Complex agricultural zoning of the territory for assessing the land and resource potential and for production planning

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Abstract. In accordance with Russian laws, agricultural land has priority in use and should be protected. However, arable land varies in quality, even within the same land plot. Applying the method of complex agricultural zoning of the territory of agricultural organizations, the land and resource potential is assessed with the subsequent allocation of specialized zones that allow for determining the value of this potential. Methodological recommendations presented in this article will allow agricultural producers to organize effective agricultural production aimed at sustainable land use development. It is proposed to plan the scale and level of intensification of the use of arable land according to the average annual indicators (with average weather and current economic conditions over 10 years) of spring wheat production. The paper presents possible scenarios for the development of situations for planning production: with an increase and decrease in yield by 20%, with an increase and decrease in the cost of products by 20%, with an increase in production costs by 10%. After the calculations were completed, each plot of the agricultural organization was assigned to groups according to the efficiency of arable land use: constantly ineffective land (under any conditions); constantly efficient land under any changes in natural and economic conditions; precariously efficient lands. The research substantiates the need to take into account the conditions of land use by means of comprehensive agricultural zoning of the territory to ensure the adoption of effective management decisions on the available arable land. At the same time, improving the quality of land and creating proper conditions for its use is one of the mechanisms for increasing the efficiency of crop production.

1. Introduction
In the market economy, agricultural organizations use lands of different qualitative and quantitative compositions. The heterogeneity of conditions within the same plot leads to significant losses in the yield due to the impossibility of growth, development, ripening, etc. [1]. Consequently, some part of the land does not provide sufficient efficiency to achieve the average regional level of plot yield. As a result of negative processes on vast territories, and the involvement of predominantly marginal lands, the overall level of soil fertility of arable land is declining, despite significant efforts made by the government to maintain and improve it. The restoration of productive forces of the land due to the ongoing degradation processes postpones the period of sustainable land use development [2]. Many scientists make attempts to determine the most promising lands on the basis of the cartographic material [3–5].
In Omsk region, each municipal district has agricultural lands of low quality that do not allow for obtaining the yield of plot crops to achieve the average regional level. Comprehensive agricultural zoning of the territory will make it possible to evaluate and give methodological recommendations to agricultural producers for the effective use of land. The methodological recommendations will contribute to the sustainability of land use, increase the taxable base for the municipality, create new jobs, ensure the socio-economic development of rural settlements, which is important in the context of increasing instability of natural conditions and crisis phenomena in the economy.

2. Methods
The authors present results of a study aimed to conduct a comprehensive agricultural zoning of the territory as an information space for production planning of agricultural organizations.

The main objectives of the study are:
1) assessment of the land resource potential;
2) allocation of specialized zones and resources based on the results of the actual use of land;
3) production planning in conditions of different levels of land quality and agricultural zoning of the territory.

The objects of assessment were lands of agricultural organizations of the Gorky district of Omsk region. The research methods used were the method of scores, the method of balance calculations, the method of expert estimates (the method of "scenarios").

3. Results
The methodological basis for the integrated agricultural zoning of the territory of agricultural organizations is a variety of land and resource potential, which is associated with the heterogeneous properties of the land (thickness of the organic horizon, humus content, particle size distribution, etc.), the required size of fixed assets, the need for labor to ensure its effective use. The proposed methodology can be applied to a region or district for agricultural producers. An assessment of the territory is carried out and zones are identified according to individual indicators characterizing the land-resource potential; specialized zones are then identified. It makes it possible to determine the land-resource potential. The final stage is methodological recommendations for business planning, including land and resource provision for solving the problems of agricultural production development.

The zoning is based on the bioclimatic potential, legal regime of land use, conditions of land use and assessment of its qualitative state, normative indicators of land use. Bioclimatic potential is assessed through the suitability of agricultural lands for the production of specific crops. Land suitability is assessed at the second stage. It includes the formation of agricultural production groups, among which arable soils of the best, good, average and below average levels of quality are distinguished [6]. The cumulative score is defined as the weighted average which varies from 53 to 100 for farms in the Gorky District of Omsk Region. The grouping of soils is as follows: from 96 to 100 points - soils belong to the first group; from 95 to 75 points - the second one; the third one - from 74 to 61 points; the fourth one - from 60 to 53. Four agro groups were formed for Alekseevskoye, Sibir-Agro and Diorit LLCs, two groups were formed for Russkoye Zerno LLC.

The soils of the first and second agro-groups occupy the largest share; for example, in Alekseevskoe - more than 64%, in Sibir-Agro - 74%, in Diorit - more than 81% and in Russkoye Zerno - about 70%; soils of the third and fourth agro-groups, suitable for use as forage lands without restrictions, as well as with restrictions or additional measures, occupy from 1.5 to 32.5%. The suitability of arable land in terms of natural properties is presented in Table 1. The areas of arable lands suitable without restrictions and additional measures are located in Alekseevskoe - 3641 hectares or 42.3%, and Siberia-Agro - 4345 hectares or 37.3%. The proportion of soils of average quality, suitable for arable land with restrictions or additional measures, is different and varies from 21.8 to 67.5%. Measures to preserve, restore and improve the properties of soils (zonal agrotechnics, fertilization, plastering of salt licks spots and their grounding) should be implemented for soils of average quality. Lands suitable for forage (not suitable for cultivation) are distributed as follows: Alekseevskoe - 2141 or 35.9%, Sibir-Agro - 1701 hectares or
25.5%, Diorit - 575 hectares or 1.54%, Russian Plot - 4937 hectares or 32.5%, but in fact these lands are occupied by plot crops.

**Table 1. Suitability of arable land in terms of natural properties by agricultural companies of the Gorky district of Omsk region, hectares %**

| Name of the agricultural company | Total arable land area | Suitable arable land without restrictions and additional measures | Suitable arable land with restrictions and additional measures | Unsuitable arable land |
|----------------------------------|------------------------|---------------------------------------------------------------|-------------------------------------------------------------|------------------------|
| Alekseevskoe LLC                 | 8599/100               | 3641/42.3                                                     | 2817/21.8                                                   | 2141/35.9              |
| Sibir-Agro LLC                   | 11660/100              | 4345/37.3                                                     | 5614/37.2                                                   | 1701/25.5              |
| Diorit LLC                       | 5502/100               | 0                                                             | 4927/63.3                                                   | 575/1.54               |
| Russian Plot LLC                 | 16048/100              | 0                                                             | 11111/67.5                                                  | 4937/32.5              |

Thus, in the Gorky district of Omsk region, suitable, partially suitable and unsuitable lands are involved in the land turnover. This is typical of most districts of Omsk region and other regions of the Russian Federation.

The use of land for agricultural production is determined by the suitability of arable land for its natural properties by establishing the legal status of land [7]. The lands vary by the legal regime: they are leased or owned by agricultural organizations (Table 2).

**Table 2. Distribution of arable land by types of property rights in agricultural organizations, hectares**

| Name of the agricultural company | Total arable land area | Corporate property | Rent from citizens |
|----------------------------------|------------------------|--------------------|--------------------|
| Alekseevskoe LLC                 | 8599                   | 3324               | 5275               |
| Sibir-Agro LLC                   | 11660                  | 1566               | 10094              |
| Diorit LLC                       | 5502                   | 0                  | 5502               |
| Russian Grain LLC                | 16048                  | 9                  | 16039              |
| Total                            | 41809                  | 4899               | 36910              |

Three farms own the land, the largest part of such lands is concentrated in Alekseevskoye, the smallest - in Russkoye Zerno. The variety of land use parameters (size and legal status) creates the need to establish values that ensure the development of agricultural production [8].

Assessment of the conditions of land use is an important stage in the comprehensive agricultural zoning of the territory of agricultural organizations. This assessment involves the calculation and analysis of indicators characterizing the conditions for the quality of the land resource potential of farms, including: labor supply, capital supply, energy supply, supply of fertilizers and remoteness of organizations from the nearest economic centers, legal regime of land use, etc.

In the reports on the financial and economic conditions of agricultural producers, there are no rent costs. Therefore, it is necessary to add rent costs and show how the efficiency of crop production is reduced. With the proposed approach, the reduction in production efficiency varies from 13 to 16% due to rent costs. It can be assumed that the rent period lasts 3-5 years; therefore, agricultural producers have no direct interest in implementing expensive measures aimed at improving the properties of land.

The availability of agricultural machines is different for farms in Omsk region; however, in general, there is a decrease in the number of tractors by 20%, and plot harvesters - by almost 35%; in the Gorky district, these shares are 20 and 30%, respectively. The rate of annual renewal of equipment should be increased by 10%. The disposal of agricultural machinery is reflected in a decrease in the scale in crop production, that is, in land use as a whole.

In the district, there is a tendency towards a decrease in equipment and the total number of workers employed in agricultural production by 26% and 14%, respectively, while an increase in workers employed in crop production by 4% is observed. An increase in labor resources by 12%, including those employed in crop production by 4% was observed only in Russian Plot LLC; for agricultural machinery, a decrease for all farms was 27-46%.
The main factor influencing the change in the land resource potential in Omsk region is weather conditions: two out of five years are dry. The conditions for land use depend on resource availability, territorial organization, production technology and the legal regime for land use. Therefore, dry years lead to negative consequences lengthening the time of technological operations, reducing yields and increasing the amount of losses from agricultural production. To reflect the current use of land (effective indicators of the use of arable land), associated with the value of produced (sold) products, it is necessary to perform a section-by-section land accounting.

Plot contains many nutrients required for vital activity - proteins, carbohydrates, fats [9]. The sectional assessment of arable land aims to determine the production efficiency for each crop in the structure of plot and leguminous crops for a specific year. For this, the average yield for the farm is calculated and proportionally distributed taking into account the quality of soil for each plot, applying a certain yield point, which allows for obtaining the estimated yield of plot crops in proportion to the point. By comparing the cost and production costs, the effect (conditional income) is established with the output on production efficiency (R), which is summarized in Table 3.

### Table 3. Efficiency of using arable land for spring wheat in agricultural organizations of the Gorky district of Omsk region

| Name of the agricultural company | Area, hectares | Efficiency level | constantineffective | unstable effective | stable effective |
|----------------------------------|---------------|------------------|---------------------|-------------------|-----------------|
|                                  |               | constantlyineffective | insufficien
ty effective (<15%) | low-efficient (15%<R<30%) | medium-effective (30%<R<50%) | High-effective (50%<R<100%) |
| Alekseevskoe LLC                 | 5067          | 0                | 0                   | 2990              | 2077            | 0               |
| Sibir-Agro LLC                  | 5287          | 0                | 0                   | 4124              | 1163            | 0               |
| Diorit LLC                      | 4476          | 0                | 1253                | 3223              | 0               | 0               |
| Russian Grain LLC               | 14737         | 0                | 3236                | 9736              | 1765            | 0               |
| Total                           | 29567         | 0                | 4489                | 20044             | 5005            | 0               |

### Table 4. Characteristics of the quality of land and resource potential based on the actual use of sown areas for plot crops in agricultural organizations of the Gorky district of Omsk region

| Name of the agricultural company | Production cost, thousand rubles | Production costs, total thousand rubles | including | Production level | Production level | Production level | Production level | Profitability estimated, % | Profitability (actual), % |
|----------------------------------|---------------------------------|----------------------------------------|-----------|------------------|------------------|------------------|------------------|---------------------------|--------------------------|
|                                  | Production cost                  | total                                   | Production | efficient         | Low efficient    | Income from efficient production, thousand rubles | Income from low efficient production, thousand rubles | Cost of products in total, thousand rubles | Profitability (estimated), % | Profitability (actual), % |
|                                  |                                 |                                        | level      |                  |                  |                   |                   |                           |                          |
| Alekseevskoe LLC                 | 25018                           | 24496                                  | 37700      | 18147            | 19553            | 6871              | 4943             | 49514                     | 30                       | 23                      |
| Sibir-Agro LLC                  | 21071                           | 29748                                  | 37953      | 15701            | 24052            | 5370              | 5695             | 50819                     | 27                       | 15                      |
| Diorit LLC                      | 34629                           | 0                                     | 27098      | 0                | 27098            | 0                 | 7530             | 34629                     | 28                       | 5                       |
| Russian Grain LLC               | 0                               | 132545                                 | 87302      | 66642            | 20660            | 45243             | 0                | 132545                    | 51                       | 8                       |
| Total                           | 80718                           | 186789                                 | 190053     | 100490           | 91363            | 57484             | 18168            | 267507                    | 34                       | 12                      |
The specific weight by the levels of crop production efficiency (for example, spring wheat) in the Gorky district was distributed as follows: lands with a constantly ineffective level - 15%, with an unstable effective level - 68% and with a sustainably effective level - 17%. Based on the results of the actual use of arable land for spring wheat, specialized zones are allocated according to the levels of land and resource potential of agricultural organizations.

The level of realization of the land-resource potential of farms is calculated in Table 4, where the data show an increase in the estimated profitability over the actual one.

The comparison of the actual and estimated types of profitability shows that the shortfall in income is due to its loss in the production process.

4. Conclusion

The information base developed as a result of complex agricultural zoning of the territory provides an opportunity for agricultural producers to draw up business plans for effective development in the short and long term, which will create conditions for sustainable development of agribusiness; therefore, agricultural production is carried out by improving the management system of enterprises of various organizational and legal forms [10]. Among the areas of business planning in conditions of varied quality of lands and completed complex agricultural zoning of the territory are

- determination of the level of land efficiency, taking into account different planning periods;
- planning of the arable land rent.

The first direction is associated with the determination of sectional efficiency of arable land in the farms: with an increase and decrease in yield by 20%, with an increase and decrease in the cost of sold plot products by 20%, with an increase in production costs (prices of fuels and lubricants, seeds, fertilizers, spare parts) by 10%. On the basis of the data obtained, zones of stable manifestation are established; they are allocated on the basis of a sample performed according to the change in the levels of plot production with the prediction of possible scenarios for the arable use conditions. Each plot was assigned to a separate group according to the proposed scenario options:

1) constantly ineffective land (under any conditions);
2) constantly efficient land under any changes in natural and economic conditions;
3) a group of unsustainably efficient land, in accordance with the presence or absence of certain conditions, arable land can be efficient and inefficient.

Therefore, 10 plots in Alekseevskoe, 16 in Russian Zerno, 8 in Sibir-Agro, 15 in Diorit have a consistently ineffective level of production which reduces the overall profitability of production. Based on the analysis of efficiency of the use of arable land for average conditions and possible scenarios, measures are being developed to ensure an effective land use system as the basis for sustainable development of production.

The second direction of business planning aims to determine the rent term. The rent plan plays an important role for agricultural producers due to the efficiency of agricultural production. It helps the farm to select promising production options in order to avoid risks. Land rent planning for five years is carried out taking into account the forecast of changes in natural and economic conditions. The profitability of production is determined for the rent term. After that, massifs of the best lands by quality, remoteness, compactness and efficiency are formed. As a result of calculating the production efficiency of using arable land in Alekseevskoye, 12 plots were excluded from arable lands, in Russkoye Zerno 18 plots were excluded, in Sibir-Agro 6 plots were excluded, and in Diorit - 15 plots were excluded.

Thus, effective crop production involves the development of a business plan for an agricultural organization for a medium-term up to 5 years and a long-term period, during which, crop productions directions are established or specified. It is necessary to analyze

- the use of all available arable land to ensure efficient production, taking into account the state of the agricultural market (change in the cost of products sold);
- the use of arable land leases to ensure efficient and sustainable crop production.
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