

## FARM HOLDINGS OPTIMIZATION

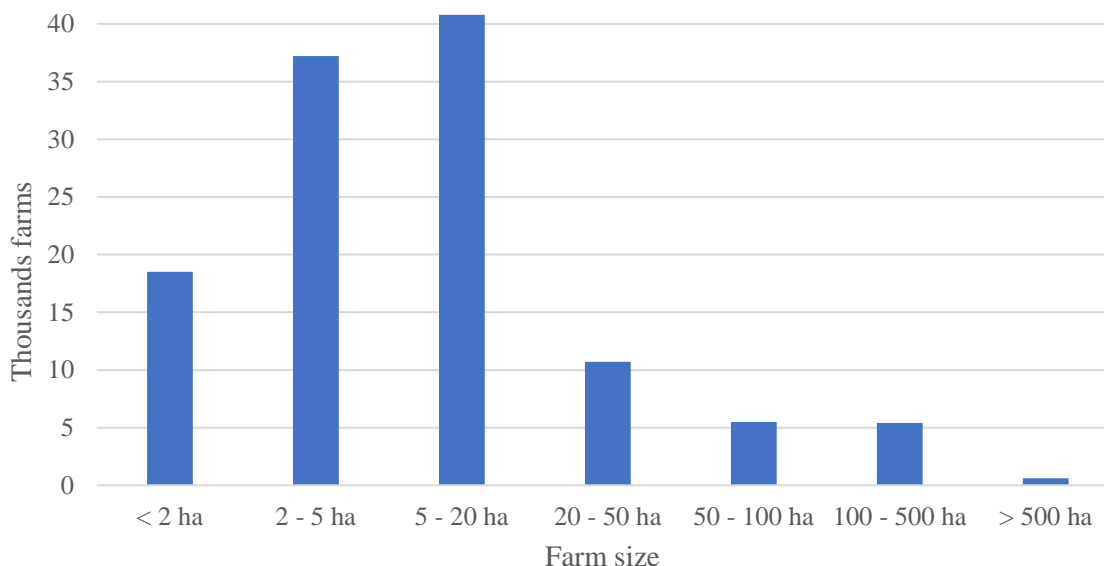
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**Abstract.** The paper's main objective is to analyse the distribution of large farm plots and opportunities for their optimization. In the context of intensive changes in the management and use of agricultural land, it is particularly important to optimise the land holdings of large farms. Most large farms are characterised by a fragmented, uncompacted spatial distribution. 15 large farms were selected for analysis in Jonava municipality. There are 22 separate fields on average per holding, 2/3 of the farm centres (farmsteads) are located in large settlements, and 1/3 of the farm centres are located in one-farm settlements and in small villages. It was found that the average area of individually cultivated fields is 14.9 ha, and the average distance from the farmstead to the fields is 4.35 km. Land holdings are very fragmented – fragmentation coefficient K2 value range from 2.64 to 8.81 (average 3.62) for selected farms. It is proposed to draw up municipality land use planning schemes, which would project the prospective boundaries of land holdings, and to legalize by law the right of pre-emption for the farm owner to acquire the ownership of the plots of land to be sold within these boundaries in order to increase the compactness of farm land holdings. A state can facilitate sporadic land consolidation by farmers through the preparation of the proposed municipality land use planning schemes.

**Keywords:** land holding, land plots fragmentation, land use planning schemes, sporadic land consolidation.

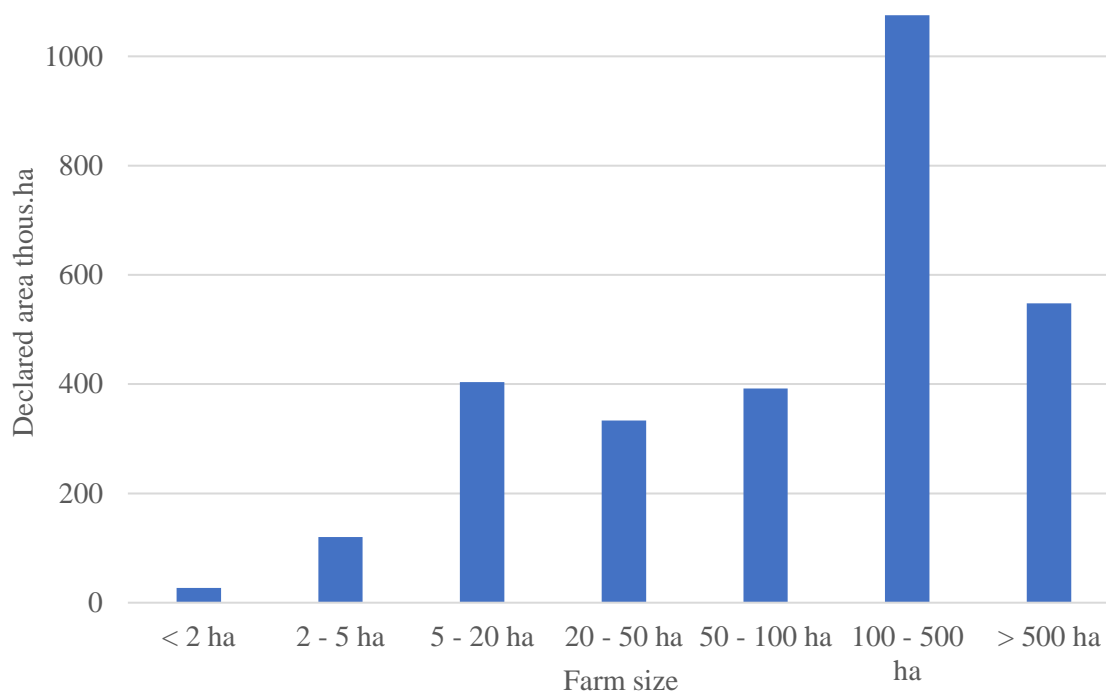
### Introduction

Land reform in Lithuania started in 1989 and one of its results is the creation of around 140 000 natural and legal farms. 1465.8 thousand plots of private agricultural land were registered in the Cadastre and Register of Real Property, with a total area of 3501 thousand ha (average plot size 2.39 ha) until 2022. Most of this area is used by agricultural subjects receiving direct payments from the State. These include farms of private persons meeting the definition of a farmer in the Law on the Farmer's Farm (Lietuvos..., 2002b) and farms of legal persons engaged in agricultural activities and other farms declaring agricultural land. There is a great distribution in terms of distribution of the number of farms and their declared area (fig. 1).



**Fig. 1.** Distribution of a number of farms according to their size. Source: (Informacija..., 2022).

118.7 thousand farms declared 2900 thous. ha, with an average farm area of 27.4 ha in 2022. Only a small part of farms is larger than 50 ha, however the small number of such farms doesn't mean that they cultivate less area of land, its opposite (fig. 2).



**Fig. 2.** Distribution of declared area of farms according to their size. Source: (Informacija..., 2022).

In order to identify the possibilities to regulate the process of farm development and to gradually build up rational farm land holdings, this paper analyses the land holdings of large farms that are within the recommended rational farm size.

According to the first version of the Temporary Law on Acquisition of Agricultural Land of the Republic of Lithuania (Lietuvos..., 2003a), the concept of a rational farm holding or tenure was considered to be an area of land owned by a single farmer in private ownership, the size of which, and the location of individual parts of the territory with respect to the roads and the centre of the farm, creates favourable conditions for the development of efficient farming activities, applying advanced production technologies and complying with the requirements of the environment. In other legislation (Lietuvos..., 2002c), the definition of a farmland holding included the agricultural land used and declared by the farm. Thus, a farm's land holding includes both the land owned by the farm or its manager and land owned by the State and other landowners and used by the farm on the basis of the lease.

The researchers at the Lithuanian Institute of Agrarian Economics (LAEI) found that "the rational size of a farm, calculated on the basis of the need for investment in the technical equipment and modernisation of farms, the need for labour and the need for funds for the members of the farm, is:

- 200 ha for crop production (cereals, oilseed rape) with only family members and 470 ha with farm members and employees, maximising the use of state-of-the-art machinery and advanced crop production technologies;
- dairy farming - 20 dairy cows with only family members (40 and 52 ha, according to land productivity) and 50 dairy cows with hired labour (103 and 132 ha, according to land productivity);
- mixed farming (predominantly herbivores) - 90 and 120 ha, according to land productivity (Kriščiukaitienė et al., 2007a, 2007b).

According to a survey of the economic activity of the respondent farms, in 2009 the most technically efficient farms are large farms with more than 100 ha (Vinciūnienė et al., 2009). When looking at farm size modelling using the return of scale analysis method, LAEI researchers (Baležentis et al., 2013) also state that "the optimal farm size for crop production is around 280 ha, for mixed farming - 200 ha and for livestock production - 125 ha".

In 2001, an analysis of the land holdings of 224 farms larger than 40 ha, carried out at the Lithuanian University of Agriculture, showed that the land holdings of large farms (with an average of 94 ha of agricultural land) are not compact: it was found that some of the farms' land parcels are not located in a single massive and that the average distance to the fields of the farmer's own land is 3.2 km, and the distance to the fields of the entire land area of the farms is 4.38 km (Aleknavičius et al., 2002). This shows that even farms of a reasonable economic size do not always meet the requirements of a rational distribution of land

holdings. Therefore, it has been suggested that the compactness of farm land holdings should be increased through the preparation and implementation of land-use planning documents.

The state legal regulation instruments that influence the process of formation of farm land holdings are such spatial planning documents, the decisions of which promote economically sound land use and correspond to the directions of rational use of land as specified in the legal acts. The general plan of the territory of the Republic of Lithuania (Lietuvos..., 2002a) provides for the following directions for the use of the country's land fund: 1) to ensure long-term land use priorities and rational land use; 2) to essentially maintain the traditional land and forestry and to territorially differentiate it. In order to implement these provisions, master plans are drawn up for the country's administrative territories, and, on the basis of these plans, special and detailed plans are drawn up. The land-use planning documents drawn up within the general planning system, such as land-use planning schemes and rural development land-use projects, are classified as specific plans. The content of the preparation of land-use schemes is specified in Article 38 of the Law on Land of the Republic of Lithuania (Lietuvos..., 2004a). One of the important issues addressed in land-use planning schemes is the prospective boundaries of farm land holdings. These boundaries would only be defined for farms with a business perspective, together with the possibility of improving the use of agricultural land through the restructuring of land ownership and use. Land use schemes should only be made for large or medium-sized farms' land holdings. Current trends showed that there is a rapid decline in the number of small farms

Nowadays the land owned by farmers is very fragmented. Researchers who have studied similar problems point out that the fragmentation of agricultural land in Central Europe is very high, which hinders the emergence of private commercial farms (Dijk, 2003). In addition, the fragmentation of land parcels prevents the creation of larger land parcels (Demetriou et al., 2012; Maasikamäe et al., 2015). Since changes in the shape and area of land parcels determine the cost of production, and the number of parcels and their fragmentation affect the cost of transporting the produce, it has been proposed to optimize these parameters (Alvarez et al., 2007).

One of the most commonly used instruments to increase the rationality of land holdings and reduce the fragmentation of parcels is land consolidation. However, these projects are relatively expensive, publicly funded, and time-consuming. Land use schemes could reduce the need for public funding for land consolidation by facilitating sporadic land consolidation, i.e. where landowners use their own resources to expand the area of their holdings and to reduce the fragmentation of existing parcels.

The main aim of the research is to investigate the fragmentation of large farms' land holdings and to identify opportunities for their optimization.

### **Methodology of research and materials**

To achieve the aim of the research methods of cartographic material analysis, analysis of laws, and other legal acts, mathematical statistical methods were applied.

The research was carried out using legal acts and scientific articles on agricultural land use and spatial planning issues. The general plan of the territory of the Republic of Lithuania, the state accounting data of the Land Fund of the Republic of Lithuania, the data of the Department of Statistics, the Land Information System material on the territory of the farms under consideration, the statistical data published by the State Enterprise Centre of Registers, the National Land Service under the Ministry of Agriculture (hereinafter - NLS) and the National Paying Agency, the statistics of the Centre of Agricultural Information and Rural Business and the cartographic data of the Application Acceptance System, and the results of the specialists' survey have been analysed as well.

Farm land holdings selected for the study are located in Jonava municipality. In terms of indicators affecting the size of farm land holdings, Jonava municipality is close to the national average: the average land productivity score, the share of private land, and the area of declared land per farm differ from the national average by no more than 6 %. Data from 15 farms in Jonava, using 5006.5 ha of agricultural land, were used for the research.

ArcGIS software was used to analyse the cartographic material and calculate the average distances to the fields. Data on agricultural land use from the State Enterprise Centre for Agricultural Information and Rural Business, the National Paying Agency and the State Land Fund were used for the research.

The following formulas were used to assess the compactness of the land holding (Aleknavičius, 2002):

$$K_k = \frac{L}{\sqrt{P}}; \quad (1)$$

$K_k$  – compactness coefficient of land holding;

$L$  – average distance from land plots to farm centre ( $\frac{\sum P \cdot L}{\sum P}$ ), ha;

$P$  – average farm holding area, ( $\sum P$ ), ha.

$$K_k = K_1 \cdot K_2; \quad (2)$$

$K_1$  – theoretical ideal coefficient of land holding structure ( $K_1 = 0,049$ );

$K_2$  – coefficient of land holding fragmentation.

$$K_2 = \frac{K_k}{0,049} \quad (3)$$

The location of the land parcels comprising the farm holdings in the study area, their declared agricultural area and the average distance from the farmsteads were calculated using ArcGis software.

## Discussions and results

**Studies on the compactness of farm land holdings.** Depending on the location of the arable fields and the territorial conditions for the organisation of agricultural production, farm holdings can be characterised as fragmented or scattered, close to compact and compact. Scattered holdings consist of several or several dozen separate fields with no common boundary. In this situation, the farm has longer distances from the farmhouse to the fields, limited possibilities for efficient use of agricultural machinery, and higher transport and crop production costs. An analysis of 15 large farms (334 ha of used agricultural land per farm on average) in Jonava district showed that most of these farms have a fragmented land holding pattern: the number of individually located fields on the farms ranges from 7 to 65, or an average of 22 per farm, with an average field area of 14,9 ha. 10 farm centres (farmsteads) are located in towns and large settlements, 5 farm centres are located in small villages. The average distance from the farmstead to the fields is 4.35 km, and the value of the  $K_2$  coefficients of land holding fragmentation ranges from 1.8 to 8.8 (average 3.62), of which four farms have a higher value than the recommended maximum (Aleknavičius..., 2002). A lower coefficient of land-holding fragmentation shows a lower level of fragmentation. The main reasons for the formation of non-compact farm land holdings are the peculiarities of land supply to farms during the land reform.

According to the statistical data published by the NLS and the State Enterprise Centre of Registers, the area of agricultural land plots registered for the first time in this category, by type of land ownership, is distributed as follows: 73.4% acquired through the restoration of land ownership rights (returned in kind on the former site or transferred to ownership free of charge with an equivalent area on another site), 16.6% acquired through privatisation of personal farm land used by the owner, 10.0% acquired through the purchase of plots of the free state land fund. On average, per natural person, the initial land area acquired during the land reform is only 6-7 ha. The owner of the farm had to decide for himself whether to further increase his land holding for the development of agricultural production and to purchase or lease land from persons not working on it. This process, with little regulation by the state authorities, has resulted in farm land holdings of various sizes. Moreover, as a farm becomes larger, the compactness of its land holdings decreases and the number of individually located fields increases.

Thus, the differentiation of farms in Lithuania according to the area of land used by agricultural entities was determined by the peculiarities of their formation during the period of land reform:







- the size of the land area, to which the farmers' property rights were restored;
- the possibility of purchasing state land adjacent to the farm's land holding;
- the farm's increasing production capacity thanks to the farm's activities and state support, which required the farm to grow more agricultural produce;
- the farm's economic opportunities to acquire ownership of, or rent conveniently situated land plots from other owners.

In the context of intensive changes in the management and use of agricultural land, it is particularly important to optimise the land holdings of large farms by matching the land area and the production volume in trying to reduce transport costs.

By 1 July 2016, 3551 land users in Jonava District privatised or used 7517 ha of personal farm land under state land lease agreements (2.1 ha on average). By this date, 10 213 applicants had their property rights restored by returning in kind or by transferring 41489 ha of rural land (4.1 ha per person on average) to

ownership in an equivalent area. In addition, 5469 ha of state agricultural land in the free fund was sold or leased to farmers. In 2016 1321 agricultural holders declared agricultural land in the municipality. During the land reform works, the law and its implementation procedures allowed to provide of land (with the help of land management measures) to natural persons setting up small farms with an average area of 10 ha. A typical example of a dispersed farm holding is shown in Figure 2.



-  Land restituted in the same place or by the equal value area for a farm owner;
-  Private land which was inherited;
-  Land which was purchased or obtained in other ways into ownership;
-  Rented private land;
-  Rented State land;
-  Location of a farmstead.

**Fig. 3.** Structure of incompact farm tenure by type of land acquisition.

The agricultural land used by the farm (101,6 ha) is scattered in over 17 separate fields with an average area of 6,0 ha. The distance by road from the farm centre to the fields varies from 0,2 to 3,0 km (average 1,2 km). The farm had acquired 63,2 ha, of which 4,6 ha were acquired by restitution of ownership, 20,7 ha were inherited from landowners who had regained their land, 4,1 ha were acquired by donation, and 33,8 ha were purchased privately. In addition, private land rented by the farm amounts to 38,4 ha or 37,8 % of the total agricultural land in use.

These figures are similar to those of other large farms. An analysis of land use ownership data for 11 farms in Jonava municipality shows that on average, at the time of the establishment of the farm (1992-2008), the farm had 12 ha of privately owned land per farm, while in 2016 it was already 123 ha. However, land rented from other owners and from the state accounts for 34.5% of the total land used by these farms. The annual rent paid by farms to landowners for renting private land is between 80 and 100 €/ha, which is about 9 times higher the land tax for the owners of agricultural land (9-11 €/ha).

**Legal framework for farmland optimisation.** In order to facilitate the conditions for farms to increase the size of their own land and to improve the compactness of their land holdings, the conditions for the acquisition of land in to private ownership are regulated by the Law on the Acquisition of Land for Agricultural Purposes. This law determines a priority or pre-emption right for acquisition of private land as follows:

1. The co-owners of the land parcel, according to Lithuanian Civil Code;
2. The user of the land plot being sold, who has a rent agreement registered in the Real Estate Register and has used this land for agricultural activities for at least one year;
3. A person who owns the agricultural land plot, which is bordering to the land plot being sold (Lietuvos..., 2014).

However, such a priority order is applied to land plots regardless of the distance to the farming centre. Remote plots may even worsen the conditions for organising production. It was found that 90 plots of land used by 15 analysed farms in Jonava municipality were located 5 – 10 km away from the farmsteads, covering an area of 1731 ha or 34,6 % of the total area of these farms.

To prevent such a situation land use schemes for prospective boundaries of farms can be drawn up. Such schemes are special planning documents defined by laws, although none of them has been prepared yet.

It is not appropriate that even in those areas for which land use planning schemes will be drawn up and the prospective boundaries of the farms' land holdings will be planned, the plots of private land within these boundaries will be sold on a preferential basis to other persons. Therefore, it is proposed to improve the legislation by establishing the right of pre-emption for the purchase of private land according to the prepared land use planning scheme within the prospective boundaries of the land holding.

The establishment of prospective boundaries of farm land holdings through the preparation of land use schemes and the implementation of the solutions of these schemes may facilitate the rational arrangement of farm land holdings. Moreover, it would increase the possibility for farms to acquire on a preferential basis other plots of land within a reasonable economic distance, thus gradually creating a more compact farm land holding.

In addition, the design of the prospective boundaries of farm land holdings in land use planning schemes should be combined with the preparation of land consolidation projects or should allow the identification of areas where it makes economic sense to prepare land consolidation projects.

When revising the rules for the preparation of land use schemes, it is recommended that:

- Prospective boundaries of farm land holdings should be established for all farms using and declaring more than 40-100 ha of agricultural land;
- Location of farmsteads and existing buildings, and the location of land used by farms (owned and rented) are identified during the design work;
- The prospective boundaries of farms land holdings are designed considering a need for land for the efficient use of the farm's productive capacity, the interests of neighbouring farms, and the possibility of minimising transport costs for agricultural work.

The following project solutions are proposed for the determination of the prospective boundaries of the farms' land holdings:

- To interchange the land plots used by these farms if they are located closer to the farmstead of another farmer;
- To include in the prospective boundaries of farms land holdings land plots used by other farms, but which are located at a greater distance from these farms;
- To include in the prospective boundaries of the farms land holdings vacant, undeclared plots of land that are interfered between the fields of farms.

### **Conclusions and proposals**

1. The differentiation of farms in Lithuania according to the area of land used by agricultural entities was caused by the peculiarities of their formation during the land reform period: the size of the restored land area to which the owners' property rights were restored; the possibility of purchasing state land adjacent to the farm land holding; the farm increasing production capacity thanks to farm activities and state support, which required the farm to grow more agricultural produce; and the farm economic opportunities to acquire ownership or rent conveniently located land plots from other owners. In the context of intensive changes in the management and use of agricultural land, it is particularly important to optimise the land holdings of large farms, matching the size of the land with the production volume of the farms and reducing transport costs.

2. Most large farms are characterised by a fragmented, uncompact spatial distribution. These holdings are made up of separate, widely separated fields, the use of which increases transport costs and the cost of production. In addition, a large proportion of farmsteads are located in a town or other larger settlement, rather than in a farmland holding. In the 15 farms of Jonava district analysed, the average area of one farm holding is 334 ha, there are on average 22 separate fields per holding, 2/3 of the farm centres (farmsteads) are located in large settlements, 1/3 of the farm centres are located in one-farm settlements and in small villages. The average distance from the farmstead to the fields is 4.35 km, and the value of compactness coefficient  $K_2$  coefficients of landholding ranges from 1.8 to 8.8 (average 3.62), of which four farms have a higher value than the recommended maximum. In order to reduce the labour costs on farms and improve the conditions for organising production, the development and conversion of large farms need to be regulated by legal and spatial planning measures.

3. When drawing up land use planning schemes providing the prospective boundaries of farms' land holdings, it is appropriate to include methodological recommendations and requirements in the rules for the preparation of such land use planning documents. It is proposed to take account of these provisions:

- Prospective boundaries of farm land holdings should be established for all farms using and declaring more than 40-100 ha of agricultural land;
- Prospective boundaries of farm land holdings should not include land parcels that are more distant (e.g. more than 5 – 10 km away from the farm centre);
- In addition to the fields closer to the farm and used by the farm, it is proposed to include land parcels used by other farms, but distant from their farmhouses;
- To include in the prospective boundaries of the farms land holdings the vacant, undeclared plots of land that are interfered between the fields of farms;
- The prospective boundaries of the farms land holdings are designed considering the need of land for efficient use of the farm's productive capacity, the interests of neighbouring farms, condition of access roads, distances, and the possibility of minimising transport costs for agricultural work.

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