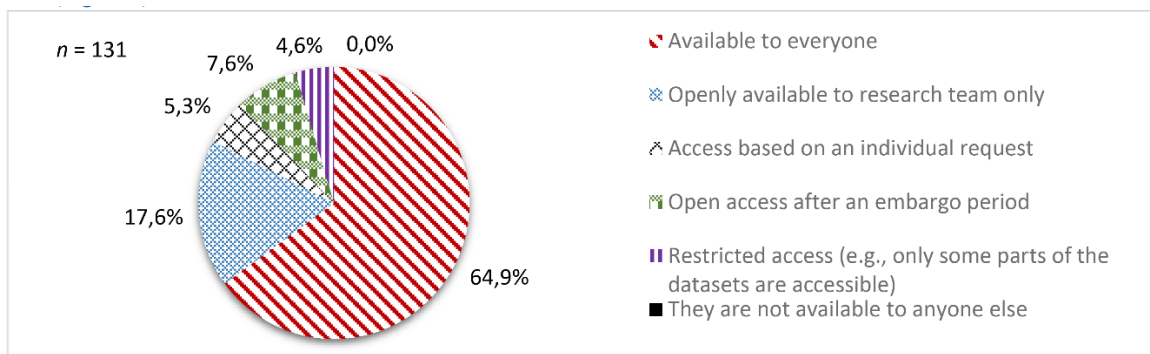


Figure 6: The level of access researchers are ready to give to their research data

group. Open access after an embargo period supports 10 researchers or 7.6%. Open access based on individual request is an option chosen by 7 researchers or 5.3%. Only 6 researchers or 4.6% answered that they did not want to give anyone access to their research data (Figure 6).

The next question was about motivations or obligations that make researchers to publish their research data in open access (multiple answers). Most of respondents (85 persons or 64.9%) answered that they open research data for dissemination and promotion. More than half (54,2%) or 71 respondents do it for research stimulation. Institutional Policy on Open Science or Open Access is the motivation for 57 respondents or 43.5%. It is worth mentioning that 43 respondents or one third are motivated to open research data by personal commitment. A quarter of respondents or 33 researchers

open research data because they are obliged by the funding agency policy. Another 24 respondents, or 18.3% answered that they open research data because of editorial policy (Table 6).

The respondents were asked to present the barriers to share research data (multiple answers). The data below (Table 7) show that among answers predominate the lack of time to share data (32.1%), concerns about data security and privacy (26.7%), losing control over intellectual property (26%). Other often selected reasons are misinterpretation and misuse of data (22.1%), lack of motivation (19.1%), underappreciating of the value of data (14.5%), corruption or falsification of open data (14.5%).

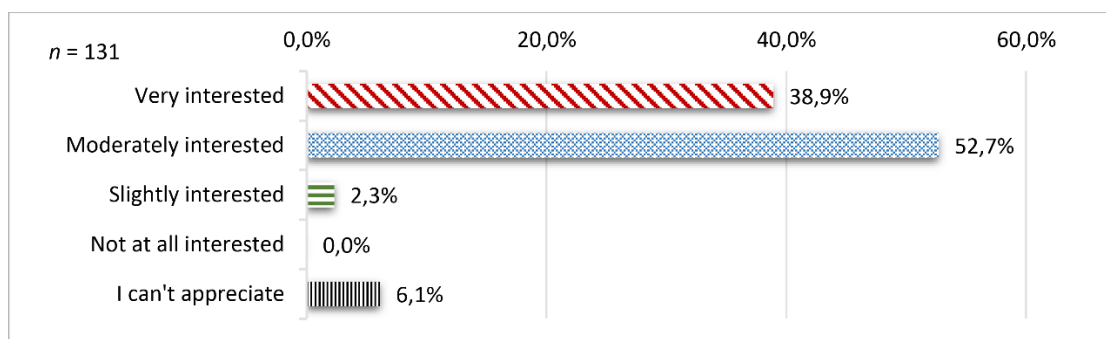
The respondents were asked to specify the level of their interest in library assistance with data management. Data presented in Figure 7 reveal that 38.9% of respondents are very interested and

Table 6: Motivations or obligations to publish data in open access

What motivates/obliges you to publish your research data in open access?	No of responses	Share of total
Dissemination and promotion of own research	85	64.9%
Research stimulation	71	54.2%
Institutional policy	57	43.5%
Personal commitment to open data	43	32.8%
Funding body policy	33	25.2%
Editorial policy	24	18.3%

Table 7: Barriers to share research data

What would be the reasons for not sharing your research data?	No of responses	Share of total
Insufficient time to share data	42	32.1%
Data security and privacy concerns	35	26.7%
Concerns about losing control over intellectual property	34	26.0%
Concerns about the misinterpretation and misuse of data	29	22.1%
Motivational barriers (lack of incentives to share data, etc.)	25	19.1%
The data are not valuable to others	19	14.5%
Open data can lead to data corruption/falsification	19	14.5%
Lack of necessary technical skills and knowledge	18	13.7%
Data may not be in a presentable and understandable form	17	13.0%
No rights to make the data public	12	9.2%
Others may not be able to replicate the findings	11	8.4%
Fear of side effects in using data for unintended purposes	10	7.6%
The data are too big to share	8	6.1%
Fear of discovering errors in data	7	5.3%

**Figure 7: The level interest in library assistance with data management**

52.7% are moderately interested. We will mention that the option “Not at all interested” was not selected by anyone.

The respondents mentioned that they would need training on the following topics: data processing and analysis, data storage and preservation, archiving data in digital repositories, dissemination and communication of data to the public, development of the data management plan, ethical use of data, data citation rules, copyright, licenses, FAIR principles (findable, accessible, interoperable and reusable).

4 CONCLUSIONS AND RECOMMENDATIONS

The survey results based on answers of 131 scholars of agricultural field reveal that researchers are aware of the importance and benefits of data sharing. The respondents consider that shared research data can help to solve many problems, especially, adapting to climate change, enhancing the management of plant pests and diseases, more efficient use of fertilizers, reducing the risks of drought and frost, raising awareness of consumers about risks of food contamination.

Among the main benefits of open data, researchers emphasized the visibility and transparency of research, opportunities for collaboration, acceleration of science development, avoiding duplication of research. Although 98.5% of respondents agree that research results obtained within projects funded by Government should be in open access, the evidence shows that the number of researchers that have made publicly available produced or collected research data are less (82.4%). Even less respondents (64.9%) are ready to share research data with everyone. Yet, the main motivations to share research data are dissemination and promotion of own research, institutional, funding body or editorial policy, but also personal commitment to open data. Among the main barriers to share data, researchers mentioned lack of time, data security and losing control over intellectual property concerns, possible misinterpretation and misuse of data. Uncertainty aspects seem to influence the interest and intention of data sharing.

Although agricultural researchers in the Republic of Moldova understand the importance and benefits of open data and are in favor of open data, their experience with sharing open data can be considered very modest. A lot of them have low level of knowledge on open data practices. Thus, efforts to increase the awareness and uptake of open data practices and to improve researchers' knowledge on data sharing should be considered.

Despite the fact that some studies carried out in the Republic of Moldova showed that sharing of research data is a current topic in the scientific community, this problem is not regulated at the national level, there is a lack of a systematic and holistic approach to data management. At present this approach is bottom-up and not top-down. There are no mandatory requirements on research data sharing. Thus, research data are shared according to the wishes of researchers.

Relevant ministries and research funding agencies should commit to approving appropriate policies and regulations for research data management and provide mechanisms to stimulate data sharing. This would lead to increasing the capacity of researchers and organizations to manage, share and use data effectively and responsibly.

The challenges the Republic of Moldova is facing at present are similar to the those faced by many developing countries. The implementation of Open Science and FAIR principles in the Republic of Moldova represents a complex and expensive process, which requires a lot of expertise, collaboration, interoperability rules, efficient coordination models, human resources with appropriate skills, etc. There is a strong need for both a general effort to open up research results that are increasingly based on data-intensive use, and an effort made by the disciplinary community members to prioritize, organize, and coordinate community-specific needs.

Recommendations:

- designing effective research data management approaches at the national level, elaboration and setting up an efficient mechanism for implementation of research data management in the Republic of Moldova;
- developing a national policy on research data, based on which institutional, disciplinary data management and sharing policies would be created that would encourage agricultural researchers to share their data more widely;

- continuous training and development of the competences and abilities of the data support staff regarding all aspects of research data management, followed by the training of researchers for the effective management of research data;
- change the culture, inspire trust and create a climate that encourages research data sharing among researchers.

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