EVALUATION OF SOME EFFECTIVENESS ELEMENTS OF THE PIG BREEDING INDUSTRY IN BULGARIA, THROUGH CLUSTER ANALYSIS

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Abstract: An evaluation was made of the effectiveness elements of the pig breeding industry in Bulgaria in the period 2001-2016, through cluster analysis. The studied period was divided in 3 subperiods, each one with three similar groups (clusters). Through application of cluster analysis, the proximity of the different administration regions in the country was defined in accordance with certain indicators of the pig breeding effectiveness. It was found that in the first cluster for the period 2001-2006 fall North-Western and South-Western region. The North-Eastern and North-Central region form the second cluster. The South-Eastern and South-Central region fall mainly into the third cluster. In the first cluster for the period 2007-2011, the North-Western, South-Western and South-Central regions have a priority with the lowest number of sold animals. The North-Eastern and the North-Central region, forming a third cluster, remain with the highest effectiveness of the pig farming. After the end of 2013 an aggregation of the sector began. For the period 2012-2016, the second cluster is formed from three regions – North-Western, South-Western, and South-Central in 2013.

Key words: clusters, cluster analysis, effectiveness, pig breeding, regions

Introduction

Pig breeding in Bulgaria, as part of livestock breeding, has its own deep traditions, despite the dynamics in its development through the years. The instable economic environment in the period 1990-2010 led to a decrease in the number of pigs, which inevitably led to a drop in the industry. As a result of this negative statistic, the production of pork is below the level it was in its beginning in the previous century *(Dermendzhieva et al.,2013)*. According to *Ivanova et al. (2011)* after the slight stabilization of the livestock breeding industry in 1997-2000, the production has decreased, as a decrease of nearly 2% of the gross added value in it

has been reported. What is worrying is that the biggest decrease in the gross production is reported exactly in pig breeding.

For more than 20 years the economic environment in the country has been too dynamic and insecure, which has put domestic pig breeding in difficult situations. After our country joined the European Union, the qualification of pig carcases under the (S)EUROP system became obligatory for Bulgarian pig breeding, too. According to *(Otouzbirov and Zhelyazkov, 2008)* this will lead to improvement of the selection process, increase of the productive and slaughterhouse qualities of the pigs, but in parallel with this, the consumers shall pay a higher price at the purchase of pork.

The analysis of the state of pig breeding by regions and in different stages of development, allows the making of an evaluation of the effectiveness of the industry, especially when keeping in mind its dynamic state through the years.

All this gave us a reason to make an evaluation of some effectiveness elements of the pig breeding industry in Bulgaria by means of cluster analysis.

Material and Methods

The analyzed material consisted of data from the bulletin of the Agrostatistics Department of Ministry of Agriculture and Food (MAF) about the farm animals in Bulgaria, the activity of slaughterhouses for red meat and meat production in the country, Annual Report on the Status and Development of Agriculture in the period from 2001 to 2017, as well as National Strategy for stable development in Agriculture in Bulgaria in 2014-2020 (MAF, 2013).

The following indicators were analysed: 1. Number of slaughterhouses; 2. Total amount of slaughterhouse meat (t), 2.1. Including meat from pigs (t); 3. Sold pigs (transmitted to slaughterhouses, slaughtered in farms and sold to intermediaries) (in thousands); 4. Number of farms, where sows are bred, 4.1. Number of bred sows; 5. Number of farms, where total pigs bred, 5.1. Number of total pigs bred.

In order to form groups based on the specified indicators, we used the K-Means Cluster method. The Euclidean distance between the groups was used as a measurement of similarity.

The studied period was divided in 3 subperiods (2001-2006, 2007-2011 and 2012-2016), each one with three similar groups. Figures, which represent the grouping of the studied indicators in clusters graphically, were built.

The statistic processing was performed with IBM software product SPSS version 24.

Results and Discussion

After Bulgaria joined the European Union, the geographical zoning of the country is performed in accordance with Regulation (EO) No. 176/2008. According to this document, our country is divided in 6 regions – North-Western, North-Central, North-Eastern, South-Eastern, South-Western, and South-Central one (Fig.1).
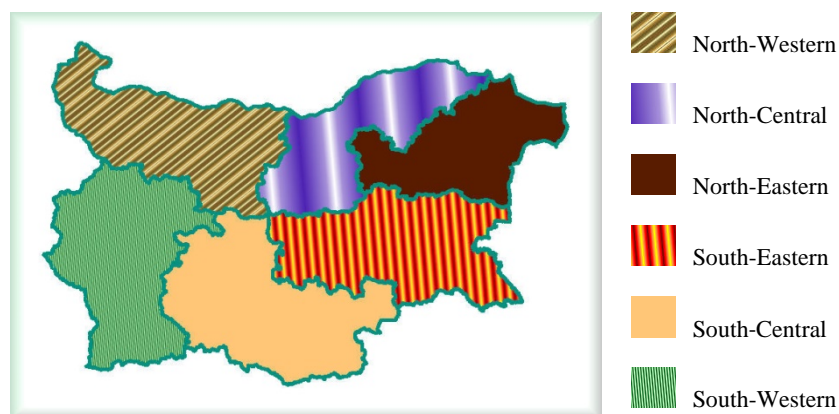

North-Western

North-Central

North-Eastern

South-Eastern

South-Central

South-Western

Fig. 1. A common classification of territorial units for statistics (NUTS) by reason of the accession of Bulgaria to the European Union

When forming the clusters for the first studied period, the indicators with the biggest significance are the ones for the amount of the obtained meat, sold pigs in slaughterhouses and farms, as well as their number in different categories. (Table 1). The total number of slaughterhouses does not have an effect on grouping.

Table 1. F-criterion and degree of reliability (ANOVA table)

	F-criterion and degree of reliability		
	2001-2006	2007-2011	2012-2016
1.NS	2.315	6.065**	0.515
2. TASM	12.386***	8.678**	2.79*
2.1. TASM incl. pork	5.953**	4.344*	3.149*
3. SP	97.623***	134.704***	2.636*
4. NFSB			13.666***
4.1. NBS	16.362***	35.799***	3.534*
5. NFTPB			98.012***
5.1. NTPB	51.884***	75.652***	2.129
***P<0.001; **P<0.01; *P<0.05			

The F-criterion was used for the purposes of the description only, without having to consider hypotheses *(Harizanova-Metodieva et al., 2016)*

1. NS-Number of slaughterhouses; 2. TASM-Total amount of slaughterhouse meat (t), 2.1. TASM incl. pork-Including meat from pigs (t); 3. SP-Sold pigs (transmitted to slaughterhouses, slaughtered in farms and sold to intermediaries) (in thousands); 4. NFSB Number of farms, where sows are bred, 4.1. NBS-Number of bred sows (in thousands); 5. NFTPB-Number of farms, where total pigs bred (in thousands), 5.1. NTPB-Number of total pigs bred (in thousands)
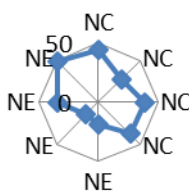
Table 2 shows the final cluster centres, by periods. The first cluster for 2001-2006 displays relative similarity in the studied indicators in the North-Western and South-Eastern regions (Fig 2a). This is the group with the lowest number of bred and sold pigs. The North-Eastern and the North-Central regions form the second cluster (Fig 2b). These are regions, rich in cereal crops, and, where regularly the highest number of pigs from different categories, is bred and sold. The central point of the second cluster includes 32.38 slaughterhouses, with 10.23 thousand tonnes of pork, nearly 269 thousand animals sold in slaughterhouses and farms (Table 2). For the period 2001-2006, the third formed cluster takes a middle ground in all studied indicators, with the exception of the amount of carcass, which is the lowest, compared to the two other similar groups. The South-Eastern and South-Central regions fall into this cluster, the South-Western, with its indicators from 2003, and North-Eastern in 2001 (Fig. 2c).
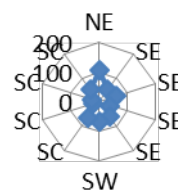

2001-2006 (Fig.2a)

2001-2006 (Fig.2b)

2001-2006 (Fig.2c)

Table 2. Final cluster centres

Period	2001-2006			2007-2011			2012-2016		
Cluster	1	2	3	1	2	3	1	2	3
Traits									
1. NS	27.75	32.38	20.80	9.82	12.67	14.70	12.21	11.00	11.50
2. TASM	7.33	15.60	5.52	6.78	5.57	14.83	12.37	10.11	7.60
2.1. TASM incl. pork	5.31	10.23	4.62	5.92	4.88	10.63	10.88	8.77	ll
3. SP	59.25	269.4	138.4	60.5	137.9	297.3	206.1	39.00	128.9
4. NFSB							274.53	726.00	669.50
4.1. NBS	7.25	21.44	15.17	4.61	10.53	15.09	9.18	3.07	5.76
5. NFTPB							2375.5	13422.3	6631.5
5.1. NTPB	94.33	245.4	173.1	53.6	132.1	189.6	114.1	41.3	74.5
1. NS-Number of slaughterhouses; 2. TASM-Total amount of slaughterhouse meat (t), 2.1. TASM incl. pork-Including meat from pigs (t); 3. SP-Sold pigs (transmitted to slaughterhouses, slaughtered in farms and sold to intermediaries) (in thousands); 4. NFSB Number of farms, where sows are bred, 4.1. NBS-Number of bred sows (in thousands); 5. NFTPB-Number of farms, where total pigs bred (in thousands), 5.1. NTPB-Number of total pigs bred (in thousands)									

Table 3. Distances between the final cluster centres

	2-nd cluster	3-th cluster
2001-2006		
1-st cluster	259.364	112.162
2-nd cluster	-	150.608
2006-2011		
1-st cluster	110.483	273.460
2-nd cluster	-	169.815
2012-2016		
1-st cluster	11057.532	4275.148
2-nd cluster	-	6791.745

The proximity between the separate homogeneous groups, reported through the Euclidean distance, shows that the first and third cluster are more similar in the studied indicators (112.162), compared to the second and the third (150.608). During the first analysed period, the first and second cluster share the lowest number of common characteristics (Table 3).

The state of pig breeding in the economic year of 2007 is defined, to a certain extent, by the unfavourable weather conditions and subsequent low grain yields, and the high prices of concentrated fodders. That was the first year of Bulgarian membership in the European Union. The total number of pigs decreased by 12.3% compared to 2006 and by 8.8% compared to 2005. The same trend to a decrease is observed with the sows as well as in the number of pig-breeding farms *(Zapryanova, 2015)*.

2007-2011 (Fig.3a) — Distance from the center of the 1-st cluster

2007-2011 (Fig.3b) — Distance from the center of the 2-nd cluster

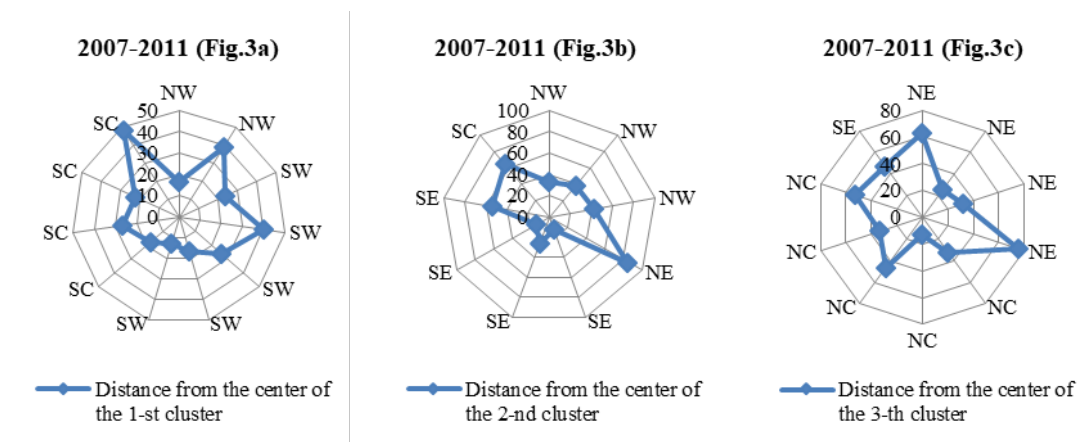2007-2011 (Fig.3c) — Distance from the center of the 3-th cluster

The yield of pork carcass after 2000 is relative parallel through the years in all regions, without sharp amplitudes in the values. The North-Eastern region makes an exception in the period 2006-2008, as from relatively moderate, it turns into a centre of the produced amount of carcass with 22.95 thousand tonnes in 2007 *(Zapryanova, 2018).*

In the first cluster for the period 2007-2011, the North-Western, South-Western and South-Central regions have a priority (Fig. 3a). The lowest number of sold animals (60.4 thousand animals) is characteristic of the group, as well as the number of the animals from all categories, which are bred in these regions (Tabl.2). The number of the slaughterhouses is also the lowest, but unlike the previous period, this indicator has significant effect on formation of the cluster (Tabl.1). Regardless of the serious decrease of the values of the indicators, the North-Eastern and North-Central region, forming the third cluster, remain with the higher effectiveness in pig breeding (Tabl. 2, Fig. 3c). The second homogeneous group, including mainly the North-Western and South-Eastern region has the characteristics of 12.67 number of slaughterhouses, 4.88 thousand tonnes of pork (which is the lowest for the studied period), the number of the bred sows and the total number of pigs take a middle position, respectively with 10.53 and 132.1 thousand animals (Tabl. 2, Fig. 3b).

The most distant in their homogeneity are the first and third cluster (the Euclidean distance is 273.460), and most similar are first and second cluster (the Euclidean distance is 110.483) (Tabl. 3).

Within the last studied period, we have the possibility to add two more indicators – number of farms, where sows are bred, as well as animals from the other categories. These two indicators have reliable effect on the formation of the clusters (Tabl.1). In this time span, however, the number of slaughterhouses as well as the total number of pigs, appears an unreliable source at the formation of homogeneous groups.

2012-2016 (Fig.4a) 2012-2016 (Fig.4b) 2012-2016 (Fig.4c)
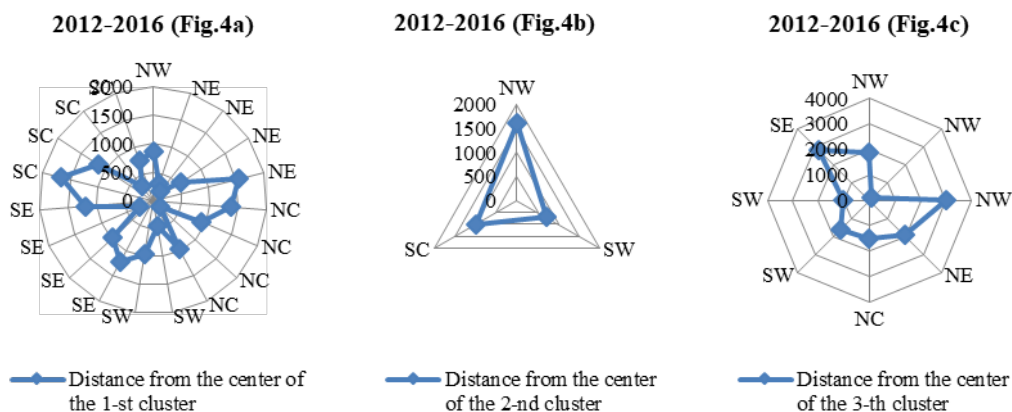
Reviewing the three formed clusters (Fig 4a, b, c) the one that makes the most impression in the second one, which is formed from three regions – the North-Western, South-Western and South-Central one – in 2013. Main features of this cluster are the lowest number of sold animals (39 thousand animals), the lowest total number of pigs, but with the highest number of farms, where these animals are bred (Tabl. 2).

The difference between the first and third cluster is the higher number of observations in all regions and years, which form the first group. At the same time, here is the highest number of slaughterhouses (12.21), sold pigs (206.05 thousand animals), lowest number of farms, where the highest number of pigs of different categories are bred.

In our previous research we concluded that consolidation of the sector was reported after the end of 2013, when the number of pigs on farms with more than 200 animals increased by 5.3 thousand, although the number of farms dropped down. In the last five years the largest share of the pigs has been concentrated in three regions of the country – North Central, South-Eastern and North-Eastern *(Zapryanova, 2015).*

Conclusions

The first cluster for the period 2001-2006 shows a relative similarity in the studied indicators in the North-Western and South-Western region. The North-Eastern and North-Central region form the second cluster. The South-Eastern and South-Central region fall mainly into the third cluster.

In the first cluster for the period 2007-2011, the North-Western, South-Western and South-Central regions have a priority with the lowest number of sold

animals. The North-Eastern and the North-Central region, forming a third cluster, remain with the highest effectiveness of the pig farming. The second homogeneous group includes mainly North-Western and South-Eastern region.

After the end of 2013 an aggregation of the sector began. For the period 2012-2016, the second cluster is formed from three regions – North-Western, South-Western, and South-Central in 2013. The difference between the first and the third cluster is the higher number observations in all regions and years. The highest number of slaughterhouses is in the first group (12.21), sold pigs (206.05 thousand animals), the lowest number of farms where the highest number of pigs from different categories is bred.

Evaluacija nekih elemenata efikasnosti svinjarstva u Bugarskoj, kroz klaster analizu

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Rezime

Izvršena je evaluacija elemenata efikasnosti svinjarstva u Bugarskoj u periodu 2001-2016, kroz klaster analizu. Proučavani period je podeljen u 3 podperioda, svaki sa tri slične grupe (klasteri). Primenom klaster analize utvrđena je blizina različitih administrativnih područja u zemlji u skladu s određenim pokazateljima efikasnosti uzgoja svinja. Utvrđeno je da u prvi klasteru za period 2001-2006 pada severozapadni i jugo-zapadni region. Severoistočni i severno-centralni region čine drugi klaster. Jugoistočni i južno-centralni region uglavnom spadaju u treći klaster. U prvom klasteru za period 2007-2011, severozapadni, jugo-zapadni i južno-centralni region imaju prioritet sa najmanjim brojem prodatih životinja. Severoistočni i severno-centralni region, koji formiraju treći klaster, su regioni sa najvećom efikasnošću u svinjarstvu. Nakon kraja 2013. godine počela je agregacija sektora. Za period 2012-2016, drugi klaster je formiran iz tri regiona - severozapadni, jugo-zapadni i južno-centralni u 2013. godini.

Ključne reči: klasteri, klaster analiza, efektivnost, uzgoj svinja, regioni

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