

## Research Article

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# Agricultural sciences publication activity in Russia and the impact of the national project “Science.” A bibliometric analysis

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**Abstract:** Science plays an important role in the development of agriculture. Publication activity is one of the factors in the assessment of science intensity in certain areas. Evaluating the number of articles on a specific topic in a certain period can indicate a trend in developing science in the country and international cooperation. Agricultural science in Russia lags far behind leading topics such as chemistry and physics, especially in international cooperation. This article aimed to assess the publication activity in Russia in the area of agriculture to analyze the development of agricultural science in the country and the impact of the national project “Science” on the trend of change. The authors used the Web of Science Core Collection database for this study and analyzed 7,436 papers on the topic of agriculture co-authored by Russian and foreign authors. This study showed the number of articles by year, research areas, and distribution publication records in collaboration with other countries. The article results showed that agricultural science has been growing in a general trend in recent years. The most significant increase in the overall publication in agriculture topics and cooperation occurred after the project “Science” was launched. The project showed a great impact on publication activity in Russia.

**Keywords:** bibliometric, science, agriculture, Russia, WoS

## 1 Introduction

The Russian Federation ranks seventh position in terms of its publication output in the list of the world’s largest-producing science regions [1]. One of the important indicators of the practical activity of scientific institutions is publication activity, which determines the scientific potential [2]. Physics and Chemistry are the most widespread areas of publication in Russia. International cooperation is being intensively conducted in these areas based on the number of publications with international co-authorship [3]. The development of a particular industry and international collaboration largely depends on government support, policies, and projects [4,5].

To increase publication activity in Russia as one of the goals, the National Project “Science” was launched in 2018 [5,6]. Recent studies [5,7–9] have indicated an increase in publication activity in Russia due to national projects and reorganizations. The objective of project “Science” is to create an advanced infrastructure for research, development, and innovation [10]. According to the project “Science” of the Ministry of Science and Higher Education of the Russian Federation [10] and based on the Decree of the President of the Russian Federation of May 7, 2018 No. 204 [11], by 2024, Russia should become one of the 5 leading countries globally, carrying out research and development in areas determined by scientific and technological development priorities. The national project aims to form world-class scientific and educational centers in the Russian Federation in cooperation with the world’s leading scientific organizations. In order to form the technological foundations for the breakthrough development of the Russian Federation, special attention was paid to domestic and international scientific and industrial cooperation [5,6].

National projects in Russia are also being created in the development of agricultural science. The Department of Informatization and Scientific Support is being created at the Ministry of Agriculture. Its tasks include the

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implementation on the territory of the regions of state scientific measures and technical policy in the interests of agricultural development, accelerated implementation of digital technologies in agriculture, the federal scientific and technical program for the development of agriculture in 2017–2025, and the departmental project “Digital agriculture” [12–14]. Within the framework of the project, a special direction is assigned to create a network of advanced infrastructure for innovative activities in the field of agriculture. The project aims to develop the agricultural industry in a scientific breakthrough. The tasks are the transition to a highly productive and environmentally friendly agriculture and aquaculture, the development and implementation of systems for the rational use of chemical and biological protection of agricultural plants and animals, storage and efficient processing of agricultural products, the creation of safe and high-quality food products, including functional foods [12,13].

Agriculture in Russia has always played an important role in developing the economy and science. Since land resources are in abundance, the expansion of production depends on expanding sown areas [15]. The development of agriculture on a large scale requires a systematic approach and investment in science research. Agricultural mechanization and engineering play an important role in developing technologies and improving the quality of crops. However, the mechanization of production lags behind the world level, which affects the country’s competitiveness and export potential [4]. Therefore, it is important to develop scientific potential, especially in international cooperation, in order to attract foreign researchers and enhance international cooperation.

Regarding the scientific production in agriculture, the study’s first goal was to analyze the Web of Science (WoS) database publications in Russia to show the country’s development of agricultural science. The authors used the Clarivate Analytics search tool to access publication activity under WoS Core Collection by years, research areas, and co-authorship countries. The authors evaluated the contribution of scientific publications on agricultural disciplines to assess potential scientific growth in recent years. This study reviewed the history, national projects, and reorganization of scientific departments that affected publication rates. Therefore, the second goal was to assess the impact of the project “Science” on the change in publication activity. Analyzed database of publication activities in the country showed an increased record in the papers of Russian authors in total and in collaboration with other countries after the project “Science.” The analyzed research topics showed that the most significant number of articles on the topic of soil science was published since the history

of development as a branch of this science was laid in Russia. The data presented might help evaluate the work of national projects to enhance scientific achievements and contribute to the world scientific community.

## 2 Materials and methods

Bibliometric analysis of scientific records provides quantitative analysis of written publications such as scientific articles, reviews, book chapters, and proceedings materials [16,17]. Published records are collected in indexed databases such as WoS and Scopus, constituting bibliometric data [17]. Bibliometric data can be referred to as big data that show scientific contributions to the global scientific community. Analyzing a large data cluster can provide a picture of scientific development across regions worldwide and different disciplines [18,19]. The development of human resources implies an increase in the level of competence of personnel, one of the components of research work, assessed, among other things, by the number and quality of publications [2]. Analysis of the number of publications makes it possible to assess the effectiveness of research in a particular topic and a specific scientific community and their cooperation [9,20]. Publication analysis is one of the main quantitative evaluation research intensity methods for compiling scientific research’s structure and dynamics. Publication activity reflects the directions of a particular industry’s scientific community and development trends [21,22].

Some of the Russian bibliometric studies analyzed publication productivity [23], global rating trends and share of publications [24], projects impact on publication productivity [5], and examples of detailed analysis of University’s employees’ publication productivity [6]. For its part, international studies have shown many bibliometric research experiences such as country publication activity [25,26], topic-focused analysis [27–30], and worldwide analysis [31–33].

The authors used Clarivate Analytics (2021) search tool to construct datasets based on the WoS Core Collection. The authors used the search key address: Russia and Research topic: Agriculture, to search for the publications. Data were analyzed by publication years, countries, and WoS categories. The workflow graph is represented in Figure 1. The article data were available from 1992 to 2021, but 2021 was excluded from the analysis as it contains incomplete data. The resulting dataset provided publication data for 7,436 articles as of June 2021.

The authors used the R software 4.0.2 to classify data by years, research topics, and countries of co-authorship.

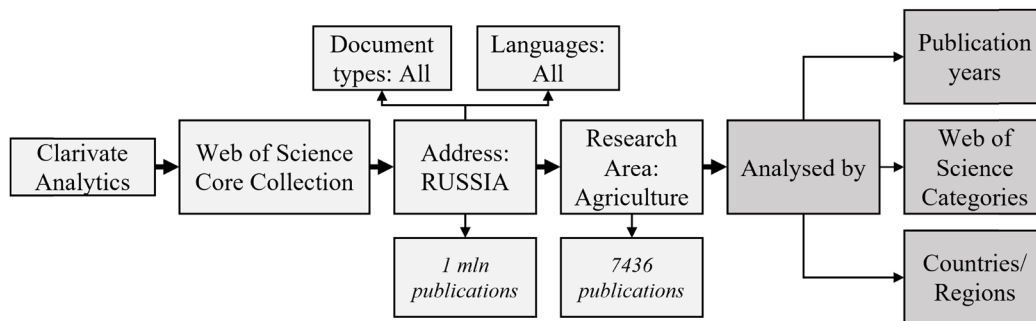


Figure 1: Workflow graph for data selection using Clarivate Analytics database.

The author generated column and row data in text data by key phrases for the  $x$ -axis and  $y$ -axis and visualized data using the programming language R with `geom_bar()` for graphs, and `geom_polygon` for map plotting under ggplot package. “fill” variables separate the data by Russian and foreign co-authorships.

### 3 Results and discussion

In the years after the collapse of the USSR, when it was necessary to develop import substitution of products, the question arose about increasing agricultural products’ production. In recent years, with the growth of the agricultural output, the export potential has increased, impetus the Russian economy’s development in the sector [34].

In 1992, under the conditions of the beginning of socio-economic transformations, Russian science, for the first time, found itself on the periphery of state interests and ceased to be considered by the authorities as a priority branch of activity. This manifested itself in a sharp reduction in government science funding. In conditions of scarce budgetary funding, the priority of scientific work began to decline rapidly [35]. During the 1990s, the number of people working in the scientific industry decreased significantly. This led to a reduction in the number of scientific papers. Also, scientific organizations could not work with the agricultural sector because the number of people working in agriculture was reduced more than twice. Thus, the lack of workers prevented them from carrying out scientific implementations. Generally, at the end of the 90s, agricultural production has been growing mainly due to crop production [36].

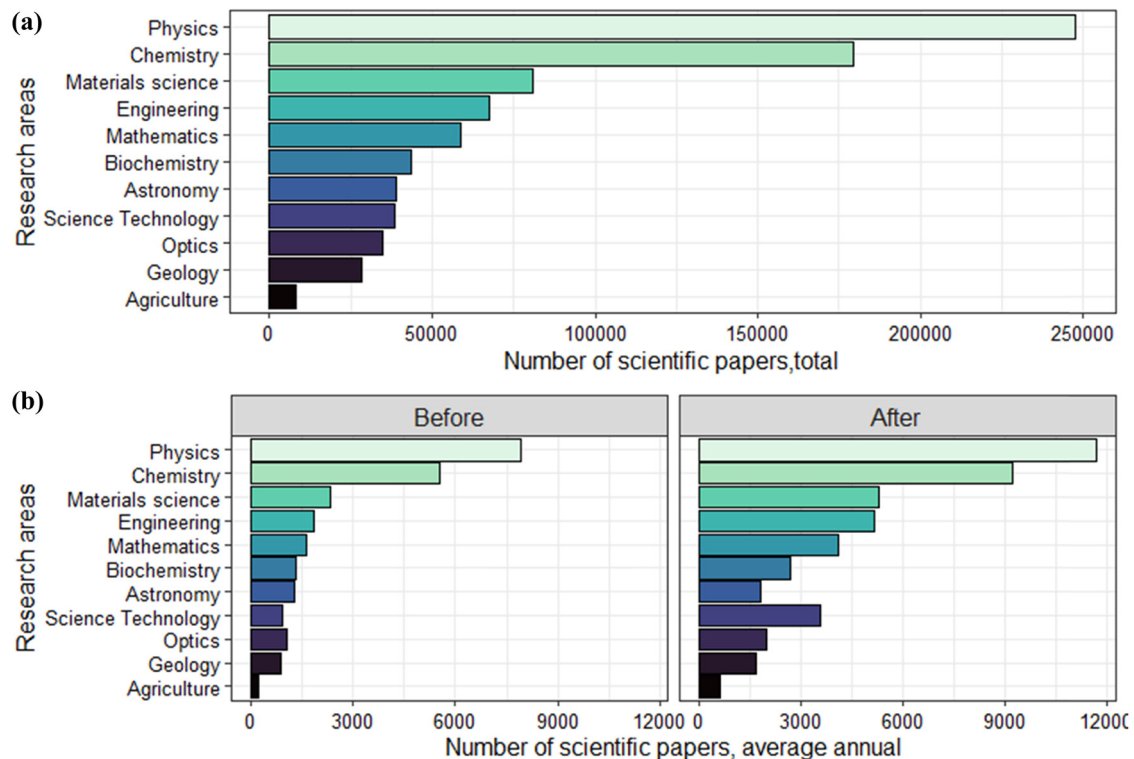
The agricultural industry is one of the most developed in Russia and is always the subject of government programs [4]. Unfortunately, agriculture as a direction in science was not as widespread as physics or chemistry,

which are 23.8 and 17.2% of total publications in Russia, respectively (Figure 2a). Agricultural sciences occupy only 0.757% of the total number of publications in the WoS database published by Russian authors and in co-authorship. However, in recent years, publication records have been increasing in agriculture, especially after the project “Science” launch. The average annual production of publications in the given areas increased by 1.9 times from 2,260 papers, and only in agriculture by 2.9 times from 216 (Figure 2b).

Figure 3 shows the distribution of scientific publications by years from 1992 to 2020 in the agricultural area. The most critical period for both agriculture and science was the period from 1991 to 1998. The agriculture industry also suffered reorganization processes, and there was a lack of funding and a decline in production since the USSR collapsed. The period 2011–2013 was an echo of the economic crisis. The global financial crisis that appeared in the second half of 2008 affected the activities of almost every subject of the Russian economy. Scientific organizations fell under budget cuts and could not carry out research work fully [37].

In 2013, the Russian Federation launched a process of reforming the country’s academic complex, which provides for the merger of three state academies of the Russian Academy of Sciences, the Russian Academy of Medical Sciences, and the Russian Academy of Agricultural Sciences with the simultaneous deprivation of their subordinate scientific institutes, and the creation of a new federal agency, Federal agency for scientific organizations. One of the main innovations determining the ranking of scientific organizations was the availability of publications [38]. Thus, since 2013, the increased volume of publication materials has been stimulated.

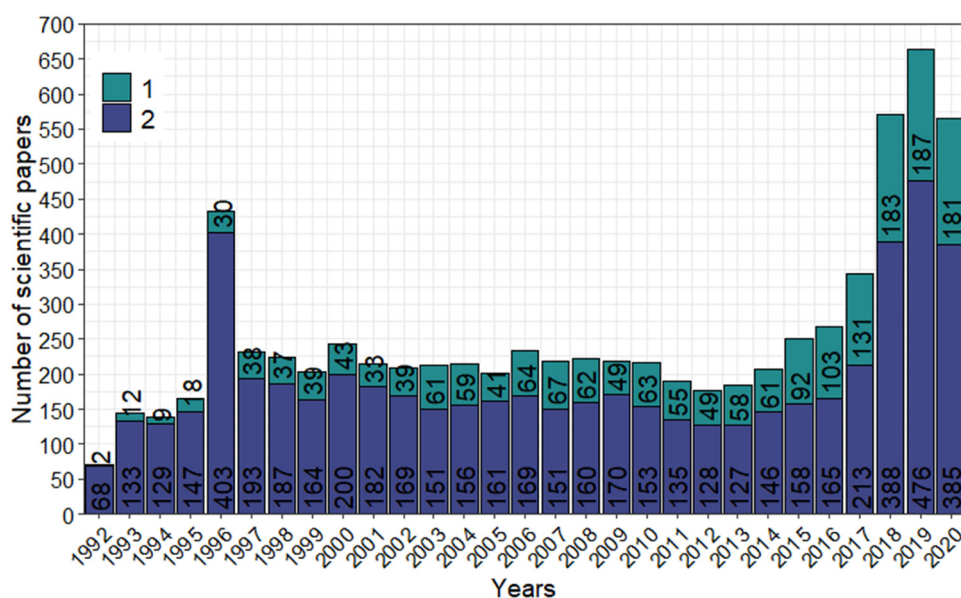
The number of articles gradually increased in three steps from the beginning of the 90s and since 2013, but the most significant jump occurred in 2018 when the project “Science” was launched. After the project, publication production by Russian authors increased by 2.7 times.



**Figure 2:** The number of scientific papers by research areas with Russian and foreign co-authorships from 1992 to 2020. (a) Total number of published scientific papers for the period. (b) Average annual publications separated before and after the project “Science.” Source: Own calculation using R software 4.0.2 (2021) based on the data aggregated by the Clarivate Analytics, WoS Core Collection (2021).

An important regulator of the project was the need for publications in international journals to enter the international scientific community [1,6].

As mentioned above, after the start of the project “Science” in 2018, it was assumed to develop all scientific industries, including agriculture. Due to the allocation of



**Figure 3:** The number of scientific papers distributed by years, from 1992 to 2020. (1) By Russian authors co-authored with foreign authors. (2) By Russian authors only. Source: Own calculation using R software 4.0.2 (2021) based on the data aggregated by the Clarivate Analytics, WoS Core Collection (2021).

budgetary funds [1,5], the Ministry of Science created scientific centers and new laboratories [5]. There is also an increase in publication activity in international journals due to the project's aim of contributing to the scientific world community.

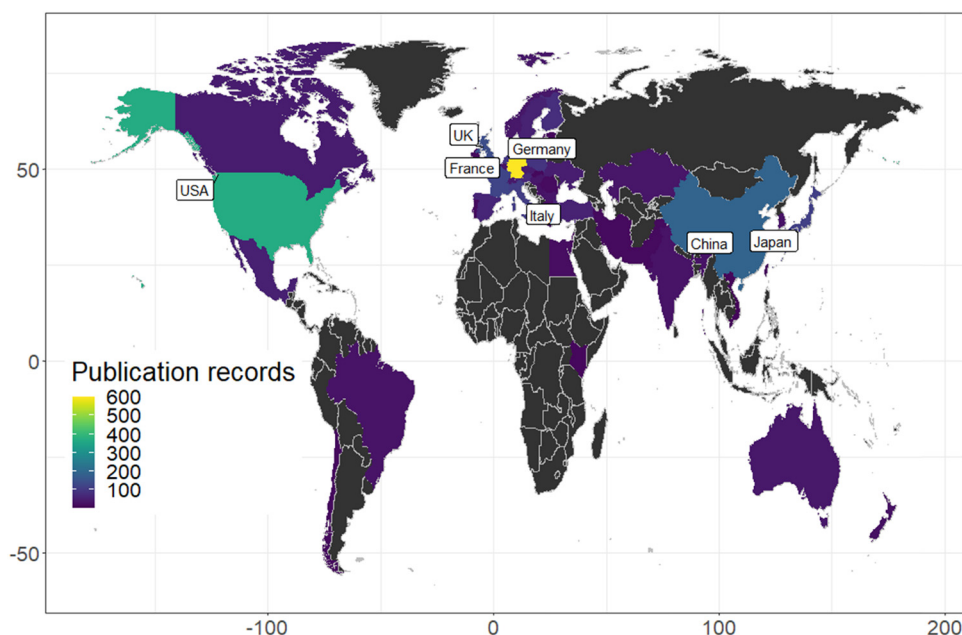
The growth of international cooperation was also noticeable, slowly starting in 1992. This followed with the signing of new agreements on international cooperation in science and technology by the Russian Federation at the beginning of the 90s [39]. The growth of foreign co-authoring has been increased since 2018 with the project “Science” [6]. In fact, the average annual rate of international publications in agriculture was increased by 3.7 times after the project (Figure 3).

International communication in science can also be traced using the assessment of publication activity. The author highlighted the countries that participated in the publication of scientific papers with Russia on the topic of agriculture. Published articles co-authored with authors from different countries characterize the intensity of international cooperation. Russia had the largest number of publications of 600, 370, and 191 from 1992 to 2020, with Germany, the United States, and China, respectively (Figure 4).

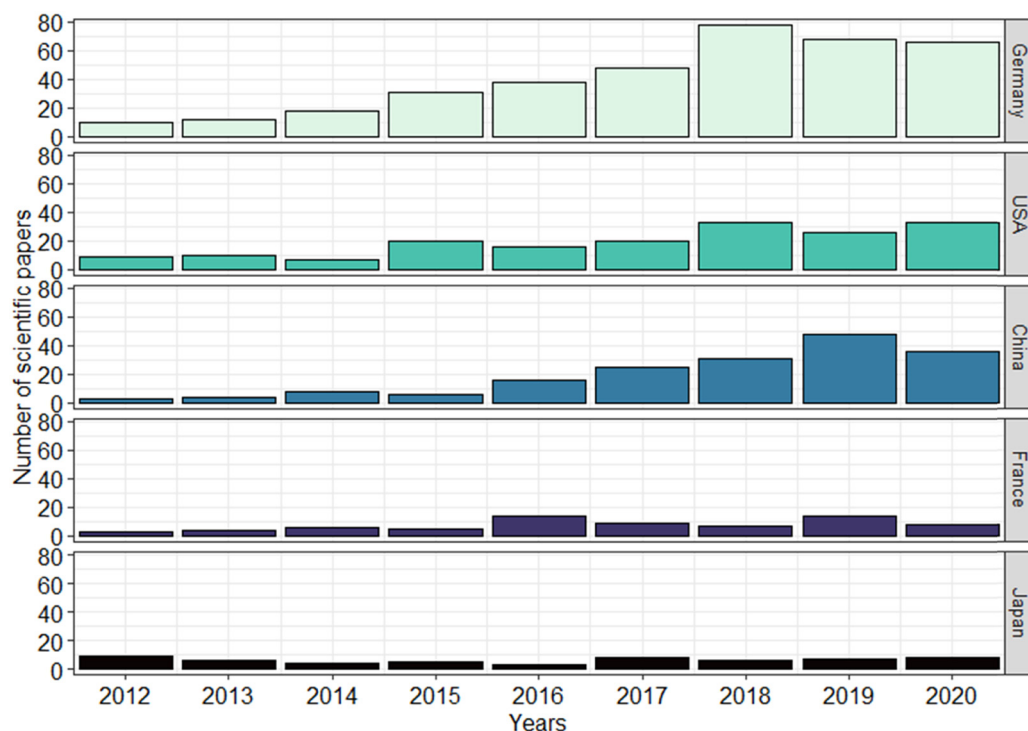
Russia and Germany are developing relations in various fields, including science and technology. According to the Ministry of Foreign Affairs of the Russian Federation [40], Russia positions scientific and technical cooperation

with Germany as one of the most important tools for integrating the country into the European and world scientific community. The countries laid the foundations for cooperation in several bilateral documents, the main ones are the “Agreement on scientific and technical cooperation” signed in 2003 [41] and the “Joint Statement on the German–Russian Strategic Partnership in Education, Research, and Innovation” signed in 2005 [42]. The 2009 agreement on joint scientific and technical cooperation replaced the agreement on cooperation between the USSR and the FRG signed in 1986 [42,43]. This agreement creates an opportunity for interaction in the field of innovation and implementation of joint commercialization of the results of completed scientific and technical works. Scientific cooperation is aimed at close cooperation of scientific organizations (institutes), universities, and innovative companies of both countries [42]. Therefore, the high number of publications co-authored with Germany indicates the results of joint scientific works and has increased significantly since the start of the project “Science.” Indeed, the average annual number of publications increased from 26 papers yearly to 2.7 times. These numbers confirm that Germany was one of the leading countries of cooperation with Russia and their relations intensified even more after the introduction of the project for the latest years (Figure 5).

The United States ranks second in the number of joint publications with Russia in the agricultural area. The



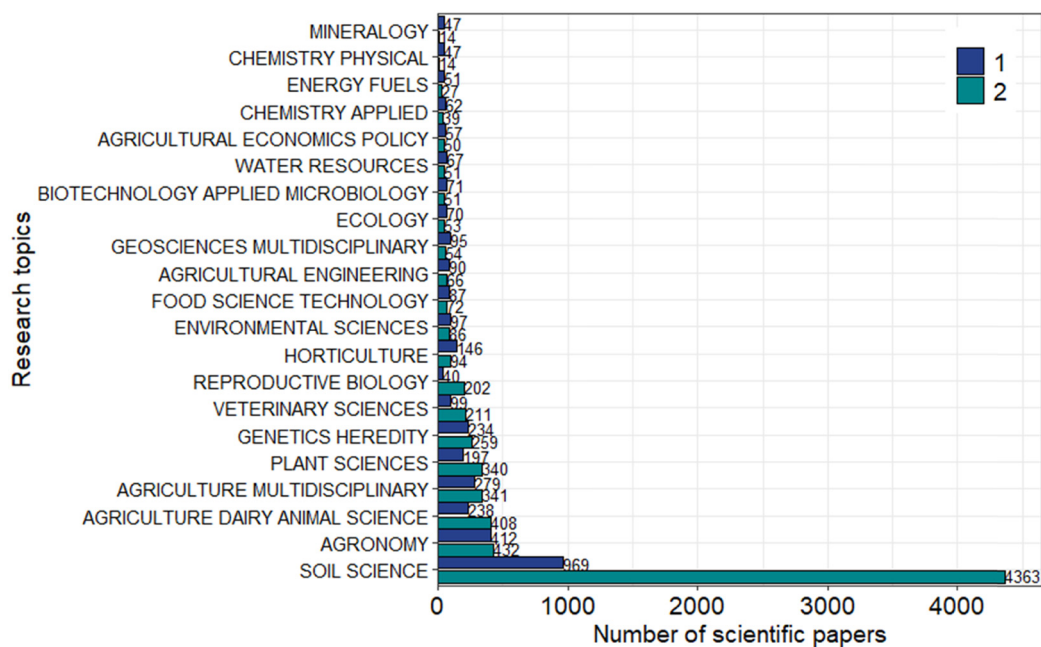
**Figure 4:** Distribution map of publication records by countries, authored by Russian authors with foreign co-authoring, from 1992 to 2020. Source: Own calculation using R software 4.0.2 (2021) based on the data aggregated by the Clarivate Analytics, WoS Core Collection (2021).



**Figure 5:** Publications of the top five countries in collaboration with Russia from 2012 to 2020. Source: Own calculation using R software 4.0.2 (2021) based on the data aggregated by the Clarivate Analytics, WoS Core Collection (2021).

average annual output of publications was 14 articles before the project “Science” and 31 articles after, which shows an increase of 2.2 times (Figure 5).

Chinese agricultural research institutions have established partnerships with Russian institutions in recent years. Using their strengths, China and Russia are



**Figure 6:** The number of scientific papers distributed by WoS Categories, from 1992 to 2020. (1) By Russian authors co-authored with foreign authors. (2) By Russian authors only. Source: Own calculation using R software 4.0.2 (2021) based on the data aggregated by the Clarivate Analytics, WoS Core Collection (2021).

developing cooperation in areas such as the exchange of highly qualified personnel, the introduction of advanced technologies and the exchange of experience in the field of production management, biotechnology, technologies that prevent the decline in production efficiency, cultivation methods, field irrigation, and genetically modified crops, according to Russian Council on International Affairs [44]. As one of the largest consumers of soybeans, China is interested in non-GMO products, which makes the Russian market attractive. These countries are physically bordering, which allows for scientific research on the production of crops in similar climatic conditions. Therefore, on the east of Russia, joint research is being carried out on cultivating high-productivity non-GMO soybean varieties [45,46]. In recent years, after the start of the project, the number of publications with China has increased significantly. The average annual numbers increased by 3.8 times (Figure 5).

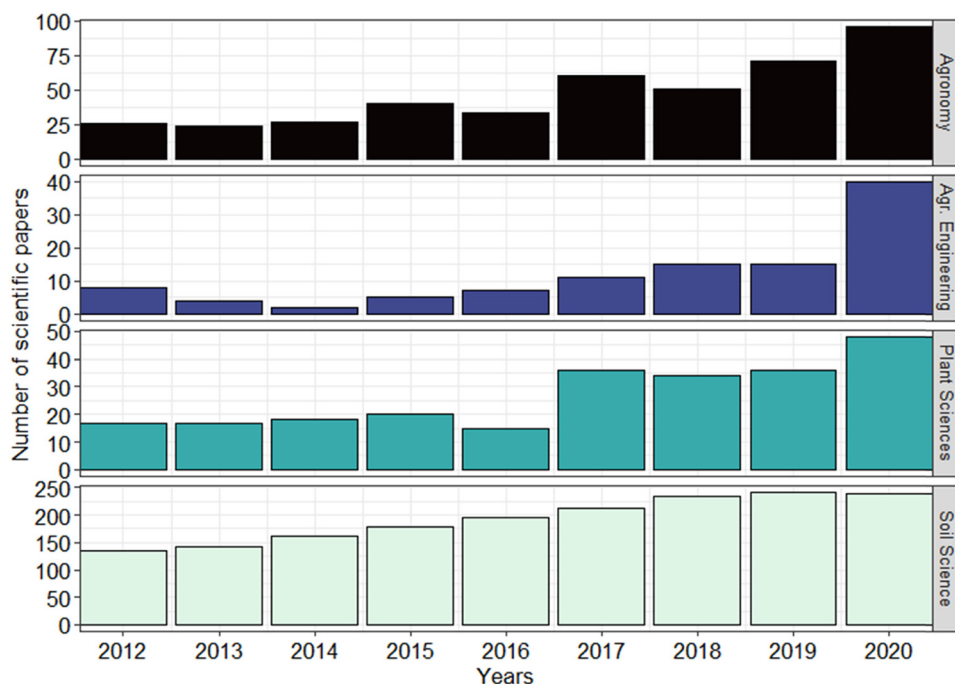
As for France and Japan, which are in the top five countries of co-authors with Russia, the number of publications has not changed significantly and increased by 1.4 and 1.1 times, respectively.

Figure 6 shows under which topics scientific articles have been published in the agriculture sciences under the WoS Categories search key. The figure shows that soil science is the most widespread area of published scientific papers. In agriculture, the soil is characterized

as one of the main sources for growing crops. The soil's cultivation, type, and composition largely affect the crop being grown and how it should be grown [47]. Therefore, scientists and farmers have increased yields throughout the development and fall of agriculture through land cultivation methods research and soil science.

Soil science has played an important role in the history of Russian science. In the nineteenth century, Vasilii V. Dokuchaev made a huge contribution to the development of soil science in Russia and the world [48]. Dokuchaev introduced the term soil genetics. He put forward soil science as a separate independent scientific branch [47]. Thus, soil science has been one of the strongest scientific fields in Russia.

Moreover, on the initiative of Dokuchaev, the world's first journal about the problems of soil science, "Pochvovedenie," was created. The first number was released in 1989 and is being published. The journal is now called Eurasian Soil Science, indexed in international databases like Scopus and WoS. Therefore, one of the reasons for the high publication activity in soil sciences in Russia is the presence of this journal in the WoS Core Collection database, which was analyzed in this study. Most of the papers in this journal are in the field of soil science and account for almost 50% of the entire WoS database on agriculture in Russia [3].



**Figure 7:** Publication records on general topics: soil science, plant science, agricultural engineering, and agronomy from 2012 to 2020 in Russia with foreign co-authorships. Source: Own calculation using R software 4.0.2 (2021) based on the data aggregated by the Clarivate Analytics, WoS Core Collection (2021).

Agricultural engineering is inferior to other topics based on the publication database. This indicates the underdevelopment in this industry and affects agricultural development in general. One of the challenges is unpredictable weather, such as drought and flooding, leading to crop losses and making many regions of Russia belong to the zones of risky farming [4,49,50]. Moreover, almost all regions are in frost conditions, that is why work in the fields is complicated, and the machines constantly need maintenance and repair [4]. Thus, these circumstances lead to budget cuts and a slowdown in the development of agriculture in science [51].

Despite the difficulties in the development of agricultural engineering, Russian institutes develop their machines and technologies. Unfortunately, many developments are regionally bound. Research results are published only in local collections and journals included in the Russian Science Citation Index database and are not a part of the WoS Core Collection [8]. Therefore, the number of articles in international databases is minor. However, articles on all topics, including agricultural engineering, have increased in recent years. Figure 7 presents the publication on certain topics, soil science, plant science, agronomy, and agricultural engineering. Based on the presented data, the overall publication capacity in agricultural sciences increased and is expected to grow steadily. Publication records in agronomy averaged 35 papers in the year before the project “Science” and 72 after, which is a 2-fold increase. Publications for agricultural engineering increased almost four times after the project was implemented. In plant sciences and soil science, the growth was not so high and amounted to an increase of 2 and 1.4 times, respectively.

## 4 Conclusion

The innovative development of the modern economy is carried out in the context of implementing the model of open innovation when economic entities of different countries combine their efforts in the scientific and technical sphere and actively exchange the results of their work. The Russian Federation actively supports international cooperation in the innovation field. It provides for close interaction of science, business, and the state to implement innovative projects.

In this study, publication data of WoS Core Collection database results showed Russia’s current state of publishing activity. The authors analyzed agricultural topics as the least widespread but very important in the Russian economy. During the period from 1992 to 2020, 7,436

articles were published on the topic of agriculture in Russia, including international co-authorship. The Russian scientific community has undergone constant reforms, which affected the leaps in publication activity. Despite the constant reorganization of scientific departments, substantial growth has been significant over the past few years. The main reason for that was the acceptance of the project “Science” in 2018 to provide the region with scientific potential. Moreover, the government set the goal of developing international cooperation to attract scientists to the world scientific community.

With the project “Science” launch, there was growth for the last 3 years due to allocating a budget for science and publications. Publications in agriculture in Russia grew by 2.9 times. Collaboration papers with other countries increased by 3.7 times, indicating a greater interest in international cooperation. Publications in non-wide-spread topics showed a significant increase after the project, as agronomy and agricultural engineering grew by 2 and 3.9 times, respectively, when the most popular area of soil science grew only 1.4 times.

The national project created to ensure the enhancement of scientific potential makes a contribution that can be seen from the results presented in the article. The notable increase was where the indicators were tiny, and the project gave impetus to the development of new collaborations and in new directions.

However, in such a short period of time, the full picture of the project’s impact is not visible in some terms or just started in the last years since the indexing of publications can take up to 1 year. In this regard, this work on the study of the development of publication activity will continue.

The involvement of Russian scientists in international cooperation should help develop the agricultural industry and science since many aspects, especially in mechanization, are backward. In further work, the authors will analyze the development of topics and innovations in publications to assess the contribution of foreign scientists to agricultural sciences.

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