On the use of citizen science in the agricultural sector

Igor Botygin[1,*], *Natalya* Goncharova[2], *Anna* Sherstneva[3], and *Vladislav* Sherstnev[1]

[1]Tomsk Polytechnic University, Department of Information Technology, Tomsk, Russia
[2]Tomsk Polytechnic University, Department of Social Sciences and Humanities, Tomsk, Russia
[3]Tomsk Polytechnic University, Department of Mathematics and Computer Science, Tomsk, Russia

Abstract. You The development and active introduction of computerized technology and information and communication technologies into the agrarian sphere contribute to the emergence of new forms of active e-participation and rural citizens in the socio-political processes of their regions. The article examines the concept of citizen science and theoretical approaches to assessing the effectiveness of e-participation projects. In the stack of smart agriculture tools and technologies, citizen science is an approach that has great potential as a tool that can provide timely and relevant data to improve the well-being of the agricultural sector, by keeping the entire population engaged and informed. The study will be of interest to government and business representatives involved in the development, implementation and improvement of existing information and communication technologies for socio-political participation of citizens.

1 Digitalisation and citizen science

Modern agro-industrial complexes in Russia are entering a new stage of technological development, which is called «Agriculture 4.0» [1-4]. The relevance of digital transformation of agriculture was demonstrated at the IVth Federal IT Forum of the Russian agro-industrial complex held in late October 2022 [5]. The transformation is based on the introduction of «smart» solutions to control the stages and quantify the results of agricultural production.

For illustration purposes, the following are a few examples from the new technological agricultural paradigm: GPS-controlled tractors; self-monitoring combine harvesters;

satellite positioning systems; remote sensing; sensors and internet of things technology for automated control of various agricultural objects, processes, stock assessment in real time; robots for feeding, harvesting and milking; autopilot systems for detecting animals before mowing, large weed nests; drones for fertiliser application and pest control and much more.

An example of a computer platform for a modern agricultural enterprise is the Agroanalytics system, which provides planning, execution control and analysis of the results of fieldwork [6]. In addition, the smart farming tools identified at the World Government Summit [7] as «Agriculture 4.0 – The Future of Farming Technology» not only contribute effectively to energy saving, increased productivity, risk minimisation, cost reduction and

* Corresponding author: bia@tpu.ru

operational optimisation, but also help to reduce the environmental impact of agricultural production specifically in a techno-productive way.

There is no doubt that the state has a key role in creating the right conditions for innovation and further technological development of the agricultural sector. However, it may take time for innovations to spread to the market on a large scale. This is usually related to the costs of technology adoption, but also to the existence of a positive attitude to and familiarity with the innovation in question, especially when it comes to the dissemination of more complex innovations. But nowhere is the digital divide, which reflects differences in access to information and technology, more pronounced than in agriculture. Creating an enabling environment for digitalisation of agriculture requires developing and improving infrastructure, developing the skills of people to use the Internet effectively, so that they can benefit from digitalisation. All workers (skilled and unskilled) must have access to and skills to use digital technologies if they are to participate effectively in agricultural value chains.

Thus, to accelerate the digitalisation of the agricultural sector, an information and communication infrastructure needs to be in place, which should include knowledge bases and interactive communities with a wide network of integration business platforms. In other words, a digital environment with a unified information space and a workforce capable of working in the new environment are needed. The above-mentioned challenges point to the need for increased cooperation between all stakeholders.

One important element for improving the quality of life in such an environment is the involvement of citizens in decision-making, known as citizen science [8-11]. The problem is that collecting and disseminating sufficient and reliable information is still a challenge. The administrative and management apparatus does not have complete information to assess all possible situations and make timely decisions. At the same time, the population, in general, does not know enough about the problems of the areas in which they live to participate effectively in the governance process as active citizens. In order to confront both of these problems simultaneously, one possible solution is to use citizen science.

Citizen science instrumental platforms allow a wide range of people to learn, understand and discuss scientific methods, standards and values, developing their general scientific literacy. This can raise people's awareness of the value of scientific research for solving problems encountered in everyday life, as well as a deeper understanding of global challenges. In this way, citizen science can have a positive impact on society by providing opportunities for learning, empowerment and social engagement, and increasing the scientific baggage.

A prime example of demonstrating the potential of citizen science is given in [12]. After authorities ignored residents' claims that water was contaminated, students from Virginia Polytechnic Institute and State University undertook a project in which they provided tools and training to Flint residents to enable them to collect and analyse water samples. In this way, it was proven that there were dangerously high levels of lead in the water, prompting the government to address the problem.

Of course, citizen science is not without its drawbacks. Projects that use traditional research methods already face problems in ensuring data quality. In addition, using the help of volunteers unfamiliar with the scientific methodology can introduce more errors. In addition, there are limits to how complex the subject matter of citizen science can be. Citizen science is often most effective when the project is simple enough. However, these dangers should not be exaggerated, as they can be mitigated with proper preparation and consideration of possible risks.

In this way, citizen science empowers the community to address issues that directly affect them. Citizen science enables communities, regardless of their location, background, culture, literacy level, to formulate questions and conduct research that directly benefit them.

2 The concept of citizen science

Citizen participation, also known as «public participation», is a concept that refers to "a process that enables individuals to influence public decisions, and which has long been a component of democratic decision-making" [13]. In other words, people go beyond passive acceptance of public policy outcomes. The state should take steps to include ordinary citizens in the definition of policy, but at the same time, citizens should take advantage of the opportunities the state provides, or demand them. if they are lacking.

This is why citizen participation is closely linked to the idea of democratisation. In countries that are transitioning from authoritarian regimes, it is relatively easy to set up a parliament with deputies and elections every four years, and this meets the requirements of formal democracy. However, these systems are very fragile and easily revert to authoritarian regimes. This is why authors such as Plostajner and Mendes [14] argue that citizen participation allows for a «double democratisation». Not only are political institutions transformed, but also civil society itself, and they can work together for the common good and to limit abuses of power.

Citizen participation and democracy are thus realised not just for their own sake, but also as a means to an end. Wang [15] argues that cooperation between government and society can achieve three important objectives: to meet the needs of ordinary people by giving them a voice among influential interest groups: to build consensus on goals and expected outcomes among stakeholders: and to help people have more confidence in government.

In addition, citizen participation initiatives can overcome the shortcomings of other approaches. For example, democratic participatory solutions are very different from the technocratic approach, in which experts select the most effective method to solve a particular problem. This makes sense in theory, but in practice the technocratic approach often fails to capture the socio-cultural nuances of the context in which the project will be implemented, thus creating more problems than it solves [13].

Moreover, the idea that new technologies should facilitate citizen participation has now become more prevalent. As a result, the concept of "e-participation" ("e-paiticipation") has been formulated. E-participation is understood as "the process of engaging citizens through information and communication technologies in policy development, decision-making, and service design and delivery to make it active, inclusive and deliberative" [16].

3 The effectiveness of e-participation

In general, the concept of e-participation is associated with the idea of e-government, which is understood as the use of information and communication technology and its application by the relevant public authority to provide people with information and public services [17]. While it is not difficult to argue that citizen participation is important, it is more difficult to define criteria for evaluating the effectiveness of participation tools. After all, if a particular project is successful, to what extent can this success be attributed to participation? Is there a way to know if it would have been more successful with a different kind or even a lower degree of participation? In addition, a study by Berner, Amos and Morse [18] showed that different stakeholders interpret the effectiveness of citizen participation differently. For elected officials, the clearest indication of effectiveness is re-election or lack of complaints. For civil servants, participation is achieved if citizens are informed and encouraged to participate. For citizens themselves, however, the clearest sign of effectiveness is that That they feel that a two-way channel of communication with government has actually been established.

There can therefore be much subjectivity in assessing the effectiveness of citizen participation projects. One way in which evaluation can be achieved in a more objective manner is to do so in a negative way; in other words, by identifying potential problems in implementation. For example, there may be confusion about responsibilities, unrealistic expectations, lack of motivation or simply a lack of staff and funding [19]. Thus, the logic behind this kind of 'negative evaluation' is that if a particular project has not encountered these problems, it can be considered 'effective'. Another way is to measure the degree of citizen participation in a project. For example, passive participation, which involves simply one-way delivery of information or requesting information, and active participation, which involves building consensus on specific issues.

In order for e-participation projects to be highly effective, the article [20] suggests assessing the technical parameters of the interaction platform, the reality of the mechanisms to influence the decisions, the public importance (relevance) of the socio-economic problem discussed. The US Environmental Protection Agency (EPA) [21] proposed a simplified classification of participation categories:

- tools for informing the public (public meetings and websites);
- tools for collecting and receiving information from citizens (seminars and focus groups)
- tools to reach consensus and seek agreement (advisory councils and citizens' juries).

The International Association for Public Participation proposed the following classification of levels of participation to assess the degree of public participation [22]:

Inform - providing balanced and objective information to understand the problem, alternatives, and solutions.

Consult - receiving public feedback on the analysis, alternatives and solutions.

Involve - ensuring that public concerns and aspirations are understood, taken into account throughout the process.

Collaborate - collaborate with the public in every aspect of the decision, including developing alternatives and identifying the preferred solution.

Empower - ensuring that the public makes the final decision.

In terms of efficiency and degree of citizens' participation in electronic communications (use of information and communication technologies), one should also pay attention to the E-Government Development Index, which is calculated by the United Nations since 2003 [23]. Each country is evaluated based on the following criteria:

- Telecommunications Infrastructure Index (development of data networks).
- Human Capital Index (training of skilled professionals).
- Online Service Index (involvement of citizens in decision-making processes).

The 2022 ranking places Russia 42nd among 193 countries.

The e-Participation Index is an interesting attempt at a systematic and worldwide telecommunication assessment of citizens. However, the index unfortunately does not take into account the physical geography of the country or the efficiency of information and communication technology use.

In general, in practice, all of the above types of classifications tend to be inadequate for evaluating performance, as most projects rarely reach their highest levels of development. Moreover, it makes no sense to argue that in order to be considered «effective», one must reach a level of «empowerment». A project can only achieve its objectives using the appropriate level and type of participation.

As a result, practices aimed at increasing the integrity of the public participation process should be guided by the principles of the IAP2 Federation Code of Ethics [24].

4 Conclusions

In today's world, the opportunities for modernising the agricultural sector are enormous, enabling it to become a high-tech industry capable of creating new markets for innovative solutions and developments to address a wide range of practical challenges. At the same time, the digitalisation of agriculture is also generating huge amounts of data. This "big data" can contain a range of information assets, which can be processed through new analytical methods and assess the possible impacts of a range of actions and conditions. All of this can support planning and support decision-making processes.

In the stack of smart agriculture tools and technologies, citizen science is an approach that has great potential as a tool to provide timely and relevant data to improve the well-being of the agro-sphere, by keeping the entire population engaged and informed. In the face of significant challenges due to environmental, economic, demographic and socio-political changes, the power of citizen science must also be used to raise public awareness when evidence-based policy-making, scientific knowledge and some of the fundamental truths of democracy cannot be taken for granted. This, in turn, can contribute to society's goals, including progressive policies pursued by civic institutions.

Citizen science is defined and interpreted in different ways. Definitions are often in conflict for different reasons. For example, regarding the exact degree of public participation, the voluntary nature of participation and the extent to which the findings can be used in science and policy. Because of these nuanced definitions, there are often differences in the implementation of citizen science. However, at a basic level, it is a purposeful collaboration in which the general public participates in the research process. Non-professional scientists voluntarily participate in data collection, analysis and in the joint development of projects. Citizen science as a process is thus currently of considerable interest and is increasingly recognised for its multifaceted nature and complexity.

Further understanding of the motivations and drivers of citizen science engagement can help better develop projects in agribusiness through bottom-up development and engagement, This can be facilitated by programmes including the provision of training, cloud technology infrastructure, reliable and easy-to-use internet of things devices, timely visualisation and data transfer. It is important that influential stakeholders who participate in the policy and regulatory life of society support these programmes. A significant impact of citizen science on society will be achieved when the data collected to solve a local problem can also be used for subsequent environmental, social and economic purposes.

References

1. Agriculture 4.0. How digital agriculture is fundamentally changing the future, https://dzen.ru/
2. Field of Opportunity (Kommersant), https://www.kommersant.ru/
3. N. V. Orlova, E. V. Serova, D. V. Nikolaev, A. S. Khvorostyanaya, Y. A. Novikova, E. V. Yavkina, E. Yu. Bobkova, P. V. Ragozin, R. G. Yanbykh, A. V. Sokolov, A. A. Chulok, Agriculture 4.0. **128**, (2020), https://conf.hse.ru/mirror/pubs/share/361056435.pdf
4. H. Zatnbon, l. Zambon, M. Cecchini. G. Egidi, M. G. Saporito, A. Colantoni, Processes **7**, 36 (2019)
5. IV Federal IT-forum of the Russian agro-industrial complex SMART AGRO (ComNews, 2009-2023), https://www.comnews-conferences.ru/
6. An effective agribusiness management system with satellite monitoring, equipment and employee tracking, yield and cost control (SmartAgro, 2023), https://smartagro.ru/

7. World government summit (Oliver Wyman, 2023), https://www.oliverwyman.com/
8. S. Hecker, M. Haklay, A. Bowser, Z. Makuch, J. Vogel, A. Bonn, Citizen Science: Innovation in open science, society and policy **582** (2018), https://discovery.ucl.ac.uk/
9. Learning through Citizen Science: enhancing opportunities by design (National Academy of Sciences, 2023), https://nap.nationalacademies.org/
10. M. Haklay, Citizen Science and policy: a european perspective, https://www.wilsoncenter.org/
11. B. J. Strasser, J. Baudry, D. Mahr, G. Sanchez, E. Tancoigne, Science & Technology Studies **32(2)**, 52 (2019)
12. A. Maynard, Can citizen science empower disenfranchised communities? (The Conversation Media Group Ltd., 2010-2023), https://theconversation.com/
13. B. Parker, Planning analysis: the theory of citizen participation, https://pages.uoregon.edu/
14. Z. Plostajner, I. Mendes, Citizens Participation, https://library.fes.de/
15. X. Wang, Assessing public participation in U.S. cities (ResearchGate GmbH, 2008-2023), https://www.researchgate.net/
16. United Nations E-Government Survey 2018, https://publicadministration.un.org/
17. G. Ntulo, J. Otike, E-Government: its role, importance and challenges, https://www.researchgate.net/
18. M. Berner, R. S. Morse, J. M. Amos, What constitutes effective citizen participation in local government? Views from city stakeholders (ResearchGate GmbH., 2008-2023), https://www.researchgate.net/
19. Stakeholder Engagement Framework, https://www.health.gov.au/
20. S. A. Revyakin, Issues of State and Municipal Governance **2**, 94, (2018), https://publications.hse.ru/
21. Public participation guide: tools, https://www.epa.gov/
22. IAP2 spectrum of public participation (IAP2 International Federation, 2018), https://cdn.ymaws.com/
23. Russia and the UN e-Government Development Index – 2003-22 (E-government expert center), https://d-russia.ru/
24. Code of Ethics, https://cdn.ymaws.com/