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Land relations in Bulgaria through the lens of agricultural clustering in 2003 and 2020

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Abstract

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The study of land relations is part of the process of studying the nature and state of economic relations. Using clusters on level of municipality we aim to understand and trace what affects the state of land use in Bulgaria. After the macro social transformation in the agriculture of Bulgaria, certain inequalities among the economic subjects matured and developed dynamically.

Keywords: Land relations; landuse Bulgaria; agricultural clustering

Introduction

The study of land relations is part of the process of studying the nature and state of economic relations in the face of changes in the economic environment in which agriculture functions. A study of the state of agricultural holdings during two periods with different institutional environments aims to trace how they affect the state of land use in Bulgaria.

With the increasing concentration of goods in the portfolios of an ever-smaller part of economic agents, conditions are created for the emergence of new theoretical schools, existing scientific platforms are improved in order to respond to a number of macroeconomic processes with a strong impact on economic and social life of society. Our contemporaneity of the last three decades has also brought to the fore in scholarly research these issues such as inequalities (Stiglitz 2012, Piketty 2014). Two theories of inequality by world-renowned economists – Joseph Stiglitz "The Cost of Inequality" (2012) and "The Great Divide" (2015) and Thomas Piketty "The Capital of the XXI Century" (2013) represent a methodological enrichment of modern political economy. Stiglitz and Piketty provide a kind of methodological toolkit for the analysis of a number of current and developing till now business processes with a strong socio-economic significance. The introduction of the phrase "one percent" into scientific discourse allows the adaptation of their theoretical approach to the analysis of characteristic processes in the Bulgarian primary sector. After the macro social transformation in the agriculture of Bulgaria, certain inequalities among the economic subjects matured and developed dynamically, the study/presentation of which is also the aim of the present study. Katrandjiev et al. (2021) explore the role of clusters and the business environment in fostering national competitiveness in Bulgaria. Their comparative study with other EU countries offers insights into the factors influencing land prices and economic competitiveness in the region (Katrandjiev et al., 2021). The article is devoted to determination of the role of agricultural clusters in provision of food security. The authors allocated the following main courses of the increase of the food security by means of development of agricultural complex, through formation of agricultural clusters: development of the sectors of agricultural cluste (Borisova at. al 2015). From a sustainability perspective, the existence of multifunctional agriculture that responds to the needs of society by providing non-market goods and services justifies government intervention in a market economy through agricultural and sectoral policies (Dos-Santos, 2016; I. G. D. Santos et al., 2018).In Bulgaria Stoyanova & Harizano-

va-Bartos (2019) identify the place and the role of Bulgarian agriculture in rural development based on the clusterization. The clustering of holdings of specific characteristic in agriculture can create a favorable environment for better food security and environmental and social prosperity if we identify the strengths and weaknesses of every cluster.

Methodology

Desk research, graphic method, analysis, synthesis and the statistical method of clustering, etc., are applied to fulfill the set goals for this research article. K-means clustering is a popular unsupervised machine learning algorithm used to divide a set of data points into clusters based on their similarity. In this method, data points are grouped into k-means clusters, where K is a predefined number, and each data point is assigned to the cluster with the closest mean value.

The K-means algorithm works by iteratively updating the cluster centroids and assigning data points to their nearest center until the centroids converge. The objective function of the algorithm is to minimize the sum of the squared distances between each data point and its assigned center.

The K-means clustering methodology has been extensively studied and documented in the literature. One of the earliest works on K-means clustering was by J. MacQueen in 1967, who proposed an algorithm that iteratively splits data into k clusters by minimizing the sum of the squared distances between each data point and the centroid of the assigned her cluster.

Lloyd (1982) later proposed a similar algorithm that initializes the centroids randomly and iteratively assigns data points to their nearest centroid, followed by updating the centroids.

Since then, the K-means algorithm has undergone several modifications and extensions, including the use of different distance metrics, initialization techniques, and convergence criteria. For example, the K-means++ initialization technique proposed by Arthur and Vassilvitskii (2007) improves convergence speed and accuracy by selecting centroids that are far apart.

Another modification is the MiniBatch K-means algorithm proposed by S. Sculley in 2010, which reduces the computational complexity of the algorithm by processing data in small batches.

K-means clustering is a widely used method in data analysis and was performed in this study using SPSS software. In SPSS, cluster analysis of K-means values can be followed by ANOVA (analysis of variance) to test whether there are significant differences between the mean values of variables in different clusters. This can help to further interpret the results of the clustering analysis and determine whether the clusters are meaningful and useful. Z-scores, also known as standard scores, were used in the analysis. They are a statistical measure that indicates how many standard deviations a data point or observation is away from the mean of the distribution. They are used to standardize and compare values in different data sets or variables.

A preliminary check of the optimal number of clusters was made using Hierarchical clustering. The data used for the clusters are data from the 2003 and 2020 census of rural holdings by the Ministry of Agriculture, and for the clustering we have chosen the indicators of the number of agricultural holdings and the used agricultural area. In the two periods, we predict that there will be significant differences, taking into account the differences in the existing institutional environments and the implementation of the CAP in 2020. The level of regionalization of clustering is LAU. Eurostat maintains a system of local administrative units (LAU) compatible with NUTS. These LAUs are the building blocks of NUTS and include the municipalities of the European Union.

Results and Discussion

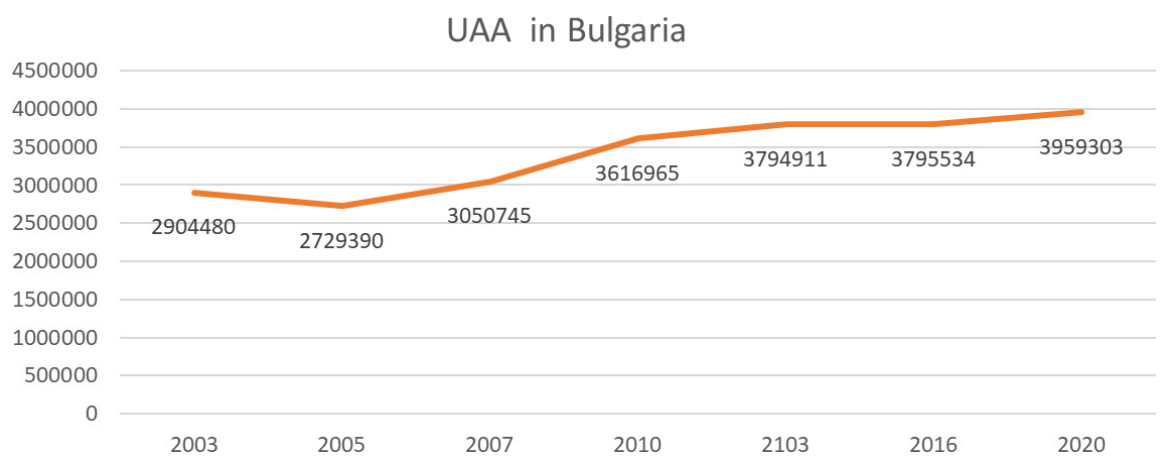
For the last twenty years the primary sector of agriculture in Bulgaria have gone true significant number of changes including social, economic and institutional. Agriculture is key sector on which a large part of production in the country is based (Popov & Marinov, 2023). A big part of this changes are presented in the landuse and landowning, Koteva and Fidanska (2021) examines the role of small farms in the development of entrepreneurship and family business, which contribute to the sustainable development of rural areas in Bulgaria. In earlier studies we have examined the role of small and medium farms for food security and sustainable development (Yovchevska at. al. 2022) and here we want to continue with this examination but on level of municipalities in Bulgaria. The importance of regional differences and understanding why and what factors play a role in process of consolidation of the small and medium farms and there extinction. The new CAP policy 2023+ seeks to ensure a sustainable future for European farmers, provide more targeted support to smaller farms, and allow greater flexibility for EU countries to adapt measures to local conditions (CAP, 2023).

For the first part of this research, we will focus on the process of landuse and landowning on national level to understand the macro-level process and gather the general trend in Bulgarian agriculture. For the last 20 years the number of holdings in Bulgaria has decrease 80,05%. That is happening while the land used has increased by 36,3% which means that

more farms are getting bigger, while the number of small and medium farm decrease. This pose a problem on several levels, more of the big farms use mechanization which means less people are employed in the local agriculture. Bigger farms in Bulgaria tend to use CAP stimulus as decision making tools for what to produce (mostly grains or other subsidies crops) that creates monoculture in agriculture, as well there is lack of crop rotation and other practices that help sustainability. In a cereal monoculture, plant biodiversity is extremely low (Willsey et al., 2020) One of the main problems with monoculture farming is the elimination of biological diversity. Sufficient variety of specific plants, animals, and insects in a particular environment helps to control excessive proliferation of pests, crop diseases, and other negative manifestations caused by disruption of the natural balance of soils on monoculture farmlands (Kogut, 2023). All of the above creates an environment that is nether socially nor environmentally sustainable or people friendly (Figure 1, Figure 2).

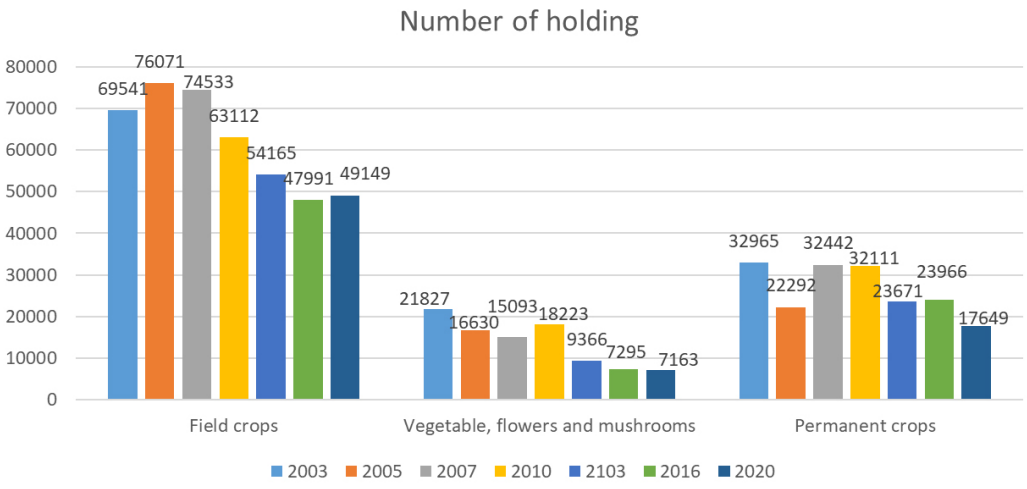
Significant change of number of holdings can be seen in all of the different subsectors of production in agriculture that shows us, that most of the small and medium farms has been assimilated by the big ones. The trend shows us that this changes predominately happened after 2007 when CAP policy was introduced in Bulgaria after the countries accession to the EU. The most notable in the graphs even without further methods used we can see the decrease in field crops, grazing livestock, pigs' poultry and rabbits and mixed cropping. There is a big difference between the various specializations of the agricultural holdings. The Cereals and Industrial crops dominate, at the expense of all other productions. There is an imbalance regarding the cultivation of various agricultural crops and livestock, i.e. harvested is the crop that is most subsidized at the given time (Dimitrova, 2023). The policy for sustainable development in the world has determined a crucial role of agriculture and the food system in achieving the Sustainable Development Goals of the United

Graph. 1. Number of holdings (FSS) Bulgaria
Source: FSS, Ministry of agriculture

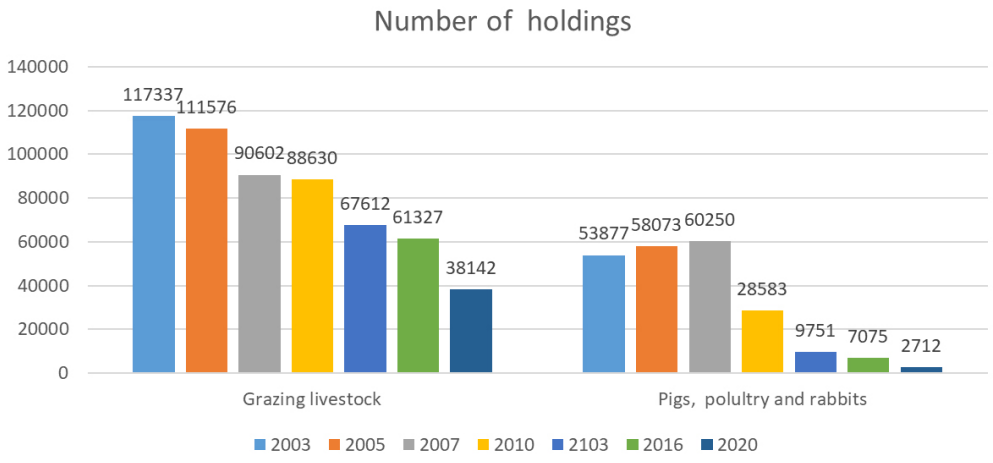


Graph 2. UAA in Bulgaria
Source: FSS, Ministry of agriculture

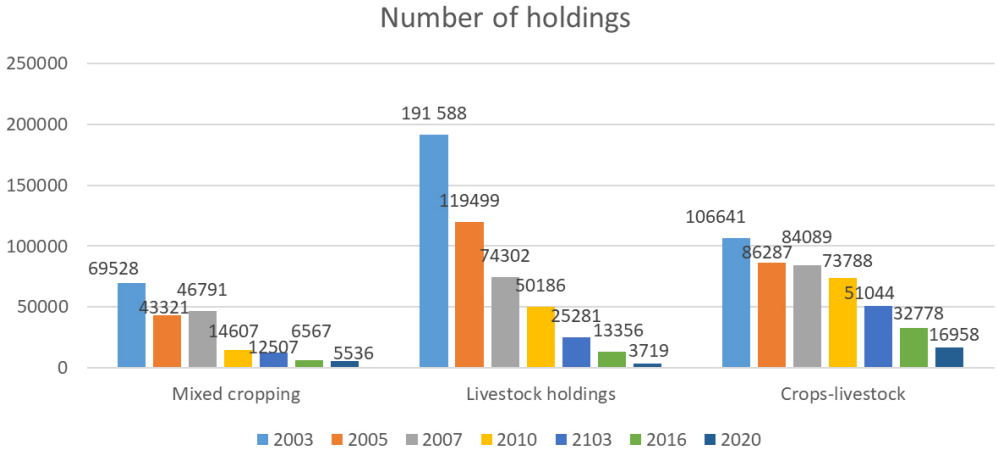
A)



B)



C)



Graph 3. Number of holdings of subsectors of agriculture

Source: FSS, Ministry of agriculture

Nations (Kirechev 2022) for this sustainability to work in Bulgaria a transition towards help for the small a medium holding is needed (Figure 3 A), B), C)).

To further the analysis we are using data on agricultural holdings in different municipalities to see how the national trend has a reflection on regional level and what differences and factor for this differences can we find in Bulgarian municipalities. The clusterings were made for two time segments, 2003 and 2020, with the indicators of Utilized agricultural area and number of farms at the LAU level selected. When clustering with SPSS, we chose the largest possible number of Iterations. After preprocessing the data with Hierarchical cluster, a difference was observed in the optimal number of clusters for the two selected years. In 2003, the optimal number of clusters was 3, while in 2020, the optimal number was 2. We are not using a bigger possible number because the clusters we want to differentiate are big, medium and small in UAA and number of holdings if possible. The changing institutional environment, the accession in 2007 into the EU and the transition to subsidized agriculture led to changes in the structure of agricultural holdings. In 2003, Bulgaria was in the pre-accession period before joining the EU. Agriculture is still in the period of completion of the process of returning the lands to real boundaries.

The clustering calculations were completed after 13 iterations, with a elapsed distance between the first selected cluster centers of 51,525.061.

The latest clusters created have the following characteristics. In cluster 1 are the regions in which agricultural holdings have the smallest number (up to 2111) and a size of up to 5,500 ha. In the second cluster are the municipalities with the largest agricultural holdings and the largest number of agricultural holdings, and in the third are the municipalities with more number of holdings (up to 4098), but with a small area. The largest number of municipalities are located in cluster 1, where the number of farms is up to 2111 and the agricultural land used is up to 5466.9. On graph 4, where the distribution of the farms according to the two indicators is clearly shown, we see that the farms are oriented towards a size even below 2000 ha and are less than 1000 in number. In cluster 2 are the municipalities with the farms, which are the largest area in terms of size and as we can see in the graph, they are over 6,000 ha in size, with the largest farm having a size of almost 120,000 ha. In cluster 3 there are municipalities where farms are between 2000 and 6000 ha in size and there is one outlier municipality with a size of over 4000 where there are many farms in number (over 3000), all other municipalities the number of farms is around 1000. In cluster 2, where the municipalities of Iskar, General Toshevo, Dobrichka and Tundzha are home to the largest agricultural holdings, The shift from a centrally planned economy to a market-oriented one necessitated agricultural reforms. Initial land restitution led to fragmentation as lands were returned to previous owners or their inheritors, making efficient agricultural production a secondary concern initially (Richard Graver, 2006).

Cluster 1. Iteration History[a]

Iteration	Change in Cluster Centers		
	1	2	3
1	8148,581	21992,149	27155,457
2	667,982	7722,450	4975,802
3	638,175	5060,444	4083,395
4	520,066	,000	2036,550
5	117,715	,000	485,779
6	112,332	,000	484,699
7	225,537	,000	873,313
8	167,437	,000	595,571
9	56,024	,000	190,839
10	108,803	,000	375,567
11	54,862	,000	178,204
12	53,975	,000	178,172
13	,000	,000	,000

a. Convergence achieved due to no or small change in cluster centers. The maximum absolute coordinate change for any center is ,000. The current iteration is 13. The minimum distance between initial centers is 51525,061.

Cluster 2. Final Cluster Centers

	Cluster		
	1	2	3
Number of holdings 2003	2111	4690	4098
UAA 2003	5466,9	82015,8	26580,1

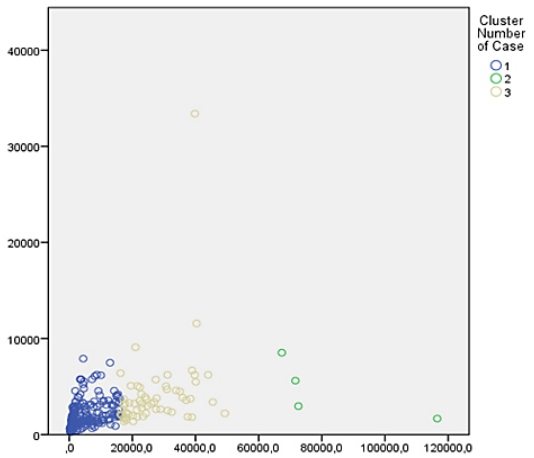


Chart 1. Cluster of municipalities 2003

Legend: Number of holdings – y axis, UAA – x axis
Source: Own calculation data FSS Ministry of agriculture

Cluster 3. ANOVA

	Cluster		Error		F	Sig.
	Mean Square	df	Mean Square	df		
Number of holdings 2003	99863265,465	2	5829734,812	260	17,130	,000
UAA 2003	20388590159,662	2	41662684,712	260	489,373	,000

The F tests should be used only for descriptive purposes because the clusters have been chosen to maximize the differences among cases in different clusters. The observed significance levels are not corrected for this and thus cannot be interpreted as tests of the hypothesis that the cluster means are equal.

The ANOVA table shows the F-statistic and p-value for the overall effect of cluster membership on the dependent variable. If the p-value is less than the significance level (usually set at 0.05), then there is evidence of a significant difference in the means of the dependent variable across the clusters. Pairwise comparison results will show which clusters are significantly different from each other by indicating which variables contribute most to the differences between clusters.

Both selected metrics have the Sig level. below the standard error of 0.05 indicates that both metrics contribute the most to differences between clusters.

Table 1. Municipalities and their cluster affiliation

Cluster 1	Cluster 2	Cluster 3
Belogradchik, Boynitsa	Iskar	Byala Slatina
Bergovo, Vidin,	General Toshevo	Vratsa
Gramada, Dimovo, Kula, Makresh, Novo Selo, Ruzhnitsi, Chuprene,	Dobrichka	Walnut
Borovan	Tunja	Lovech
Kozloduy, Krivodol, Mezdra, Mizia, Roman, Hairedin, Apriltsi, Letnitsi,		Wolfdrum
Lukovit, Teteven, Troyan, Ugarchin, Yablanitsa, Berkovitsa, Boychi-		Montana
novtsi, Brusartsi, Varshets, Georfi Damyanovo, Lom, Medkovets,		Lower Metropolis
Chiprovtsi, Yakimovo, Belene, Gulyantsi, Gorna Oryahovitsa		Dolni Dabnik
Elena, Zlataritsa, Lyaskovets, Strazhitsa, Suchindol, Gabrovo, Dryano-		Princess
vo, Sevlievo		Levski
Tryavna, Zavet, Loznitsa Samuil, Tsar Kaloyan, Borovo, Slivo pole,		Nikopol
Cenovo, Alfatar, Kaynardzha, Sitovo, Avren, Aksakovo, Beloslav, Byala,		Pleven
Varna, Devnya, Dolni chiflik, Dulgopol, Suvorovo, Antonovo, Omurtag,		Pordym
Opaka, Veliki Preslav , Venets, Varbitsa, Kaolinovo, Kaspichan, Nikola		Red Beach
Kozlevo, Smyadovo, Chitrino, Malko Tarnovo, Nessebar, Pomorie,		Veliko Tarnovo
Primorsko, Rouen, Sozopol		Pavlikeni
Sungurlare, Tsarevo, Kotel, Tvarditsa, Brothers Daskalovi, Gurkovo,		Polish Trambezh
Galabavo, Kazanlak, Maglizh, Nikolaevo, Pavel Banya, Bolyarovo,		Svishtov
Yambol, Bansko, Belitsa, Blagoevgrad, Gotse Delchev, Garmen, Kresna,		I washed
Petrich, Razlog, Sandanski, Satovcha, Simitli . , Gorna Malina, Dolna		Kubrat
Banya, Dragoman, Elin Pelin, Etropole, Zlatitsa, Ikhtiman, Koprivshtit-		Razgrad
sa, Kostenets, Kostinbrod, Mirkovo, Pirdop, Pravets, Samokov, Svoge,		White
Slivnitsa		Veto
Chavdar, Chelopech, Ardino, Jebel, Kirkovo, Krumovgrad, Kardjali,		Two mounds
Momchilgrad, Chernoochene, Batak, Belovo, Bratsigovo, Velingrad,		Ivanovo
Lesichovo		ruse
Panagyurishte, Peshtera, Rakitovo, September, Strelcha, Asenovgrad,		Chief
Brezovo, Kaloyanovo, Karlovo, Krichim, Kuklen, Lucky, Perushtitsa,		Dulovo
Plovdiv,		Silistra
Parvomai, Rakovski, Rodopi, Sadovo, Stamboliyski, Saedeinenie, His-		Tutrakan
arya, Banite, Borino, Devin, Dospat, Zlatograd		Windy
Madan, Nedelino, Rudozem, Smolyan		Valchi dol
Chepelare, Ivaylovgrad, Lyubimets		Provadia
Madjarovo, Mineralni bani, Svilengrad		Balchik
Simeonovgrad, Stambolovo, Topolovgrad		Dobrich
Harmanli		Cavernous
		Pears
		Tervel
		Stencil

Table 1. Continued

Cluster 1	Cluster 2	Cluster 3
		Popovo Targovishte New market Noisy Aitos Burgas Stone Carnobat Medium Nova Zagora Sliven Opan Radinovo Stara Zagora Chirpan Elhovo Straldza Pazardzhik Maritza Dimitrovgrad Haskovo

With the release of the results of the new census of agricultural holdings 2020, we want to analyze what the changes are by municipality and what the appearance of agricultural holdings in Bulgaria is. With the entry of the country into the EU and the implementation of the CAP, Bulgarian agriculture moved towards the consolidation of agricultural holdings, from this process there were also negative trends that affected the rural municipalities. With the cluster analysis, we aim to examine the process in chronotopy and make recommendations for future policies.

Cluster 4. Iteration History[a]

Iteration	Change in Cluster Centers	
	1	2
1	16743,251	38810,846
2	480,611	29679,397
3	407,415	13348,589
4	674,240	14727,431
5	739,557	9574,543
6	762,446	7381,832
7	1279,652	7934,360
8	638,131	3058,933
9	589,437	2640,896
10	96,067	397,524
11	,000	,000

a. Convergence achieved due to no or small change in cluster centers. The maximum absolute coordinate change for any center is ,000. The current iteration is 11. The minimum distance between initial centers is 177139,731.

The resulting clusters were formed after 11 iterations and have a minimum distance between cluster centers of 177139.731 with our set of 2 clusters. The decision in 2020 to split into two clusters was made after a Hierarchical cluster analysis if we applied 3 clusters only 1 outlier was present in it. We have left the outliers when presenting the clusters, but in any further study they will be removed. All the previously described processes find expression in clusterization, and at the end of the period the clusters were reduced by 1 of the three that were identified in 2003. This is one of the main indicators of the inequalities created. More of the middle cluster with a medum number of UAA and medium number of holdings no longer exist.

The latest clusters created have the following characteristics. In cluster one there are municipalities with a small number of farms and a small PES, while in cluster 2 there are municipalities with more farms with a larger PES. In cluster 1 there are farms with a size of up to 11383.5 ha, and they are up to 433 in number, and in cluster 2 there are farms up to 49907.8 ha and a number of up to 836. On graph 2 we observe the two clusters, as in cluster 2 there are 2 outliers, 1 is a municipality with farms size of 170,000 ha (Iskar), and the

Cluster 5. Final Cluster Centers

	Cluster	
	1	2
Number of farms 2020	433	836
Agricultural area used 2020	11383,5	49907,8

other is a municipality with larger farms in terms of IZP, but many in number (over 5,000; Razgrad). Post Bulgaria's EU membership, there has been a trend towards commercialization and consolidation. The average size of farms tripled over a decade, with 9% of the farms accounting for 85% of the utilized agricultural land (UAL) (*Bulgaria: 2020 Agricultural Census Confirms Farm Consolidation and Growth*, 2021). Janus and Markuszewska (2017) state that CAP financially supports land consolidation activities aiming to equalize the conditions for farming production, which may indirectly promote land consolidation, in Bulgaria land consolidation work a little too well and now even the EU is looking into ways to fix the created problem using the instruments of the common agricultural policy. Under the new CAP, countries like Bulgaria will implement national CAP Strategic Plans, combining funding for income support, rural development, and sectorial programs. This may drive land consolidation indirectly by providing financial incentives and support for more efficient agricultural practices.

Both extremes are in the second cluster, where larger farms are classified. 70 Razgrad, many in number and larger farms, 45 Iskar, not many in number of farms, but with a very large area. In Iskar case the general trend of land consolidation and the influence of EU policies like CAP could be factors affecting agricultural holdings in Iskar similarly to other regions in Bulgaria. The competitiveness of agricultural holdings in Bulgaria is influenced by the sector of specialization, with the beekeeping sector being the most competitive followed by field crops, mixed livestock, and mixed crop production.

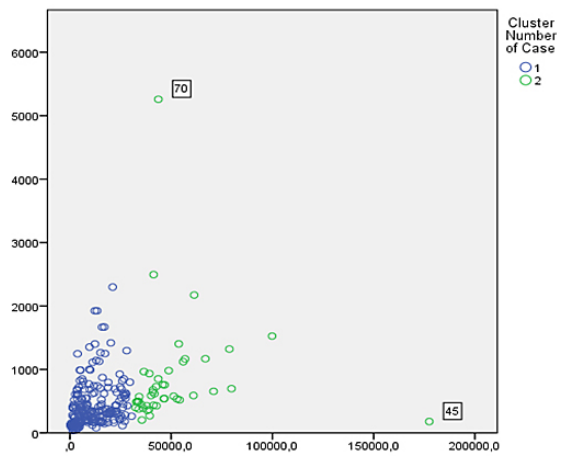


Chart 2. Clusters 2020 by municipalities

Legend: Number of holdings – y axis, UAA – x axis
Source: Own calculation data FSS Ministry of agriculture

ANOVA shows that both selected indicators are relevant to the analysis. Both selected metrics have the Sig level. below the standard error of 0.05 indicates that both indicators contribute to differences between clusters.

Other Bulgarian authors also note the trends of land concentration and polarization are continuing, although the European and national policy priorities are directed at overcoming the imbalances and differences. These land concentration processes are accompanied by accumulating a significant share of direct payments in large holdings. (Beluhova-Uzunova et al., 2023). Authors discuss that Bulgarian agriculture has to correspond with the goals for sustainable growth of food production in order to create and develop more productive, economically efficient and ecological agricultural holdings. Agricultural holdings with a large economic size increase, while those with a small size almost disappear (Dimitrova, 2023).

The existence of only two clusters proves our hypothesis that the land is consolidating and small and medium-sized farms in Bulgaria are starting to disappear.

In a further analysis we aim to take the two municipalities that are extremums in our study and do a case study on them to understand what are the factors that facilitate such big differences from the other municipalities.

Conclusion

The present study shows that in agriculture the processes related to land relations are not always predictable. At the same time, "in the dynamic time in which we live, uncertainty and risks … take on new dimensions and forms" (Mantarova 2023 :71). Economic results are leading, but the role of agricultural holdings for the socio-economic development of rural areas is an unavoidable factor for their viability. The application of RDP and CAP in Bulgarian conditions leads to

Cluster 6. ANOVA

	Cluster		Error		F	Sig.
	Mean Square	df	Mean Square	df		
Number of holdings 2020	6049311,269	1	227092,477	261	26,638	,000
UAA 2020	55358227936,610	1	156060232,351	261	354,723	,000

The F tests should be used only for descriptive purposes because the clusters have been chosen to maximize the differences among cases in different clusters. The observed significance levels are not corrected for this and thus cannot be interpreted as tests of the hypothesis that the cluster means are equal.

Table 2

Cluster 1	Cluster 2
Belogradchik, Boynitsa, Bergovo, Vidin Gramada, Dimovo, Kula, Makresh, Novo Selo Ruzhnitsi, Chuprene, Borovan, Kozloduy, Krivodol, Mezdra, Mizia, Oryahovo, Roman Hairedin, Apriltsi, Letnitsi, Lukovit, Teteven, Troyan, Ugurchin, Yablanitsa, Berkovitsa, Boychinovtsi, Brusartsi, Varshets Georfi Damyanovo, Lom, Medkovets, Chiprovtsi, Yakimovo, Belene, Gulyantsi, Dolni Dabnik, Nikopol, Pordim, Cherven bryag, Gorna Oryahovitsa, Elena, Zlataritsa, Lyaskovets, Strazhitsa, Suchindol, Gabrovo, Dryanovo, Tryavna, Zavet, Isperih, Kubrat, Loznitsa, Samuil, Tsar Kaloyan, Borovo, Byala, Vetovo, Dve Mogili, Ivanovo, Slivo pole, Cenovo, Alfatar, Hlavnica, Kainardzha, Sitovo, Tutrakan, Avren, Aksakovo, Beloslav, Byala, Varna, Vetrino, Devnya, Dolni Chiflik, Dulgopol, Suvorovo, Krushari, Tervel, Shabla, Antonovo, Omurtag, Opaka, Veliki Preslav, Venets, Varbitsa, Kaolinovo, Kaspichan, Nikola Kozlevo, Novi Pazar, Smyadovo, Chitrino, Aytos, Malko Tarnovo, Nessebar, Pomorie, Primorsko, Rouen, Sozopol, Sredets, Sungurlare, Tsarevo, Kotel, Tvarditsa, Brothers Daskalovi, Gurkovo, Galabavo, Kazanlak, Maglizh, Nikolaevo, Opan, Pavel Banya, Bolyarovo, Yambol, Bansko, Belitsa, Blagoevgrad, Gotse Delchev, Garmen, Kresna, Petrich, Razlog, Sandanski, Satovcha, Simitli, Strumyani, Hadjidimovo, Yakoruda, Bobov Dol, Boboshevo, Dupnitsa, Kocherinovo, Kyustendil, Nevestino, Rila, Sapareva Banya, Treklyano, Breznik, Zemen, Kovachevtsi, Pernik, Trun, Total for Sofia Anton, Bozhurishte, Botevgrad, Godech, Gorna Malina, Dolna Banya, Dragoman, Elin Pelin, Etropole, Zlatitsa, Ikhtiman Koprivshtitsa, Kostenets, Kostinbrod, Mirkovo, Pirdop, Pravets, Samokov, Svoge, Slivnitsa, Chavdar, Chelopech, Ardino, Jebel, Kirkovo, Krumovgrad, Kardjali, Momchilgrad, Chernoochene, Batak, Belovo, Bratsigovo, Velingrad, Lesichovo, Panagyurishte, Peshtera, Rakitovo, September, Strelcha, Asenovgrad, Brezovo, Kaloyanovo, Karlovo, Krichim, Kuklen, Laki, Maritsa, Perushtitsa, Plovdiv, Parvomai, Rakovski, Rodopi, Sadovo, Stamboliyski, Saedeinenie, Hisarya, Banite, Borino, Devin, Dospa, Zlatograd, Madan, Nedelino, Rudozem, Smolyan, Chepelare, Ivaylovgrad, Lyubimets, Madzharovo, Mineralni Bani, Simeonovgrad, Stambolovo, Topolovgrad, Harmanli	Byala Slatina, Vratsa, Lovech, Valchedrum, Montana, Dolna Mitropolia, Iskar, Knezha, Levski, Pleven, Veliko Tarnovo Pavlikeni, Polski Trambezh, Svishtov, Sevlievo, Razgrad, Ruse, Dulovo, Silistra Valchi Dol, Provadia, Balchik, General Toshevo, Dobrich, Dobrichka, Kavarna, Popovo, Targovishte, Shumen, Burgas, Kameno, Karnobat, Nova Zagora, Sliven Radinovo, Stara Zagora, Chirpan, Elhovo, Straldzha, Tunzha, Radomir, Pazardzhik Dimitrovgrad, Svilengrad, Haskovo

a dichotomy, which expands the share of land used in large farms. This process has an adverse effect on the structure of cultivated species and farmed animals. During the period of the conducted research, these unfavorable processes deepened, which is also reflected by the results of the cluster analysis.

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References

Arthur, D. & Vassilvitskii, S. (2007). „k-means++: The advantages of careful seeding." Proceedings of the eighteenth annual ACM-SIAM symposium on discrete algorithms. Society for Industrial and Applied Mathematics.

Beluhova-Uzunova, R., Shishkova, M. & Hristov, K. (2023). Bulgarian agricultural structure and prospects post- 2023. Scientific *Papers Series Management, Economic Engineering in Agriculture and Rural Development*, *23*(2), 2285-3952. PRINT ISSN 2284-7995, E-ISSN.

Borisova, O., Abramova, L., Zageeva, L., Popkova, E., Morozova, I. & Litvinova, T. (2015). Role of agricultural clusters in provision of food security. *European Research Studies Journal, 18*(3), 287-298.

Bulgaria: 2020 agricultural census confirms farm consolidation and growth. (2021, May 26). USDA Foreign Agricultural Service. https://www.fas.usda.gov/data/bulgaria-2020-agricultural-census-confirms-farm-consolidation-and-growth#:~:text=The%202020%20census%20reveals%20that,HA%29%20per%20farm.

CAP 2023-27. (2023, October 12). Agriculture and Rural Development. https://agriculture.ec.europa.eu/common-agricultural-policy/cap-overview/cap-2023-27_en.

Dimitrova, A. (2023). Trends in the Development of the Structure of the Agricultural Holdings in Bulgaria. – *Economic Studies (Ikonomicheski Izsledvania), 32*(7), 191-204.

Dos Santos, M. J. P. L. (2016). Smart cities and urban areas – Aquaponics as innovative urban agriculture. *Urban Forestry & Urban Greening,* 20, 402-406.

Fidanska, B. & Koteva, N. (2021). The role of small farms for sustainable rural development. *Nauchni Trudove*, *LXII*(2), 32–45.

https://doi.org/10.22620/sciworks.2020.02.003.

Fredriksson, L., Rizov, M., Davidova, S. & Bailey, A. S. (2021). Farms in Bulgaria and Their Contributions to Food and Social Security. *Sustainability*, 13, 7635. https://doi.org/10.3390/su13147635.

Graver, R. (2006). Land Reform 2006/1 – / Reforme agraire 2006/1 – / Reforma agraria 2006/1 /. (n.d.). https://www.fao.org/3/a0306t/A0306T03.htm.

Ivanov, A. & Petrova, B. (2020). Agricultural policy and rural development in Bulgaria: Challenges and opportunities. *Bulgarian Journal of Agricultural Science, 26*(5), 1002-1010.

Janus, J. & Markuszewska, I. (2017). Land consolidation – A great need to improve effectiveness. A case study from Poland. *Land Use Policy*, *65*, 143–153. https://doi.org/10.1016/j.landusepol.2017.03.028.

Katrandjiev, H., Bankova, Y. & Jovanović, R. (2021). Do clusters and business environment foster national competitiveness in Bulgaria? A comparative study with Eu countries. EMC Review – Časopis Za Ekonomiju – APEIRON, 21(1).

Kogut, P. (2023, August 3). Monoculture Farming In Agriculture Industry. EOS Data Analytics. https://eos.com/blog/monoculture-farming/.

Kopeva, D., Nivelin, N. & Vladimir, E. (2002). Land fragmentation and land consolidation in the agricultural sector : a case study from Bulgaria – OICRF. (n.d.). https://www.oicrf.org/-/land-fragmentation-and-land-consolidation-in-the-agricultural-sector-a-case-study-from-bulgaria "Land Fragmentation And Land Consolidation In Ceec: A Gate Towards Sustainable Rural Development In The New Millenium" Organized By Fao, Gtz, Fig, Arge Landentwicklung And Technische Universität München Munich, 25-28 February 2002 Prepared by: Food and Agricultural Organization of the United Nations.

Lloyd, S. P. (1982). „Least squares quantization in PCM." IEEE Transactions on Information Theory 28.2, 129-137.

MacQueen, J. (1967, June). Some methods for classification and analysis of multivariate observations. In *Proceedings of the fifth Berkeley symposium on mathematical statistics and probability*, *1*(14), 281-297.

Meurs, M. & Bogushev, A. (2008). Frorward to the Past? Agricultural restructuring in Bulgaria. *Mediterranee N 110*-2008, 93 -104 https://www.academia.edu/17530214/Forward_to_the_Past_Agricultural_Restructuring_in_Bulgaria?email_work_card=thumbnail.

Piketty, T. (2017). *Capital in the twenty-first century* (A. Goldhammer, Trans.). Belknap Press. ISBN 9780674979857.

Popov, R. & Marinov, P. (2023). Development of Bulgarian agriculture within the CAP in the EU 2007-2020 in the context of the green deal, farms and employed people, relative to location index for rural areas of the South Central Region. *SHS Web of Conferences*, *176*, 03001. https://doi.org/10.1051/shsconf/202317603001.

Santos, I. G. D., Cruz, C. D., Nascimento, M., Rosado, R. D. S. & De Paula Ferreira, R. (2018). Direct, indirect and simultaneous selection as strategies for alfalfa breeding on forage yield and nutritive value. *Pesquisa Agropecuária Tropical*, *48*(2), 178–189. https://doi.org/10.1590/1983-40632018v4851950.

Santos, M. J. P. L. D. & Ahmad, N. (2020). Sustainability of European agricultural holdings. *Journal of the Saudi Society of Agricultural Sciences*, *19*(5), 358–364. https://doi.org/10.1016/j.jssas.2020.04.001.

Sculley, D. (2010). „Web-scale k-means clustering." Proceedings of the 19th international conference on World wide web. ACM.

Stiglitz, J. E. (2013). The Price of Inequality: How today's divided society endangers our future. W. W. Norton & Company.

Stoyanova, Z. & Harizanova-Bartos, H. (2019). Agriculture as a possible way for sustainable district development in Bulgaria. *CBU International Conference Proceedings*, *7*. https://doi.org/10.12955/cbup.v7.1380.

Willsey, T., Kwon, J. A., Reeves, M. K., Amidon, F. & Miller, S. E. (2020). Mariana Islands Forest. In *Elsevier eBooks,* 373–402. https://doi.org/10.1016/b978-0-12-409548-9.12012-3.

Yovchevska, P., Mihailova, M. & Koteva, N. (2022). Land Use in Bulgarian Agricultural Holdings and the Common Agricultural Policy. – *Economic Studies (Ikonomicheski Izsledvania)*, *31*(4), 145-165.

Kirechev, D (2022). Agroekologichen podhod za osiguryavane na ustoichivost na hranitelnata sistema. *Izvestiya spisanie na Ikonomicheski univesriste – Varna, 66*(1), 42-61.

Mantarova, A. (2023). Sastojanie i dinamikan na prestapnostta v Balgaria: pertseptsii i reaktsii. In: *Risk prevention and management.* Avangard Prima. Sofia, 280. ISBN 978-619-239-877-4 (Bg).

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