Algorithm for identifying unused agricultural land

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Abstract. The article deals with an algorithm for identifying unused agricultural lands for their involvement in economic turnover. The research objects are the Yaroslavl region and the Smolensk region of the Russian Federation, where the share of unused agricultural land makes from 12 to 50 %. The article presents the methods of land inventory aimed at finding out the reasons for land withdrawal from active economic turnover, evaluating cultural and technical condition of land and giving recommendations for the introduction of land into agricultural turnover. The methods of estimating capital costs for involving land in active economic turnover have been suggested.

1. Introduction

According to the data of the Ministry of Agriculture of the Russian Federation, published in the Kommersant newspaper (No. 3 (6724) of 11 January 2020), the area of unused agricultural lands amounts to 52.2 million hectares, and the area of the lands withdrawn from active economic turnover amounts to about 44 million hectares, including 20 million hectares of arable lands. By comparison, these lands cover an area larger than that of the vast majority of European countries. On the one hand, even such a large figure within our country makes only 13.6 % of all agricultural lands (according to the Ministry of Agriculture of the Russian Federation). On the other hand, firstly, the situation is complicated by uneven withdrawal of agricultural lands in different regions. Secondly, this figure is not final, since the analysis of data provided by other organizations, such as the Federal Register shows that the percentage of unused lands in a number of regions is significantly higher than according to the Ministry of Agriculture.

Another important and sometimes determining point is the method of defining agricultural lands as unused. Decree No. 369 of 23 April 2012 of the Government of the Russian Federation has approved the list of features of land plots' non-use for conducting agricultural production or implementation of other activities related to agricultural production. This provision gives the following specifications regarding arable lands: 'forest and bush coverage makes more than 15 % of a land plot on the arable land', and 'works on crop cultivation and soil treatment are not performed on arable lands.' Based on the above, it can be concluded that up to 15 % of arable lands (in the case of forage lands – up to 30 %) can actually be withdrawn from active turnover, but at the same time, according to documents, these lands can be considered to be used. The wording 'to perform works' allows for different interpretations and does not let us state unequivocally that these lands are in active agricultural turnover. Materials of the research carried out by specialists of the State University of Land Use Planning in the course of inventory of agricultural lands in the Yaroslavl and Smolensk regions in 2017–2019 years [1–6] prove that the used agricultural lands should be further divided into
intensively, partially and conditionally used. Table 1 shows the results of the inventory of Kasplyanskoe and Divasovskoe rural settlements in the Smolensk region.

### Table 1. Classification of agricultural lands by the extent of use

| No. | Extent of agricultural land use     | Area of agricultural lands of rural settlements, ha |
|-----|------------------------------------|--------------------------------------------------|
|     |                                     | Kasplyanskoe | Divasovskoe |
| 1   | Intensively used                    | 320.00       | 1000.00     |
| 2   | Partially used                     | 550.00       | 250.00      |
| 3   | Conditionally used                 | 558.96       | 1243.43     |
| 4   | Withdrawn from active turnover     | 1523.50      | 348.47      |
|     | Total area of lands                | **2952.46**  | **2841.90** |

As can be seen from Table 1, 48 % and 88 % of agricultural lands of Kasplyanskoe and Divasovskoe rural settlements, respectively, belong to the used lands. At the same time, 11 and 35 % of agricultural lands of Kasplyanskoe and Divasovskoe rural settlements, respectively, are in active economic turnover.

2. **Materials and methods**

Identification of unused agricultural lands should be carried out in the course of full routine inventory [2–4]. According to Article 13 of Federal Law No. 78 'On land management', land inventory is carried out to identify unused and irrationally used land plots as well as lands used not for the intended purpose and not in accordance with the permitted use of land plots, and other characteristics of land. When identifying unused agricultural lands, other land characteristics should firstly be understood as the reasons for land withdrawal from active economic turnover, cultural and technical condition of lands and primary recommendations for the introduction of land into agricultural turnover.

It is advisable to conduct full routine inventory in three main stages: preparatory work, field research, and in-house data processing.

During the preparatory stage, it is necessary to collect all available information about an object being inventoried, primarily cartographic material. Both the land use by an agricultural organization and a municipality can be considered as an inventory object. Projects of on-farm land management, territory organization, land redistribution and some others should serve as the initial data for conducting inventory. Materials of soil, geobotanical and other studies, cadastral and administrative maps, as well as materials of previous inventories should also be taken into account. The next step should consist in vectorizing collected planning and mapping material and bringing it to a single scale and coordinate system. It is advisable to use the local coordinate system for maintaining the Unified State Register of Taxpayers.

As for a single scale, it should be determined at the most small-scale map used in the course of the inventory. This choice of a single scale is conditioned by the fact that when you zoom in, the information contained on small-scale maps will be reflected incorrectly on larger-scale maps. The second option is also possible, and in this case the scale is set by the requirements for inventory materials, and all map material made on a smaller scale can be used solely as a reference material. Bringing coordinate systems and map scales into accordance requires using both global and local methods of transformation including the Helmert method and the Molodensky method. The preparatory work results in a multi-layer digital map that reflects the state of the object being inventoried as of the year of the oldest cartographic material used in creating such a map. A digital map is a digital cartographic model, the content of which corresponds to the content of a map of a certain type and scale. GOST 28441-99. Interstate standard. Digital cartography. Terms and definitions (enacted by Decree of the State Standard of Russia on 23 October 1999 No. 423-st). As a rule, the resulting digital map reflects the reality of the early or mid-1990s. Data from the public cadastral map of the territory being inventoried should be represented as a separate layer [1, 2, 7].
Field research is carried out to clarify and correct existing cartographic material or create a new one if during the preparatory work it is revealed that no reliable maps or plans have been preserved on the territory under study. In the course of field research, a land survey is carried out with the preparation of acts for each individual plot or array of agricultural lands. Area survey can be carried out using geodesic methods or satellite geodesic measurements (constructions), as well as using unmanned aerial vehicles. Vectorized satellite images of the area can also be used to create plans for an inventory object as of the year of land development [8–10]. When using satellite imagery, one should take into account that free images are usually provided with a delay of several years. There are a lot of paid resources, but the cost of images significantly affects the overall cost of inventory. This is especially important when there is need to inventory land use with a large number of extraneous land plots belonging to other categories, and it is not possible to purchase materials only for part of the territory. It is also important to take into account that part of the territory where satellite images are ordered may be hidden by clouds, which will make it difficult to produce orthophotographic plans and vectorize objects. Based on the above, when inventorying agricultural lands, it is most often advisable to use free satellite images only as reference (additional) material. Satellite images can be effectively used as the main source of information for inventory of forest land or lands of all categories with a significant area of the object being inventoried.

At the third stage, the already formed digital map of the land use being inventoried is supplemented with new layers. First of all, it is a land use plan as of the year of land development. Using the method of comparison, lands that have been removed from active agricultural turnover are allocated. A separate procedure of allocation based on cadastral maps is carried out with regard to land plots included in the economic turnover not in accordance with the permitted use, i.e. with violations. The reasons for land withdrawal should be then determined and represented graphically. As a rule, the main reasons include small scale, remote land, low productivity of land and lack of access roads, etc. For each contour of unused land, the cultural and technical condition is determined, weed-covered, wooded, swampy, stony and other areas are identified, and the ways to involve withdrawn lands in active turnover are analyzed and evaluated. If necessary, other layers can be included in the created map, such as a map of categories of erosion-hazardous lands, a map of zones with special conditions of using territories, etc.

3. Results and Discussion

Even the most complex, picturesque and scientifically based project is not self-sufficient, it is not a goal in itself. It should be evaluated in terms of effectiveness and expediency. Today, scientists emphasize that it is not necessary to simultaneously introduce all unused agricultural land into agricultural turnover at any cost [11–15]. The task consists in identifying the most promising lands for use and developing the stages of their involvement in economic turnover. To do this, the cost of involvement and the payback period for each land plot or array of agricultural land are calculated on the basis of obtained cartographic material. Involvement of unused land in the turnover is a whole set of measures. First of all, it is necessary to improve cultural and technical condition: deforestation or mulching, uprooting, removing stumps, hummocks, stones, drainage, etc. Then, deep plowing with cutting the sod and fertilizing are required. Sometimes other measures such as liming and plastering are necessary.

The payback period is defined in a standard way – as the ratio of total capital investment in the project to the average annual net income [4, 6, 7].

After determining the main economic indicators, it is necessary to establish the stages of land involvement in active agricultural turnover. According to the methodology developed in the State University of Land Use Planning, it is advisable to apply one of the three main principles. At the first stage, the most fertile land plots are selected in order to ensure maximum production of agricultural products in the shortest possible time. The second principle implies involvement of land plots requiring minimal investment for development. This principle allows for the same initial investment to involve the maximum amount of land in active economic turnover. The third principle entails
involvement of land plots that are as close as possible to existing settlements, production centers and roads of regional significance, thereby minimizing transport costs, both during development and use of land plots. The choice of principle is made on a case-by-case basis after comparing the options and carrying out comprehensive economic analysis.

4. Conclusion
Unused agricultural lands is a huge reserve of the agro-industrial complex of the Russian Federation and their identification and development is one of the priority tasks in the field of land management. Russia has steadily become a leader in grain production, the country's food security problem is being solved, and the agricultural sector of the economy occupies a worthy place in the formation of the country's budget. Development of withdrawn lands is an important tool for stimulating the economies of a significant number of Russian regions. At the same time, the process of involving such lands in active agricultural turnover requires an individual and very careful approach. These works require significant financial expenses. The studies by the State University of Land Use Planning conducted in the Yaroslavl and Smolensk regions show that the average cost of involving one hectare of land in active agricultural turnover makes 35,000–37,000 rubles, with an average payback period of 8–10 years. The Ministry of Agriculture of the Russian Federation has developed a draft state program for the involvement of agricultural lands in the turnover and development of the reclamation complex in 2021–2030. The program implies the involvement of at least 12 million hectares by the end of this period, as well as the collection and systematization of data on 383 million hectares of agricultural land. The inventory of 10,000 hectares of land can be carried out by three specialists within 3–4 weeks under the abovementioned scheme: preparatory work – field research – in-house data processing. Thus, the inventory of 383 million hectares requires about 2 million man-days. The comprehensive approach may reduce labor costs by 50%. To carry out work on identifying unused agricultural lands for their involvement in active economic turnover, at least in their technical and field parts (digitization of planning and cartographic material and land management surveys), it is advisable to engage student land management teams under the guidance of practicing land managers. This practice was applied by the State University for Land Use Planning when conducting an inventory of agricultural organizations in the Borisoglebsky district of the Yaroslavl region and in the Smolensky district of the Smolensk region.

5. Acknowledgments
The article is prepared with assistance of a grant of the Ministry of Education and Science (The agreement of December 10, 2019 No. 075-15-2019-1939. Unique identifier of the project RFMEFI60719X0302).

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