https://doi.org/10.33472/AFJBS.6.6.2024.9046-9055

African Journal of Biological Sciences

Journal homepage: http://www.afjbs.com

Research Paper Open Access

Difficulties in Determining the Qualitative and Quantitative Characteristics of Agricultural Land

Anastasia A. Komarova[1], Boris A. Lobasenko[2], Valery A. Pavsky[3], Svetlana Ivanova[4*]

[1,2,3,4]Kemerovo State University, 6 Krasnaya street, Kemerovo, 650000, Russia;
Orcid ID-0009-0007-6514-1153; Orcid ID-0000-0003-0245-7904; Orcid ID-0000-0001-9460-7126; Orcid ID-0000-0002-1252-9572.

[1]a.komarova@i-digit.ru, [2]lobasenko@mail.ru, [3]pavva46@mail.ru
Corresponding author: pavvm2000@mail.ru

Article Info

Volume 6, Issue 6, September 2024

Received: 25 June 2024

Accepted: 22 August 2024

Published: 10 September 2024

doi: 10.33472/AFJBS.6.6.2024.9046-9055

ABSTRACT:

Monitoring of agricultural lands is an important component of sustainable agricultural development. It allows to track changes in land use, assess the land's condition, identify potential threats to land resources and develop measures for their conservation. Effective monitoring of agricultural lands makes it possible to make informed decisions on the sustainable use of land resources, increase agricultural productivity and preserve the environment. To solve the problems of updating information on agricultural lands, it is necessary to improve the coordination of efforts of various structures, increase the availability of modern technologies, train specialists in information tools for working with data, and develop cooperation, both at the regional and international levels.

Keywords: Agricultural Land, Monitoring, Control, Digital Archives.

1. Introduction

Conservation of agricultural land is an important task for ensuring food security and sustainable agricultural development (Haughey et al. 2023; Purcell et al. 2023). To do this, it is necessary to take measures to protect and sustainably use these lands, control their use and prevent misuse.

One of the main ways to preserve agricultural land is not only to establish and comply with legal norms and regulations governing the use and protection of agricultural land, but also to control land plots to monitor the condition of land and take measures to restore its fertility.

Monitoring of agricultural land includes the following main tasks (Chupina et al. 2023): assessment of the area and composition of land; determination of qualitative and quantitative characteristics of soils; assessment of the use of water resources for agriculture; study of the dynamics of changes in land use; identification of factors affecting the deterioration or improvement of agricultural land.

Various methods and tools are used for monitoring (Maglinets et al. 2017), such as satellite surveillance, geoinformation systems, as well as local observations and analyses.

Land control is carried out on the basis of up-to-date information about these lands, the availability and completeness of which cannot always be ensured. The main problems of updating information on agricultural lands include a lack of funding and resources for regular monitoring and updating of data, the availability of modern technologies and methods of data collection, insufficient knowledge of geoinformation systems and other land analytics tools, lack of information exchange between structures performing these functions.

The Russian Federation is no exception. In 2021, the State Program for effective involvement of agricultural land in the turnover and the development of the reclamation complex of the Russian Federation was approved. The main purpose of the Program was to collect and systematize data on agricultural land. The main priorities and goals of the state policy in the field of effective involvement of agricultural land into the turnover and the development of the reclamation complex of the Russian Federation have been defined as follows:

- restoration and improvement of fertility of agricultural lands, prevention of reduction of agricultural land areas, rational use of such lands, protection and conservation of agricultural lands from water and wind erosion and desertification;
- Improvement of agricultural land turnover;
- Expansion of agricultural crops at the expense of unused arable land;
- increasing exports of agricultural products;
- providing the population with high-quality and safe food products.

After the collapse of the USSR, a qualitative assessment of productive agricultural lands, a comprehensive on-farm assessment of land by fertility, location and technological properties of land plots were not carried out. The assessment of the composition of agricultural lands was not carried out not only by forms of ownership, but also by land, the degree of manifestation of degradation processes (water erosion, deflation, salinization, etc.), cultural and technical conditions. As part of the implementation of the Concept of State Monitoring of changes in the qualitative and quantitative condition of agricultural lands, the Unified Federal Information System on Agricultural Lands and lands used or provided for agriculture as part of lands of other categories was put into operation, the basis for the formation of which is the data obtained during the monitoring of agricultural lands.

It was found that during the period from 2010 to 2020, the area of agricultural land in the Russian Federation decreased from 400.0 million hectares to 382.4 million hectares (by 17.6 million hectares or 4.6%) (RSUALRF, 2022). The total area of agricultural land fields, information about which is included in the Unified Federal Information System on Agricultural Lands according to the results of the state land monitoring in 2021, amounted to

197,498.179 thousand hectares, or 51.87% of the total area of agricultural land in the Russian Federation (RSUALRF, 2022).

A critical factor that significantly influenced the increase in the area of unused agricultural land was the reorganization of collective farms, consisting in the issuance of land shares to former employees of such farms. The result of this process was a large number of unclaimed land shares that were eliminated from agricultural turnover. Most often, users pay attention to the problem of unreliability of information that comes to the Unified Federal Information System on Agricultural Lands. For this reason, based on the results of the implementation of the measures of the State Program for effective involvement of agricultural land in turnover and the development of the reclamation complex of the Russian Federation, it is planned to create a multi-layered digital model of agricultural land (arable land, perennial plantations, forage land, non-agricultural land) to display information in a single digital map of the boundaries of agricultural land, including the boundaries of agricultural land according to Rosreestr; to form a state register of agricultural lands, containing a set of reliable systematized information about the state of agricultural lands and their use; to create a passport of a land plot from the composition of agricultural lands.

It is also planned to use artificial intelligence technologies, including the development of functionality for analyzing and determining the composition of crops and assessing the area of crops, the beginning of harvesting and the progress of its implementation, with the possibility of comparing the assessment of such work, non-use of agricultural land, and reporting based on the data obtained (RSUALRF, 2022).

The purpose of the study was to assess the difficulties in determining the qualitative and quantitative characteristics of agricultural land in the Kemerovo region.

2. Materials and Methods

Object of research

For the analysis, materials and data from state funds of data obtained as a result of land management were used that are provided by branches of the public law company Roskadaster in accordance with the Administrative Regulations of the Federal Agency for Real Estate Cadastre for the provision of public services "Maintaining the state fund of data obtained as a result of land management" approved by the order of the Ministry of Economic Development and Trade of the Russian Federation dated 11/14/2006 No. 376. The materials are presented in the form of copies:

1) 1:10000 scale digital cartographic material for the Kemerovo municipal district of the Kemerovo region – Kuzbass, made in 1995 by the All-Russia Institute of Agricultural Aero-Photo-Geodesic Studies, Siberian branch (11 map-boards, 22 files);
2) 1:10000 scale cadastral map (land cadastre) of the Lugovoye CJSC of the Kemerovo district of the Kemerovo region, made in 1995 by Roskomz Zapsib NIIgiprozem Kemerovo Enterprise;
3) Materials of land management of the lands of the fund for redistribution of JSC Lugovoye (CJSC Istok) Kemerovo region, Kemerovo region, 2005, manufactured by JSC "Kemerovo Giprozem";
4) Materials on the transfer of land to the jurisdiction of the Starochervovsky Rural Council of People's Deputies of the Kemerovo district of the Kemerovo region, 1991, made by Zapsibgiproz, Kemerovo branch;
5) Materials on the redistribution of lands of JSC Lugovoye of the Kemerovo region of the Kemerovo region, 1996, produced by the Committee on Land Resources and Land Management of the Kemerovo region;

6) On-farm assessment of the lands of the state farm "Lugovoy" of the Kemerovo district of the Kemerovo region, 1991, made by Zapsibgiprozem, Kemerovo branch;
7) Soil survey of CJSC Lugovoy of the Kemerovo district of the Kemerovo region, JSC Kemerovo Giprozem, 1995;
8) Technical report on the correction of the materials of the soil survey of CJSC Lugovoye of the Kemerovo district of the Kemerovo region, 2004, JSC Kemerovo Giprozem;
9) The project of land management (land redistribution) of the Lugovoy state farm in the Kemerovo region of the Kemerovo region, 1992, Zapsibgiprozem. Kemerovo branch;
10) Information from the Unified state Register of Real Estate (EGRN), in the form of cadastral plans of territories 42:04:0216002 (KUVI-001/2024-145737680); 42:04:0216003 (KUVI-001/2024-145737833), 42:04:0216004 (KUVI-001/2024-145737449); 42:04:0000000 (KUVI-001/2024-112185570).

Regulatory documents and materials of the report on the condition and use of agricultural lands of the Russian Federation in 2021, prepared by the Ministry of Agriculture, and sources of scientific literature were also used for the analysis.
Data processing and graphical constructions were carried out using a free desktop geographic information system with open source QGIS in the format (SHX, PRJ, DBF, CPG) and MapInfo (MapInfo Corp., 12.0, USA) in the format (mif/mid, tab).
A Public cadastral map https://pkk.rosreestr.ru/ was used to collect reference literature; the state information system "Kuzbass Regional Geoinformation System" on the basis of license agreement No. 1 dated 06/05/2024, concluded with the Ministry of Digital Development and Communications of Kuzbass (hereinafter - GIS Kuzbass).

3. Results

When conducting cadastral and/or research work on agricultural land, a special role is assigned to collecting information on the quantitative characteristics of agricultural land in combination with the qualitative characteristics of agricultural land which complement objective information about it (Kalashnikov and Kulik 2019).

The basis of the Unified Federal Information System on Agricultural Lands (EFIS ZSN) is the digitization of data from state archives containing information on materials on land redistribution and the issuance of land shares to former employees of farms, materials for land management of land redistribution funds (state lands), on-farm land assessment, soil survey materials, cadastral maps (land cadastre), etc. All materials stored in state archives have legal significance when approving projects for agricultural land demarcation and when carrying out cadastral works in relation to agricultural lands.

The use of unreliable data, carrying out work on agricultural land in violation of the requirements of federal lawleads to a lot of litigation and creates absurd situations. Thus, when clarifying forestry lands (Figure 1), projects of redistribution funds were not taken into account or partially "forested" agricultural lands were included in the boundaries of forestry land plots.

Figure 1: The intersection of the forest fund land plot (red border) and part of the agricultural land of the redistribution fund (blue border).

Source: KemSU collection.

When approving the master plans of municipalities and the boundaries of settlements by local governments, projects of funds for the redistribution of agricultural land and materials for the redistribution of land were not taken into account, which leads to the inclusion of agricultural land in the boundaries of settlements (Figure 2).

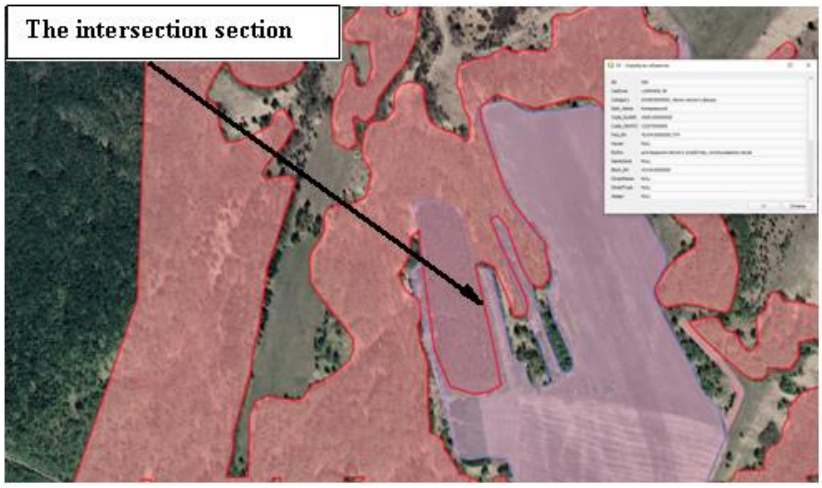

Figure 2: The intersection of the boundaries of the settlement (red border) and part of the agricultural lands of the redistribution fund (blue border). The village of Starochervovo, Kemerovo region-Kuzbass, Russia.

Source: KemSU collection.

Local governments provide land plots for horticultural non-profit partnerships (horticultural co-operatives, etc.), agricultural land from the lands of redistribution funds, which they do not have the right to dispose of. Which causes legal disputes. Agricultural lands may not be included in the boundaries of the territory of gardening by citizens for their own needs, as well as used for the construction of garden houses, residential buildings, outbuildings and garages on a garden plot. When carrying out cadastral works (Figure 3), cadastral engineers do not include non-agricultural land, which is also part of agricultural land (land occupied by on-farm roads, reclamation protective forest plantations, water bodies) in the contour of an agricultural land plot.

Figure 3. An example of the exclusion of an on-farm road from the boundary of agricultural land (red line).

Source: KemSU collection.

The lack of a unified information system with an up-to-date analysis of archival materials creates a legal collapse and does not allow government agencies at all levels to promptly and accurately approve documentation on agricultural land (Cui et al. 2024). Unfortunately, in order for an official to independently identify unreliability of the information or documents provided, they must have access to state archives and the qualifications of a land surveyor or cadastral engineer. Moreover, even most of the specialists who have special qualifications, but do not have experience working with agricultural land, may incorrectly determine the ownership of a land plot. Therefore, even with the declarative nature and a point-based approach in determining the boundaries of agricultural land, errors occur, which leads to a reduction in the area of agricultural land.

The approach of filling EFIS ZSN through authorized users, including state monitoring, but without digitizing state archives will not allow the creation of legal agricultural plots. Digitization of archives should have a massive and centralized approach (Minai et al. 2022), and the use of EFIS ZSN or its replacement programs at the regional level should be mandatory for all levels of government involved in the provision and monitoring of agricultural land. Digitization of archival materials is the first step towards determining the quantitative characteristics of agricultural land (Krotov et al. 2017).

After digitizing the archives and vectorizing the data in the form of defining the contours of agricultural land, it is necessary to develop a methodology to determine the possibility of putting these lands into turnover. A large proportion of agricultural land is currently "forested" (overgrown with woody and shrubby vegetation (Figures 4-5) or "heavy" (overgrown with weeds and unused for a very long time) fallow land. The methodology should determine the expediency and economic efficiency of the introduction of such lands

into turnover. Perhaps, in relation to some "former agricultural" lands, it would be more rational to initiate transfer procedures to the lands of the forest fund.

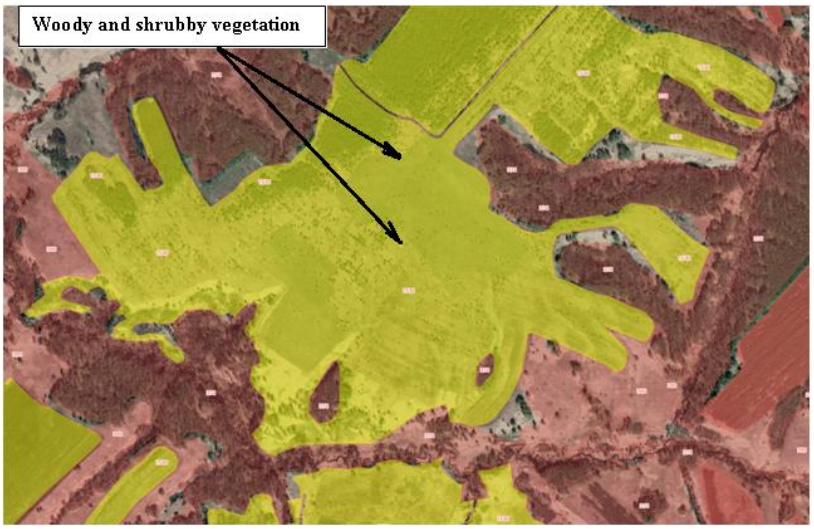

Figure 4: An example of overgrowing with woody and shrubby vegetation of an agricultural land plot (private property, Kemerovo Region, Kemerovo district, within the boundaries of the Lugovoye CJSC (Istok CJSC), the boundaries are established in accordance with current legislation)
Source: KemSU collection.

Figure 5: An example of overgrowing with woody and shrubby vegetation of an agricultural land plot, the boundaries of which are not established in accordance with current legislation (lands of the redistribution fund, Kemerovo Region, Kemerovo district, within the boundaries of the Lugovoye CJSC (Istok CJSC))
Source: KemSU collection.

4. Discussion

For the effective use of agricultural land, first of all, it is necessary to define the boundaries of land plots as objects of rights by defining legally drawn borders, assigning a cadastral number and determining the right holder or managers on the part of the state, that is, it is very important to identify the object. This is the first stage – the quantification of land. The second

equally important stage is the determination of the qualitative characteristics of agricultural land.

The qualitative characteristics of agricultural land should be linked to an identified object, that is, to a land plot with a cadastral number. Taking into account the condition and properties of soils directly affects the food security of the state. With such a combination of "management object – quality of management object", it is possible to implement a part of the state program related to the creation of a passport of a land plot from agricultural land.

In the Russian Federation, there is no uniform methodology for assessing the suitability of unused agricultural land (Rabia and Terribile 2013; Taghizadeh-Mehrjardi et al. 2020) for its involvement in agriculture. The most common method is to conduct surveys on the degree of overgrowth of unused land plots with woody and shrubby vegetation, as well as agrochemical indicators, however, to assess the feasibility of putting land plots into circulation, a number of additional factors should be taken into account, reflecting the qualitative characteristics of soils and their potential fertility, as well as terrain features, slopes, watersheds and other indicators.

Agricultural lands and non-agricultural lands are distinguished as part of agricultural lands. At the same time, in the process of determining quantitative and qualitative characteristics, agricultural land is of greater importance, but if location determination is not taken into account and non-agricultural land is not included (on-farm roads, reclamation protective forest plantations, etc.), the suitability of agricultural land can significantly decrease. Reclamation protective forest plantations are of great importance for improving the quality characteristics of soil fertility.

Agricultural lands: arable land, hay fields, pastures, deposits, lands occupied by perennial plantations (orchards, vineyards and others) - as part of agricultural lands have priority in use and are subject to special protection.

Arable land has the highest economic productivity. Arable land is used for sowing crops, perennial grasses. For the productive use of this category of agricultural land, it must be cultivated annually.

According to the data of the subjects of the Russian Federation, as of 01.01.2022, 7.7 million hectares, or 41.3% of unused arable land, are affected by overgrowth with woody and shrubby vegetation (RSUALRF, 2022). Non-use of agricultural lands entails the loss of their fertility or repeatedly increases the cost of restoration to a condition suitable for the resumption of agricultural production.

The task of removing unused plots and putting them into agricultural circulation is complicated by the lack of up-to-date and reliable information about unused plots in the structure of agricultural land, their location and boundaries, quality condition, and land owners. Because of this, in order to obtain a complete picture of the spread of unused lands, the results of work on the identification and inventory of unused plots on agricultural lands carried out in the subjects of the Russian Federation, including using data from satellites and unmanned aerial vehicles (UAVs), become especially important. According to the generalized information of the subjects of the Russian Federation, as of 01.01.2022, the area of unused arable land is 18.65 million hectares, or 16.1% of the total arable land area, and 56.4% of unused agricultural land in the country (RSUALRF, 2022).

The determination of the qualitative characteristics of agricultural land can be conditionally divided into two stages:

1) determination of qualitative characteristics without field trips and field surveys or with a minimum number of field trips (for example, for take-off and landing of UAVs):

- the degree of overgrowth of unused land plots with woody and shrubby vegetation, terrain features, slopes, watersheds (remote technologies);

- destruction of soil cover, pollution and littering of land with industrial and household waste due to anthropogenic influence (remote technologies);
- determination of soil types (data from the state data fund after digitization and vectorization of the data array);

2) Determination of agrochemical, chemical and toxic parameters, potential fertility and other indicators (laboratory studies of soil samples from territories).

It should be noted that the soil type does not change over time, however, negative processes lead to degradation of the soil cover, deterioration of soil composition and, as a result, a decrease in the quality characteristics of agricultural land. It is believed that the main negative processes leading to soil degradation include water and wind erosion (deflation), waterlogging, flooding, salinization, compaction and hardsetting, dehumification (Varlamov 2003). Erosion is one of the most dangerous types of degradation, causing soil destruction and loss of fertility.

5. Conclusion

To update information about agricultural lands, it is necessary to generate reliable and up-to-date information about the quantitative characteristics (boundaries of agricultural lands) and qualitative characteristics of agricultural lands involved in agricultural turnover as a digital information system integrated with the Unified State Register of Real Estate.

The determination of the quantitative characteristics of agricultural lands should be carried out taking into account the legal values of documents approved by land management materials stored in state archives containing information on materials on land redistribution and the issuance of land shares to former employees of farms, land management materials of land redistribution funds (state lands), on-farm land assessment, soil survey materials, cadastral maps (land cadastre), etc.

The qualitative characteristics of agricultural land must be linked to an identified object, that is, to a land plot with a cadastral number, only with such a combination of "management object – quality of management object" can effective management of agricultural land resources be achieved.

Updating information should not be declarative in nature, but should be solved comprehensively. All the archived and up-to-date information obtained on the qualitative and quantitative characteristics of agricultural lands must be integrated with the information of the Unified State Register and turned into a "live" working software product. The use of such a software product (such as EFIS ZSN or programs replacing it at the regional level) must be mandatory at all levels of authorities engaged in the provision and monitoring of agricultural land. Only under such conditions it is possible to effectively manage and bring unused agricultural land into circulation. The figures (areas of agricultural land) on paper and in the reports of the subjects of the Russian Federation must be converted into real areas of agricultural land.

Funding

The study was carried out with the financial support of the Ministry of Science and Higher Education of the Russian Federation within the framework of the agreement (No. 075-15-2022-1195, September 30, 2022) on the provision of grants from the federal budget in the form of subsidies.

6. References

1. Purcell, W., Neubauer, T., and Mallinger K., (2023). Digital Twins in agriculture: challenges and opportunities for environmental sustainability. Current Opinion in Environmental Sustainability, 61, 101252.https://doi.org/10.1016/j.cosust.2022.101252.
2. Haughey, E., Neogi, S., Portugal-Pereira, J., van Diemen, R., and Slade R.B., (2023). Sustainable intensification and carbon sequestration research in agricultural systems: A systematic review. Environmental Science & Policy 2023, 143, 14-23. https://doi.org/10.1016/j.envsci.2023.02.018
3. Chupina, I.P., Zarubina, E.V., Simakova, N.N., Zhuravleva, L.A., and Fateeva, N.B., (2023). Monitoring of agricultural lands: problems and prospects for improvement. International Agricultural Journal, 7(4). https://doi.org/10.55186/25876740_2023_7_4_15
4. Maglinets, Yu.A., Raevich, K.V., and Tsibulskii, G.M. (2017). Knowledge-based geoinformation technology for evaluation of agricultural lands. Procedia Engineering, 201, pp. 331-340.
5. Kalashnikov, K.I., and Kulik, E.N., (2019). The use of archival land survey data at study the status of agricultural land according to remote sensing. Interexpo GEO-Siberia, 4(2), pp. 221-228.
6. Cui, Y., Dong, J., Zhang, C., Yang, J., Chen, N., Guo, P., Di, Y., Chen, M., Li, A., and Liu, R., (2024). Validation and refinement of cropland map in southwestern China by harnessing ten contemporary datasets. Scientific Data, 11, 671. https://doi.org/10.1038/s41597-024-03508-5.
7. Minai, J.O., Schulze, D.G., and Libohova, Z., (2022). Renewal of Archival Legacy Soil Data: A Case Study of the Busia Area, Kenya. Frontiers in Soil Science, 1, 765248. https://doi.org/10.3389/fsoil.2021.765248.
8. Krotov, D., Samsonova, V., and Voronin, V., (2017). The use of archival maps for the monitoring of agricultural land. Mechanization in agriculture & Conserving of the resources, 63(5), pp. 183-184.
9. Taghizadeh-Mehrjardi, R., Nabiollahi, K., Rasoli, L., Kerry, R., and Scholten, T., (2020). Land Suitability Assessment and Agricultural Production Sustainability Using Machine Learning Models. Agronomy, 10, 573. https://doi.org/10.3390/agronomy10040573.
10. Rabia, A.H., and Terribile, F., (2013). Introducing a New Parametric Concept for Land Suitability Assessment. International Journal of Environmental Science and Development, 4(1), pp. 15-19.
11. RSUALRF, (2022). Report on the state and use of agricultural lands of the Russian Federation in 2021. Moscow: FSBI “Rosinformagrotech”. (In Russ.).
12. Varlamov, A.A., (2003). Land Management. Moscow: State University of Land Management.