Technology of specialized zoning of agricultural land for the purpose of their effective use

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Abstract. The article presents the technology of specialized zoning of agricultural land on the example of the Lubinsky municipal district of the Omsk region. It is noted that when organizing zoning, it is necessary to correctly identify the most important parameters that determine the leading direction of activity. It is proposed to carry out specialized zoning of agricultural lands for the purposes of their effective use in three stages, with each of the stages being the basis for the next. According to the indicators presented in the article, it is advisable to identify areas that will help assess the objective situation when planning production. These zones are represented by homogeneous complexes of signs and properties that determine the identity of ways to increase land fertility and give approximately the same effect at a certain level of use. Within the allotted zones, proposals for the preferential use of land are presented. In conclusion, it is indicated that the zoning carried out allows us to identify the potential of land resources for the implementation of efficient agricultural production. Zoning must be carried out using GIS technologies, the use of which will greatly simplify the work with information and cartographic databases.

Under conditions of the complexity of the land as a factor in agricultural production, zoning cannot be a one-time event and consists of carrying out a number of successive specialized stages of zoning, which ultimately allows the formation of homogeneous zones of the complex influence of quality on agricultural production [1].

It is proposed to carry out specialized zoning in three consecutive stages. Each stage will be an independent part, which is of separate importance in organizing the use and management of land resources, but also will be the basis of the following.

Zoning is recommended for individual agricultural organizations on a cartographic basis at a scale of 1: 25000. In this case, the scale accuracy is 2.5 m. From the data on the zoning levels of individual agricultural organizations, the total zoning of lands on the territory of the district is formed.

The first stage is zoning based on the signs of natural and ecological suitability of land for various areas of use.

1. The first step in the context of this stage is to establish the values of the indicators chosen for zoning: granulometric composition of soils, humus content, soil reaction, the depth of groundwater, the degree of erosion, salinization, waterlogging. The generalizing parameter of the considered soil indicators is the bonitet score. The most favorable climate is the southern forest-steppe. In addition, in this zone, the intensity of agriculture is traditionally high, therefore, there is the highest productivity per
1 point of natural fertility bonus [2]. Each indicator affects the boundaries of the allocated zone, partially and in combination of factors. This confirms the need to allocate zones taking into account, at the first stage, primary indicators, and subsequently generalizing indicators.

2. Indicators of land properties and conditions of its use differ in the degree of manifestation in the territory, therefore it is necessary to establish the influence of all indicators on the effectiveness and efficiency of production on the basis of correlation and regression analysis - this is the second step, in the context of this stage.

3. The use of selected indicators in the planning of agricultural production is applied to a limited extent. However, these indicators allow the formation of generalizing characteristics such as a bonitet score, according to which zoning is necessary, as this directly affects crop yields.

Having examined the characteristics of the selected indicators, it is clear that they differ. In this regard, it is advisable to identify zones that will help assess the objective situation in the subsequent production planning - this is the third step, in the context of the first stage.

Granulometric composition (GMC), soil humus content is established in the integrated work with the soil map of the district and materials from the technical report on the adjustment of soil survey materials. The determination of GMC in each area (figure 1) is carried out by visually overlay of soil differences on the base selected for zoning - field system.

In a complex work with the soil map of the region and the data of soil scientists by studying the soil difference and determining the pH within the boundaries of each site, the reaction parameter of the soil medium is established.

The level of groundwater occurrence, the degree of salinization, overwatering and eutrophication is established in the complex work with the soil map of the district and materials from the technical report on the adjustment of soil survey materials. Next, the value of each of the parameters is set within the boundaries of the established sections and zoning is performed. Figure 2 shows a zoning map for the indicator of the depth of groundwater.

Figure 1. Zoning of the territory in terms of soil texture.  
Figure 2. Zoning of the territory in terms of depth of ground water.

The boundaries of the identified zones according to soil parameters vary within the region. A clear repeat of the boundaries of the zones for the studied parameters is not observed. Detailing signs in the selected zones allows you to outline measures to eliminate negative processes, increase soil fertility, which ultimately leads to increased production efficiency.

The degree of suitability of land is determined on the basis of data on the quality of land, the intensity of negative processes, the potential for their use for the main agricultural land, taking into account data on soils.
The first fundamental condition for the use of land is the natural suitability of land for cultivating crops.

Land of high suitability is characterized by a yield of more than 50% of the potentially achievable, obtained under optimal conditions in the absence of special material costs. They are suitable for the cultivation of a wide range of crops, with minor restrictions that are overcome by simple agricultural practices. Cost-effective additional investments are provided.

Land of medium suitability is characterized by obtaining from 20% - 49% of the potentially achievable crop in the absence of additional costs. Suitable for growing field crops, taking into account labor-intensive reclamation work. Investments are needed that are economically viable only under favorable conditions.

Land of low suitability for cultivation of field crops, but suitable for intensive pasture use and forest planting. They are characterized by a high degree of susceptibility to erosion, waterlogging, and strong salinization. After complex hydraulic engineering reclamation may be suitable for cultivation of crops.

Determining the degree of suitability of land, taking into account the agroclimatic potential, affects the development of the regional grain market [3]. Table 1 below presents the area of agricultural land by degree of suitability.

| Degrees of suitability | Farmland (ha) | % | Arable land (ha) | % | Fodder land (ha) | % |
|------------------------|---------------|---|-----------------|---|-----------------|---|
| High                   | 40308.4       | 64.5 | 36836.4         | 66.8 | 3472           | 45.8 |
| Medium                 | 10252.2       | 16.3 | 8152.2          | 14.7 | 2100           | 27.8 |
| Low                    | 12208.4       | 19.2 | 10210.4         | 18.5 | 1998           | 26.4 |
| Total                  | 62769.0       | 100 | 55199           | 100 | 7570           | 100 |

The suitability of land for agricultural use, taking into account their natural potential, varies significantly across the region. For the south and southeast of the region, this shows the uneven manifestation of degradation processes, for the north, west and center it is more related to the initial potential of soils on the lands used for arable land.

Large agricultural organizations of the region, included in any territory according to their degree of suitability, represent a zone displayed graphically.

Within the allotted zones, proposals for the preferential use of land are recommended.

The analysis of the conformity of land to the allocated zones in the region, and the authors' assessment of the distribution of land by zones, in the scale of agricultural organizations of the district (table 1) show that about 64.5% of agricultural land and 66.8% of arable land are located on the most fertile soils, which says mainly on the conformity of the distribution of agricultural land to the quality of land and its suitability.

The quality of land actually determines the main elements of the zonal economic structure: forms of ownership and management, specialization and volume of production, composition of land and crops.

The final stage of the first stage of zoning according to natural conditions (according to suitability) is their corresponding mapping, in which individually additional features of the plots available in the soil survey materials are taken into account. For the development of standard technologies for land use and cultivation, sites are united by similarity and difference in zones. These zones are presented as homogeneous complexes of signs and properties that determine the identity of ways to increase land fertility and give approximately the same effect at a certain level of use.

The second stage of specialized agricultural zoning is zoning based on land use efficiency.

The basis of zoning for economic suitability is also the variety of properties of the study area. 1. The first step in the context of this stage is the selection and justification of significant criteria for zoning on the basis of the effectiveness of land use. By studying more precisely, the individual properties of the allocated zones can provide increased production efficiency.
2. The second step was to establish the degree of influence of each attribute on the productivity and production efficiency, based on the correlation and regression analysis of land use in the forest-steppe zone of the Omsk region. He made it possible to determine the combined effect of many interrelated and simultaneous operating features, as well as the individual effect of each feature on the economic process [1].

3. Regression analysis was a kind of logical continuation of the correlation analysis, it helped to determine the analytical expression of the relationship of the resulting value with factor indicators.

4. The considered factorial and effective indicators of the effectiveness of the use of agricultural land for more reasonable planning, it is advisable to reduce to a single aggregate indicator (level), which will allow you to move from different units of measurement to universal relative and show the economic condition and use of land of these entities.

5. The following significant criteria for zoning based on land use efficiency are contouring, remoteness, and relief. Based on the gradation of the slopes according to the steepness and contour indicators of the lands in the territory of the region, zoning of the territory was carried out.

6. The next step is the zoning of the territory on a generalizing basis - an index of estimated costs for arable plots. It was determined depending on: the granulometric composition of soils, the length of the headland, the distance from the settlement to the field. The remoteness of fields from business centers varies between 1 km - 8 km, which ultimately changes the level of production efficiency due to differences in transportation costs.

Based on materials of on-farm land valuation and information on the development of agricultural production: productivity, cost, and selling price, land use efficiency is determined (through the ratio of profitability and cost) - this is the next step in a more accurate description of the economic condition of land.

The efficiency level for the household is 62%, which characterizes it as average, varies from high to inefficient. This is explained by the high costs, in particular, associated with the great distance from the production centers of the fields.

7. Next, zoning is carried out according to the efficiency parameter with the establishment of the boundaries of the zones on the cartographic material (figure 3).

Business entities included in each interval represent a zone are displayed graphically.

![Figure 3](image.jpg)

**Figure 3.** Zoning of the territory carried out according to the efficiency of land use in agriculture.
The use of land for agricultural production is determined not only by natural and economic suitability, but also by the economic and legal regime of their use - this is the third stage of zoning.

Firstly, zoning according to the suitability of lands that have any restrictions or burdens in use should take into account the area of arable land on which crop cultivation technology is changing, which can lead to reduced productivity and increased costs. If there are such real estate objects as power lines, various pipelines on the territory, their negative effect on the efficient use of land arises. In such cases, the market price of adjacent land should decrease.

The zoning carried out allows us to identify the potential of land resources for the implementation of efficient agricultural production. Thanks to the zones identified by primary zoning indicators, it is possible to outline measures to improve soil fertility and eliminate the negative effects on the territory. These results are necessary for the rational implementation of production development programs and the state fertility program [4,5]. Thanks to the visual reflection of the zones for the costs of cultivating crops and indicators of the index of estimated costs, it is possible to coordinate the implementation of the field work and reduce production costs, which is important for commercial activities.

A multivariate statistical analysis of the use of the land fund of agricultural organizations of the region showed that the adopted zoning only on the basis of climatic and geographical conditions does not fully satisfy the goals of planning and organizing the use of land. The analysis revealed that within each of the natural-territorial zones, subjects with different economic indicators of agricultural production are distinguished [1]. When developing appropriate planning and organization measures for the use of land in the region, it is advisable to identify groups of agricultural organizations that objectively differ in their indicators and this is a platform for a comparative assessment of the effectiveness of their land use.

Zoning of land involves working with large databases. This type of work must be carried out using GIS - technologies that will help to create an information base and cartographic material. During the digital transformation of agriculture in the Russian Federation, the use of GIS technologies is inevitable [6,7,8].

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