Rationalization and optimization of peasant farmer facilities land use in Russia

V A Pavlova, E A Stepanova and E L Uvarova
St. Petersburg State Agrarian University, h. 2, Peterburgskoe shosse, Saint Petersburg, 196605, Russia
E-mail: vikalpav@mail.ru

Abstract. The article presents a statistical analysis to the formation and development of the peasant (farmer) facilities sector in Russia on such indicators as the composition of land, the level of agricultural production, the total land area. The authors identified groups of factors that affect the optimal parameters of land use (limiting, optimizing, maintaining) and also determined their weights using the method of hierarchy analysis.

1. Introduction
The main number of peasant (farmer) facilities was formed as a result of the pre-existing collective and state farms reorganization in the Russian Federation. Peasant (farmer) facilities include both country farms and just farms. In Russia, these terms do not have a significant difference. Country farms are based on family work and are mainly aimed at meeting their own needs. Farms, in contrast to country farms, use hired labor along with family contracts and are highly specialized and marketable. The current peasant (farmer) facilities (hereinafter referred to as PFF) have significant prospects for further development. However, in the process of functioning, farms face a number of difficulties that hinder both the economic development of the entire agricultural sector and each farm separately.

2. Materials and methods
Based on the analysis of many studies, it can be concluded that farming plays a leading role in the development of agriculture and the formation of new relations in rural areas [1-7], but to ensure the proper functioning of the PFF, it is necessary to solve a number of problems.
Within this study, the authors used such methods of scientific research as analytical, monographic, and the method of analyzing hierarchies of T. Saati (MAI).
The information basis of this study was the bulletins on the state of agriculture by the Federal State Statistics Service, state (national) reports on the state and use of land in the Russian Federation for 2005-2019.

3. Results
Based on the statistical analysis of the above materials, we have come to the following conclusions:

- The unsettled legal basis for the use of peasant (farmer) facilities land leads to difficulties in lending to the farming sector and to low efficiency as a result;
According to the Office of the Federal Service for State Registration, Cadastre and Cartography, arable land is the main part of peasant (farmer) facilities lands, so crop production is the predominant production direction in the PFF. Grazing lands occupy only 26.17% of all PFF lands, which indicates the non-proliferation of livestock specialization among peasant (farmer) facilities (figure 1);

According to the Federal State Statistics Service, peasant (farmer) facilities are increasing agricultural production at a significant pace. This growth is associated with both an expansion in the actual occupied area of farms and the improvement of the production process (table 1);

Like large agricultural organizations, peasant (farmer) facilities in Russia are mainly formed through the purchase or lease of land shares. Therefore, in the period from 1990 to 1994 (the period of reorganization of the former collective and state farms), there is a trend of significant growth in the number of peasant (farmer) facilities. In the future, economically unstable PFF were eliminated, and the remaining farms were enlarged (figure 2).

![Figure 1. Use of agricultural land by peasant (farm) farms in 2019 (in % to the total area).](image1)

![Figure 2. Changes in the number of peasant (farmer) facilities and the area they occupied (except for the lease from other organizations, businesses and citizens).](image2)

| Index                                             | 1990 | 1995 | 2000 | 2005 | 2010 | 2015 | 2019 |
|---------------------------------------------------|------|------|------|------|------|------|------|
| Farms of all categories                          | 100  | 100  | 100  | 100  | 100  | 100  | 100  |
| including:                                        |      |      |      |      |      |      |      |
| agricultural organizations                       | 73.7 | 50.2 | 45.9 | 44.6 | 44.5 | 54.0 | 57.7 |
| households                                        | 26.3 | 47.9 | 50.2 | 49.3 | 48.3 | 34.5 | 28.6 |
| peasant (farmer) facilities                      | 0    | 1.9  | 3.9  | 6.1  | 7.2  | 11.5 | 13.7 |

Table 1. Structure of agricultural output by types of farms (in current prices in billions of rubles; percentage of total).
Compared to 1990, the average PFF area grew by 86.1% in 2019 to 76.6 ha. Thus, the number of farms and the area occupied by them are individually optimized. This, in turn, contributes to strengthening the stable position of the middle level in the system of multi-layered agriculture.

The same trend is also characteristic to European countries. For example, German statistics indicate a decline in the number of farms in recent decades (from 1.6 million to 500 thousand). This fact is accompanied by the consolidation of production and its localization [8]. In Finland, there are associations of farms with different directions in cooperatives that cover the entire production process. Within such cooperatives, it sets its own requirements for the quality of output products and production standards, which allows to produce goods under a single brand. The company "Valio" is an example of such cooperation, which annual turnover of funds is 1 billion rubles/Euro.

4. Discussion
Back in the early 20th century, Russian scientists (N. D. Kondratiev, A.V. Chayanov, A. N. Chelintsev) studied the limit and optimal areas of farms. They highlighted the need for agricultural cooperation and the formation of narrowly focused farms. In his works, N. D. Kondratiev argued that the consolidation of the peasant (farmer) facilities by combining smaller farms through production cooperation will increase the productivity of these farms.

The optimal land area of the farm is influenced by a number of factors. In our opinion, these factors can be divided into groups:

- Limiting factors (determine the minimum land use area);
- Optimizing factors (determine the optimal composition of land, its area and ensure the development of production);
- Maintaining factors (contribute to the planned development of the organization and ensure the sustainability of its land use).

Let's look at the composition of factor groups in more detail.

The limiting factor for peasant (farmer) facilities should include the possibility of selling agricultural products in local markets.

Optimizing factors for peasant (farmer) facilities are the family's labor resources, investments, and the possibility of lending.

The role of maintaining factors for peasant (farmer) facilities is performed by specialization, the mechanization level of production processes, payback of funds, profitability of production.

The lack of complete and reliable statistical information on the land use of existing peasant (farmer) facilities prevents the determination of factor weights for each group by statistical analysis. To determine the degree of influence of factors affecting the parameters of peasant (farmer) facilities lands, we used the method of expert assessments.

The most suitable method for such purposes is the analysis of hierarchies by T. Saati (AHP), as it allows you to break down the problem into components to simplify the procedure for comparing objects. The implementation of this method consisted in the decomposition of the problem into increasingly simple leaving parts, then the sequence of expert judgments on paired comparisons was processed [9-14]. The corresponding priority matrices for optimizing and maintaining factors are presented in tables 2 and 3.

The next step in determining the degree of factors influence is to calculate the priority vector from the presented matrix. The priority vector is a weights set of individual factors in each factor group. To get the priority vector, you need to do the following: divide the values of each column by the sum of the values of this column (i.e., the column was normalized); then add all the values in the row; and divide the resulting sum of values in the row by the number of row elements.

The obtained dependence of factors affecting the optimal parameters of peasant (farmer) facilities land use is as follows (table 4).
Table 2. Priority matrix for a group of optimizing factors.

| The factors (criteria) | Provision of labour resources | Availability of investments | Opportunity of lending | The amount per line |
|------------------------|--------------------------------|-----------------------------|------------------------|---------------------|
| Provision of labour resources | 1 | 5 | 3 | 9 |
| Availability of investments | 0.2 | 1 | 0.2 | 1.4 |
| Opportunity of lending | 0.3 | 5 | 1 | 6.3 |
| The amount for the column | 1.5 | 11 | 4.2 | 16.7 |

Table 3. Priority matrix for a group of maintaining factors.

| The factors (criteria) | Production Specialization | Mechanization level of production processes | Payback investment | Ensuring profitability of production | The amount per line |
|------------------------|---------------------------|-------------------------------------------|--------------------|-------------------------------------|---------------------|
| Production Specialization | 1 | 5 | 0.2 | 0.14 | 6.34 |
| Mechanization level of production processes | 0.2 | 1 | 0.14 | 0.14 | 1.48 |
| Payback investment | 5 | 7 | 1 | 0.3 | 13.3 |
| Ensuring profitability of production | 7 | 7 | 3 | 1 | 18 |
| The amount for the column | 13.2 | 20 | 4.34 | 1.58 | 39.12 |

Table 4. Estimated influence weights of factors on land use parameters by factor groups.

| Optimal land use parameters | Group of factors | Name of factor | Significance (weight) of the factor |
|-----------------------------|------------------|----------------|-----------------------------------|
| Minimum land use area | Limiting factors | Product sales opportunity | 1 |
| Optimal land composition and land use area (ensuring production development) | Optimizing factors | Provision of labour resources | 0.61 |
| | | Availability of investments | 0.09 |
| | | Opportunity of lending | 0.30 |
| | | Production Specialization | 0.11 |
| Configuration, location of borders, compactness, maximum possible land use area at specified parameters (ensuring the sustainability of its land use) | Maintaining factors | Level of technological equipment, automation of production processes | 0.05 |
| | | Payback investment | 0.29 |
| | | Ensuring profitability of production | 0.55 |

5. Conclusion
The obtained data can be used in several interrelated directions:

- The established degrees of influence and the combination of factors that affect the parameters of land use in the selected groups clearly reflect the dependence of land use parameters on the quantitative value of factors (for example, a peasant farm can start functioning if there is a sales market);
Modern peasant (farmer) facilities operate under conditions of uncertainty, their size is optimized "spontaneously". Based on the analysis of the obtained weights of limiting, optimizing and maintaining factors, the most significant factor for peasant (farmer) facilities can be identified. Quantitatively increasing the value of this factor can intensify production processes and production sizes in farms;

These groups of factors and their impact on land use parameters should apply in the development of optimization models (for example, correlation and regression models) for peasant (farmer) facilities.

References
[1] Garmanov V, Bogdanov V and Zaikin V 2018 Spatial Aspects of Urban Planning: A Case Study for Saint-Petersburg Agglomeration. MATEC Web of Conferences 170 02014
[2] Lipski S A 2020 State and Use of Land Resources in Russia: Trends of the Current Decade. Studies on Russian Economic Development 31(4) 437–443
[3] Pavlova V A and Uvarova E L 2019 Application of information and communication technologies in modern Russian cadastral system. Geodezia i Kartografia 80(2) 57–63
[4] Pismennaya E V, Loshakov A V, Odinsov S V and Stukalo V A 2016 Improving model of territorial organization of agricultural land tenure. Research Journal of Pharmaceutical, Biological and Chemical Sciences 7(6) 1783-1787
[5] Rogatnev Y M, Scherba V N, Marakaeva T V, Nozhenko T V and Kapitulina N A 2018 Adaptation of the land use system as one of the main paradigms of the modern agricultural land use. International Journal of Engineering and Technology(UAE) 7(3) 301-305
[6] Sizov A 2020 The study of changes in the land fund balance to manage the sustainable spatial development of the developed and developing territories in Russia. E3S Web of Conferences 208 08023
[7] Usoltceva M, Volkova Y, Radchenko A, Guseva I, Makarova T, Garmanov V and Wenkel K-O 2016 Assessment of Natural Resource Potential of a Territory for Planning of Investment Development and Construction in Suburban Areas. MATEC Web of Conferences 73 03004
[8] Udalov A, Udalova Z, Postnikova L and Postnikova D 2019 Foreign experience in the development of agricultural business. IOP Conference Series: Earth and Environmental Science. 12th International Scientific Conference on Agricultural Machinery Industry INTERAGROMASH 012148
[9] Lepikhina O Yu, Skachkova M E and Mihaelyan T A 2018 Ranking of options of real estate use by expert assessments mathematical processing. Journal of Physics: Conference Series 1015(3) 032084
[10] Pavlova V A, Sulin M A and Lepikhina O Yu 2019 The mathematical modelling of the land resources mass evaluation in agriculture. Journal of Physics: Conference Series 1333(3) 032049
[11] Mikhaylov A 2020 Geothermal Energy Development in Iceland. International Journal of Energy Economics and Policy 10(4) 31-35
[12] Dooyum U D, Mikhaylov A and Varyash I 2020 Energy Security Concept in Russia and South Korea. International Journal of Energy Economics and Policy 10(4) 102-107
[13] Denisova V, Mikhaylov A and Lopatin E 2019 Blockchain Infrastructure and Growth of Global Power Consumption. International Journal of Energy Economics and Policy 9(4) 22-29
[14] Lakomiak A and Zhichkin K A 2019 Photovoltaics in horticulture as an opportunity to reduce operating costs. A case study in Poland. Journal of Physics: Conference Series 1399 044088