

Application of Cluster Analysis for Identifying Homogenous Zones of Operation of Agricultural Enterprises

The cluster analysis of agricultural enterprises is made by region of Ukraine. The analysis is made by the agricultural sector and its subsectors: plant-growing and animal husbandry. Homogenous regional zones characterizing the performance of agricultural enterprises are identified. The clustering is made using SPSS software. In the problems involved in the cluster analysis Euclidean distance is used. The cluster analysis is used for constructing green maps illustrating the impact of agricultural activities at enterprises on the production output of the agricultural sector and its subsectors: plant-growing and animal husbandry.

The constructed dendrogram was used for creating two clusters showing low and high performance of the plant-growing sector. The first cluster includes 17 regions of Ukraine have high performance along with low application of mineral fertilizers: Vinnytsya region, Dnipropetrovsk region, Donetsk region, Zhytomyr region, Zaporizhzhya region, Kyiv region, Kirovohrad region, Luhansk region, Mykolaiv region, Odesa region, Poltava region, Sumy region, Kharkiv region, Kherson region, Khmelnytsk region, Cherkasy region, and Chernihiv region. The second cluster includes 7 regions with low plant-growing performance along with intensive application of mineral fertilizers: Volyn region, Transkarpaty region, Ivano-Frankivsk region, Lviv region, Rivne region, Ternopil region, Chernivtsi region.

The characteristics of regional zones by agricultural production output, numbers of cattle and poultry, and agriculture performance give evidence that in view of the similarity in the conditions of their territories, they require similar measures aiming to improve business environment in the sector and mechanisms for the development of agroindustrial complex in Ukraine.

Keywords: *statistical analysis, agricultural enterprises, cluster analysis, plant-growing subsector, animal husbandry subsector, dendrogram, map, homogenous regional zones.*

Introduction. The development of agricultural sector is subject of importance in the Action Program of the Cabinet of Ministers of Ukraine [1; 2]. The government has elaborated priority areas of its implementation. The agricultural policy is designed to develop the sector at regional level; to enhance the socio-economic development in the regions; to delimitate lands in various forms of ownership, introduce the exclusively auction procedure for leasing of lands being in public or communal ownership, build the land leasing market (possibility to sell the rights and their mortgage); to simplify the procedure for registration of leasing contracts; to introduce the mechanisms for preservation and rehabilitation of land resources through melioration, re-cultivation, standard setting and standardization in the field of land protection; to grant the right for land disposal to consolidated territorial communities (or, otherwise, the obligatory negotiation of issues pertaining to land use with territorial communities). The abovementioned is supposed to boost the effectiveness of measures on government stimulation [1; 2]. This raises the importance of statistical assessment of the current business environment in the regions and regional zoning.

Literature review. The national practice has no established approach to cluster analysis and statistical assessment of the agricultural output. Scientists have outlined some aspects of this problem as part of education disciplines or research interests. Methodological, organizational and practical issues related with constructing the components of agricultural statistics are contributed by Z. Baranik, S. Herasymenko, A. Holovach, V. Yeleiko, A. Yerina, H. Kulahina, R. Motoryn, O. Osaulenko, N. Parfentseva and others. It should be noted, however, that the published works cover only a part of the problems associated with the

operation of agricultural enterprises in the regional perspective. Many aspects still remain overlooked and need further comprehensive studies and synthesis.

The objective of the study is to identify homogenous regional zones that characterize the performance of agricultural enterprises. Cluster analysis and green ecological mapping for agricultural enterprises of Ukraine is used to cluster the regions by agricultural sector as a whole; plant-growing subsector; and animal husbandry subsector.

The existing methodologies for identification and assessment of homogenous regional zones by the operation of agricultural enterprises offer an effective instrument for the assessment of agricultural performance in the Ukrainian regions. The indicators of the operation of agricultural enterprises include: production output; number of cattle; number of pigs; number of poultry; cultivated areas; available of grain combines; available tractors; mineral fertilizers applied per 1 ha of land. Each of the indicators proposed for the assessment of the operation of agricultural enterprises in the Ukrainian regions characterize a process or a phenomenon with an impact on the agricultural output.

Statistical data used in the analysis are obtained from official statistical observations (absolute and relative data), not including the temporary occupied territory of the Autonomous Republic of Crimea, the city of Sevastopol and a part of the antiterrorist operation area.

The SPSS software was used for grouping of the Ukrainian regions. In cluster analysis, the Euclidean distance is used, which is the most generalized distance.

Graphically, the clustering procedure can be depicted in form of dendrogram, given that this procedure operates only with components of the matrix of distances or similarities. Objects in the dendrogram are located horizontally at the bottom, and the results of clustering are located at the top. The magnitudes of distances or similarities in constructing new clusters are put on the vertical line on the left side [3, p. 76-77].

The standardized data were used to build the horizontal dendrogram of the classification of Ukrainian regions by agricultural output of enterprises (see Figure 1).

0 5 10 15 20 25

Fig. 1. Dendrogram of Ukrainian Regions by Agricultural Output in 2015

Source: constructed by data from [4]

The dendrogram in Figure 1 shows three clusters created by gross agricultural output. The first cluster covers six Ukrainian regions with the largest agricultural output: Vinnytsya

region, Dnipropetrovsk region, Kyiv region, Poltava region, Kharkiv region, and Cherkasy region (Figure 1, 2).

The second cluster includes 8 regions: Zaporizhzhya region, Kirovohrad region, Mykolaiv region, Odesa region, Sumy region, Kherson region, Khmelnytsk region, and Chernihiv region.

The third cluster comprises the largest number of the regions with the lowest agricultural output (Volyn region, Donetsk region, Transkarpaty region, Ivano-Frankivsk region, Luhansk region, Lviv region, Rivne region, Ternopil region, and Chernivtsi region). The map of Ukraine with cluster distribution (Figure 2) is constructed on the basis of the dendrogram (Figure 1) using the infographic software.

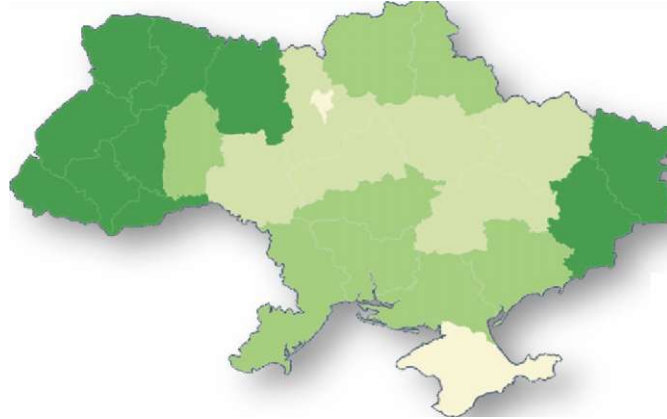


Fig. 2. The Map of the Regions' Distribution by Agricultural Output

Source: constructed by data of Fig. 1

The map shows that the regions are broken into three clusters (by agriculture performance indicators).

The cluster analysis of animal husbandry subsector is made by statistical indicators: number of cattle, thou. heads; number of pigs, thou. heads; number of poultry, thou. heads.

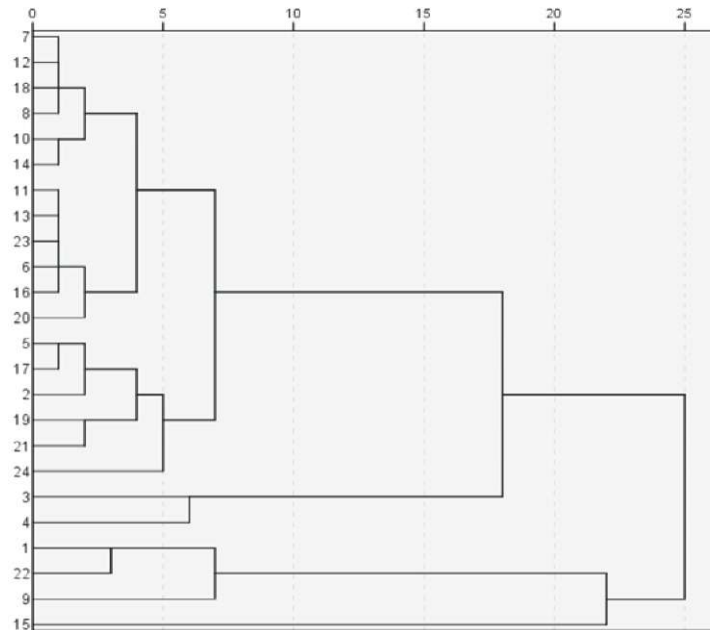


Fig. 3. The Dendrogram of Ukrainian Regions by Number of Cattle and Poultry

Source: constructed by data from [5]

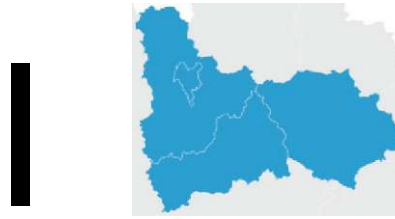


Fig. 4. The Map of Ukrainian Regions by Number of Cattle and Poultry

Source: constructed by data from Fig. 3 and [5]

The dendrogram (Figure 3) and the map (Figure 4) show two clusters formed by indicators of numbers of cattle and poultry. The first cluster includes the regions with the largest numbers of cattle and poultry (Vinnytsya region, Kyiv region, Poltava region, and Cherkasy region). The other ones are included in the second cluster.

The cluster analysis of the plant-growing subsector is made using the statistical indicators: cultivated areas, thou. ha; available tractors, units; mineral fertilizers applied per 1 ha of land; available grain combines, units. However, a problem with use of data in the cluster analysis exists, as no aggregate data are available on the plant-growing sector; the proposed indicators are, therefore, measured by incomparable scales.

Due to the incomparability of measurements units and the resulting impossibility of presenting the values of various indicators in one scale, the magnitude of intervals between the dots reflecting the objects' parameters in the space will be conditional on a scale, selected in a heuristic manner. In order to eliminate heterogeneity in measurement units of primary data, their standardization was made. They were normalized by being related to the values reflecting their characteristics.

Two clusters showing low and high levels of the plant-growing performance are constructed by use of the dendrogram (Figure 5).

17 Ukrainian regions have high plant-growing performance along with low application of mineral fertilizers: Vinnytsya region, Dnipropetrovsk region, Donetsk region, Zhytomyr region, Zaporizhzhya region, Kyiv region, Kirovohrad region, Luhansk region, Mykolaiv region, Odesa region, Poltava region, Sumy region, Kharkiv region, Kherson region, Khmelnytsk region, Cherkasy region, and Chernihiv region.

The second cluster includes 7 regions with low plant-growing performance along with intensive application of mineral fertilizers: Volyn region, Transkarpaty region, Ivano-Frankivsk region, Lviv region, Rivne region, Ternopil region, Chernivtsi region.

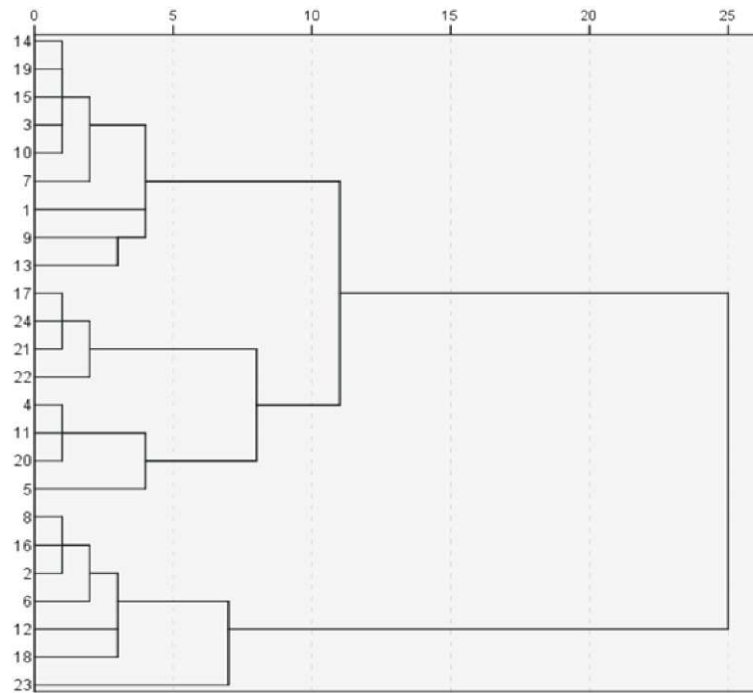


Fig. 5. The Dendrogram of Ukrainian Regions by Plant-Growing Performance
 Source: constructed by data from [6; 7]

Fig. 6. The Map of Ukrainian Regions by Plant-Growing Performance
 Source: constructed by data from [6; 7] and Figure 5

The cluster analysis of the agricultural sector is made using the following indicators: production output, million hryvnya; number of cattle, thou. heads; number of pigs, thou. heads; number of poultry, thou. heads; cultivated areas, thou. ha; availability of tractors, units; mineral fertilizers applied per 1 ha of land, kg; availability of grain combines, units.

Figure 7 shows homogenous regional zones of Ukraine by agricultural performance, identified by cluster analysis. The first cluster covers 17 regions where highly performing

agricultural enterprises are located. The other regional zones are located in less favorable conditions for operation of the agricultural sector, compared with the first cluster.

The second cluster (Volyn region, Transkarpaty region, Ivano-Frankivsk region, Lviv region, Rivne region, Ternopil region, Chernivtsi region) covers mainly the regions with less favorable natural and climate conditions for agricultural activities.

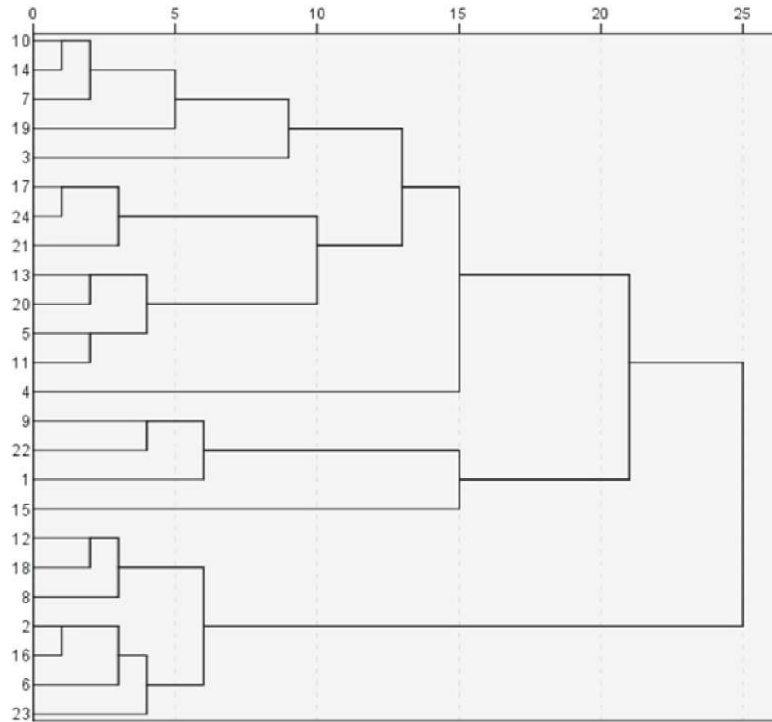


Fig. 7. The Dendrogram of Ukrainian Regions by Agriculture Performance
Source: constructed by data [4-8]

Fig. 8. The Map of Ukrainian Regions by Agriculture Performance

Source: constructed by data [4-8] and Fig. 7

The characteristics of regional zones by agricultural production output, numbers of cattle and poultry, and agriculture performance give evidence that in view of the similarity in the conditions of their territories, they require similar measures aiming to improve business environment in the sector and mechanisms for the development of agroindustrial complex in Ukraine.

Further studies with use of cluster analysis should be focused at constructing dendrograms and maps by category of polluted substances, and by amount of air pollution from stationary pollution sources, generated by the operation of agricultural enterprises. An important field of regional agricultural policies has to be analysis of ecological effects from the operation of agricultural enterprises.

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Застосування кластерного аналізу для виокремлення однорідних зон діяльності сільськогосподарських підприємств

Здійснено кластерний аналіз сільськогосподарських підприємств за регіонами України. Кластерний аналіз проведено за галуззю сільського господарства загалом і за його підгалуззями - рослинництвом та тваринництвом. Виокремлено однорідні регіональні зони, які характеризують ефективність діяльності сільськогосподарських підприємств. З метою розподілу регіонів України на групи використано програму SPSS. У задачах кластерного аналізу використовувалась евклідова відстань. На основі кластерного аналізу побудовано зелені карти, які характеризують вплив сільськогосподарської діяльності підприємств на виробництво продукції сільського господарства та його підгалузей - рослинництва та тваринництва.

Ключові слова: статистичний аналіз, сільськогосподарські підприємства, кластерний аналіз, галузь рослинництва, галузь тваринництва, дендрограма, картограма, однорідні регіональні зони.

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Применение кластерного анализа для выделения однородных зон деятельности сельскохозяйственных предприятий

Выполнен кластерный анализ сельскохозяйственных предприятий по регионам Украины. Кластерный анализ проведен по отрасли сельского хозяйства в целом и по его подотраслям - растениеводству и животноводству. Выделены однородные региональные зоны, характеризующие эффективность деятельности сельскохозяйственных предприятий. С целью распределения регионов Украины по группам использована программа SPSS. В задачах кластерного анализа использовалось евклидово расстояние. На основе кластерного анализа построены зеленые карты, характеризующие влияние сельскохозяйственной деятельности предприятий на производство продукции сельского хозяйства и его подотраслей - растениеводства и животноводства.

Ключевые слова: статистический анализ, сельскохозяйственные предприятия, кластерный анализ, отрасль растениеводства, отрасль животноводства, дендрограмма, картограмма, однородные региональные зоны.

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