

# Evaluating the Performances of Livestock Production Management. An Empirical Analysis of EU Countries

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## **Abstract**

*At national level the livestock production domain is passing through severe changes as it needs to adapt to the European framework promoted in the European Union. The micro farms are lowering their importance and are replaced by larger facilities which have a higher economic competitiveness and also an increased sustainability.*

*In this context, revealing the performance gap between Romanian livestock production and other EU member states is regarded by the policymakers with an increased attention.*

*This paper aims to evaluate the performances of livestock production management of 28 EU countries in 2014 using the hierarchical cluster analysis and to analyze the performance gap between Romania and the other EU states.*

*In order to do that, data for livestock production by type of animals is used.*

*The empirical results revealed the existence of six clusters of countries.*

*France, Spain, Germany and United Kingdom are the main actors in the field, forming each a separate class. There is a separate cluster formed by Netherlands, Poland and Denmark and the rest of the countries.*

*From the livestock production perspective, Romania forms a subclass with Greece and Italy.*

**Keywords:** *livestock production, cluster analysis, European Union states.*

**JEL classification:** Q10, R11, O13, C38.

## **1. Introduction**

Livestock production constitutes a very important component of the agricultural economy of developing countries, a contribution that goes beyond direct food production to include multipurpose uses, such as skins, fibre, fertilizer and fuel, as well as capital accumulation. Furthermore, livestock are closely linked to the social and cultural lives of several million resource-poor farmers for whom animal ownership ensures varying degrees of sustainable farming and economic stability.

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The livestock sector is one of the most dynamic sectors in the nowadays economical environment at global level. The positive dynamic is based on two main pillars: in the developing countries the sector is increasing rapidly as a consequence of the general development of the country and in particular as a direct consequence of the increasing buying power of the inhabitants, and in the developed countries even though the demand is not increasing significantly the production facilities increase their productivity and improve their sustainability.

Therefore it is obvious that the evolution of the field (livestock production) is directly connected with the increase of world population, with the increasing purchase power around the world and with the increasing urbanization level. In order to evaluate the importance of the livestock production in the modern world it is extremely important the statement made by Steinfeld in a work published in 2006 where he asserts that livestock systems occupy about 30 per cent of the planet's ice-free terrestrial surface area.

At national level the livestock production domain is passing through severe changes as it needs to adapt to the European framework promoted in the European Union. Following this direction the micro farms are lowering their importance and are replaced by larger facilities which have a higher economic competitiveness and also an increased sustainability.

Taking in account all these changes it is obvious that revealing the performances gap between Romania and other EU member states in this domain should be regarded by the policymakers with an increased attention.

## **2. Livestock production – general framework**

Livestock production plays a central role in the food security at global level and also at the level of the European Union. Therefore the livestock production should be regarded as a very important economical aspect by all member states of the European Union in general and by countries like Romania in particular (countries with an important expertise in this domain and with a very important potential).

The importance of livestock production is also emphasized by the fact that the share of animal products in the human diet has increased significantly during the recent decades. The underlying motives of these trends are multiple and they are mostly connected with the expansion of the modern lifestyle (Steinfeld et al., 2010). Noticeable is also the fact that the domain is increasing its industrial characteristics (Haan et al., 2010) at global level, being therefore considered as having an increased impact on environmental aspects with serious impact on climate change and climate problems (Steinfeld et al., 2006). In this direction is very important to take in consideration that the intensification of the process in areas with little agricultural land leads to other serious environmental impact, regarding water soil and biodiversity mostly caused by manure and waste water which are not properly managed. A clear description of these effects is presented by Menzi in a study presented in 2001.

The intensification of animal production systems proceeded rapidly in the latter part of the twentieth century, often aided by government support. However, only short-term benefits of intensification were realized and consumers started to select animal produce from less intensive production systems in the belief that it would be healthier, kinder to the animals and less likely to cause damage to the environment. Recent research has shown that the production of high quality traditional dairy products will provide an income for more people than intensive dairy production, thus helping to serve as a functional basis for rural land use. It is often argued that extensive production cannot produce enough food for the majority of the population, but such estimates rely on outdated and inadequate levels of output from the traditional systems.

The increased potential lifespan of the human population will encourage people to consume products that promote longevity, such as those with minimal contamination by pollutants. In many parts of the world, but particularly in the central continental land masses, livestock production will be challenged by global warming. Traditional production systems are likely to survive better, as they are buffered against variations in weather. It is concluded that livestock production systems have the potential to provide high quality food and employment, especially in marginal areas, and to preserve the land for the benefit of future generations. However, if badly managed, intensive systems may lead to major adverse effects on the environment, damage to human health and a reduction in food supply for those in developing countries.

### **3. Analysis of livestock production at European Level**

In recent years, the European Union (EU) has been active in harmonizing animal health measures and systems of disease surveillance, diagnosis and control; it has also developed a legal framework for trade in live animals and animal products. In part, this has been in response to consumer concerns regarding public health and food safety aspects of animal health. In this regard, the European Commission established a framework for animal health and welfare measures for the period 2007–13. In addition, the revision of legislation in 2004 on the hygiene of foodstuffs — known as the hygiene package — was implemented in the enlarged EU, with the aim of ensuring the hygiene of foodstuffs at all stages of the production process through to sale.

The EU's Common Market Organisations (CMOs) for the meat sector establish common rules and policy instruments for managing relevant markets: to stabilize markets; to restore levels of consumption of animal products, and; to make animal products more competitive on the world market. As such, policies for the meat sector try to address concerns of producers, meat processors and consumers.

Statistics on livestock give some indication of supply-side developments and adjustments, which are important to monitor the common agricultural policy (CAP).

In 2010 the total livestock population in the EU-27 amounted to 134 million livestock units which was a decrease of -2 % compared with 2005. Cattle made up 47 % of the livestock population (in LSU), pigs 27 %, poultry 15 % and sheep 7 %. In 14 Member States at least half of the livestock population consisted of cattle, the share of cattle in total livestock measured in LSU ranged from 19 % in Greece to 85 % in Luxembourg.

The livestock population decreased in most countries, with the largest decrease noted in Lithuania (-30 % and -28 % respectively). Total livestock increased however in Denmark (+8 %), Portugal (+7 %), Luxembourg (+6 %), the Netherlands (+5 %), Latvia (+4 %), Italy (+4 %), Spain (+3 %) and Austria (+3 %) and remained more or less the same in Switzerland, France, Poland and Hungary.

In 2010 the majority of livestock (81 % of total livestock) in EU-28 could be found in EU-15. Compared to 2000 the number of livestock in LSU in EU-15 in 2010 decreased with 6 %, the sheep population decreased with 20 % and cattle and goats with 9 % while the poultry and pig population remained more or less stable. **Almost half of the livestock is cattle**, a large part of the cattle population in EU-28 in 2010 (measured in LSU) being found in France (22 %), Germany (14 %) and the United Kingdom (11 %). Cattle were particularly dominant in Luxembourg and Ireland in 2010 where the share of cattle in total livestock was larger than 80 %.

The cattle population decreased in most Member States between 2005 and 2010, with the largest decreases occurring in Lithuania (-26 %) and Romania (-27 %) and Malta (-19 %). In Denmark, Hungary, France, Austria, Slovenia and Spain the cattle population remained more or less stable, while the cattle population increased in Poland (+3 %), the Netherlands (+4 %), Latvia (+7 %), Luxembourg (+8 %) and Portugal (+8 %).

In 2010 there were 152 million heads of pigs in EU-27, a slight decrease of 2 % compared to 2005. A large part of the pig population in 2010 in EU-28 is found in Germany (17 %), Spain (17 %), Poland (10 %), Denmark (9 %), France (9 %), Netherlands (7 %) and Italy (7 %). In Denmark, pigs represented 71 % of the total livestock units: Denmark was the only Member State where pigs accounted for more than half of the livestock population, although pigs were the largest category of livestock in three other Member States (Cyprus, Spain and Malta).

The pig population (measured in LSU) decreased between 2005 and 2010 in most Member States, with reductions over 20 % in Bulgaria, Czech Republic, Cyprus, Lithuania, Hungary, Slovenia and Slovakia, while pig populations increased in Denmark (+10 %), Estonia (+13 %), Greece (+4 %), Spain (+5 %), Italy (+7 %), Netherlands (+5 %) and remained more or less stable in Belgium, France, Austria, Portugal, Finland and Romania.

## Livestock population in EU-28 (1000 LSU)

**Table 1.**

	Livestock		Cattle		Sheep		Goats		Pigs	
	2005	2010	2005	2010	2005	2010	2005	2010	2005	2010
<b>EU-28</b>	:	135 212	:	64 045	:	9 539	:	1 231	:	37 076
<b>EU-27</b>	136 823	134 192	65 368	63 672	10 552	9 510	1 242	1 220	37 308	36 694
<b>EU-15</b>	110 260	109 905	54 690	53 856	9 376	8 258	1 050	1 003	28 970	29 520
<b>BE</b>	3 885	3 799	1 910	1 831	15	12	3	3	1 560	1 579
<b>BG</b>	1 327	1 149	498	474	145	142	50	39	236	177
<b>CZ (1)</b>	2 057	1 722	1 040	961	14	18	1	2	709	457
<b>DK (3)</b>	4 566	4 919	1 134	1 134	17	16	1	1	3 198	3 516
<b>DE (1)</b>	18 051	17 793	9 331	9 060	261	209	-	15	6 605	6 390
<b>EE</b>	316	306	202	182	7	9	1	0	79	89
<b>IE</b>	6 220	5 787	4 989	4 743	624	475	1	1	399	379
<b>EL</b>	2 480	2 407	507	466	907	916	482	421	234	244
<b>ES (3)</b>	14 452	14 831	4 110	4 165	1 966	1 657	253	236	5 854	6 155
<b>FR</b>	22 703	22 674	13 753	13 661	880	748	130	143	3 218	3 226
<b>HR (2)</b>	:	1 020	:	373	:	89	:	11	:	361
<b>IT (2)</b>	9 564	9 912	4 539	4 363	699	678	92	86	2 287	2 455
<b>CY</b>	244	201	43	39	25	27	32	24	101	77
<b>LV</b>	456	475	279	298	4	8	2	1	109	97
<b>LT</b>	1 290	900	783	576	4	6	6	2	310	201
<b>LU (3)</b>	158	168	133	143	1	1	0	1	19	18
<b>HU</b>	2 502	2 484	532	525	141	120	8	9	993	793
<b>MT</b>	46	42	15	12	1	1	1	0	18	17
<b>NL (3)</b>	6 388	6 712	2 678	2 777	136	113	29	35	2 371	2 496
<b>AT</b>	2 454	2 517	1 421	1 434	32	40	5	8	799	792
<b>PL (1)</b>	10 435	10 377	4 282	4 406	31	26	12	11	4 072	3 657
<b>PT</b>	2 070	2 206	950	1 030	253	222	44	42	455	459
<b>RO</b>	6 603	5 444	2 293	1 667	760	841	78	124	1 356	1 372
<b>SI</b>	524	518	330	332	13	14	3	3	120	92
<b>SK (1)</b>	768	668	382	343	31	39	1	1	236	144
<b>FI</b>	1 158	1 121	677	656	9	13	1	0	333	328
<b>SE (3)</b>	1 835	1 752	1 124	1 075	47	56	-	-	434	370
<b>UK (1)</b>	14 278	13 308	7 435	7 118	3 528	3 103	9	9	1 204	1 113

**Source:** Eurostat (FSS 2005 and 2010 LS\_DENS\_REG\_B, LS\_DENS\_REG\_THCZ, LS\_DENS\_REG\_THDE, LS\_DENS\_REG\_THPL, LS\_DENS\_REG\_THSK, LS\_DENS\_REG\_THUK).

In 2010 there were 1.6 billion heads of poultry in EU-27, an increase of 7 % compared to 2005. The largest poultry populations in EU-28 in 2010 are found in France (21 %), Spain (12 %), Italy (11 %), Poland (10 %), Germany (9 %) and the United Kingdom (9 %). The poultry population (measured in LSU) decreased between 2005 and 2010 in Lithuania (-31 %), Romania (-29 %), Ireland (-27 %), Cyprus (-20 %), Finland (-16 %), Malta (-15 %), Bulgaria (-14 %), Estonia (-12 %), Belgium (-8 %), United Kingdom (-7 %) and in the Czech Republic (-4 %), while poultry populations increased in Slovenia (+39 %), Austria (+29 %), Portugal (+29 %), Hungary (+27 %), Latvia (+22 %), Denmark (+19 %), Slovakia (+18 %), Italy (+18 %), Germany (+17 %), Poland (+16 %), Spain (+15 %), Netherlands (+10 %), Greece (+5 %) and in Sweden (+4 %) and remained more or less stable in France and Luxemburg.

In 2010 there were 95 million heads of sheep (-10 % decrease compared to 2005) and 1.2 million heads of goats (-2 % decrease compared to 2005) in EU-27. The majority of the sheep population in EU-28 in 2010 is found in the United Kingdom (32 %), Spain (17 %), Greece (10 %), Romania (9 %), France (8 %), and Italy (7 %), and goats in Greece (35 %), Spain (19 %), France (12 %), Romania (10 %) and Italy (7 %). Greece was the only Member State where sheep were the largest category of livestock, sheep have also a relatively high share in total livestock in the United Kingdom (23 %). More than one third (38 %) of the livestock in Greece consisted of sheep, while goats accounted for a further 18 %.

### Livestock numbers per EU Member State, 2014

Table 2.  
Thousand head (animals)

	Bovine animals	Goats	Sheep	Pigs
<b>EU-28</b>	88,378.57	:		148,309.93
<b>Belgium</b>	2,477.24	:	:	6,350.29
<b>Bulgaria</b>	562.36	117	1,335.28	553.11
<b>Czech Republic</b>	1,373.07	:	:	1,606.86
<b>Denmark</b>	1,553	0	:	12,709
<b>Germany</b>	12,742.19	4,254	1,600.78	28,338.99
<b>Estonia</b>	264.7	2,704.25	:	357.9
<b>Ireland</b>	6,243.05	1,271	3,324.9	1,505
<b>Greece</b>	659	61	9,072	1,046
<b>Spain</b>	6,069.69	937.03	15,431.83	26,567.58
<b>France</b>	19,253	240	7,168	13,293
<b>Croatia</b>	441	:	605	1,156
<b>Italy</b>	6,125.42	13	7,166.02	8,676.1
<b>Cyprus</b>	59.54	:	322.4	342.07
<b>Latvia</b>	422.02	70	:	349.43
<b>Lithuania</b>	736.6	4.63	123.9	714.2
<b>Luxembourg</b>	201.15	441	:	92.69
<b>Hungary</b>	802	70.71	1,185	3,136
<b>Malta</b>	14.88	:	10.53	47.25
<b>Netherlands</b>	4,169	382.05	1,070	12,065
<b>Austria</b>	1,961.2	1,417.2	349.09	2,868.19
<b>Poland</b>	5,660.27	:	:	11,265.65
<b>Portugal</b>	1,548.61	35.18	2,032.62	2,126.91
<b>Romania</b>	2,068.9	:	9,518.2	5,041.7
<b>Slovenia</b>	468.25	0	:	281.68
<b>Slovakia</b>	465.54	0	391.15	641.83
<b>Finland</b>	907.4	:	:	1,222.6
<b>Sweden</b>	1,436.49	:	588.76	1,468.9

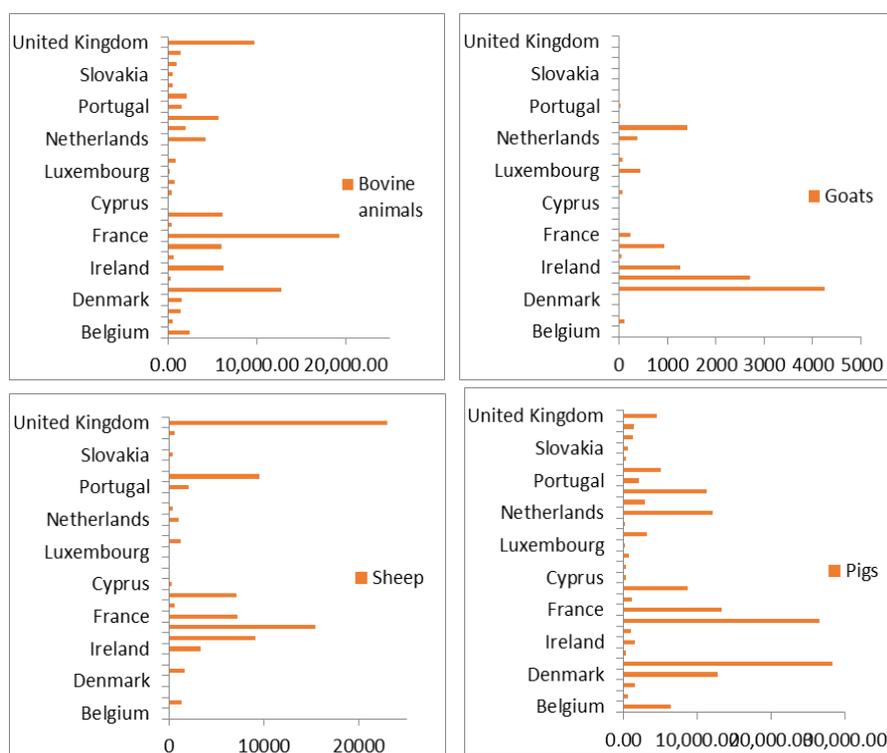
**Source:** Eurostat (online data codes: apro\_mt\_lscatl, apro\_mt\_lspig, apro\_mt\_ls sheep and apro\_mt\_lsgoat)

Between 2005 and 2010 the sheep population decreased in the United Kingdom with 12 %, in Spain with 16 %, in France with 12 %, in Italy with 3 %, while in Greece the population remained more or less stable and in Romania the population increased with 11 %. In Greece the goat population decreased with 13 %, in Spain with 6 %, in Italy with 6 %, while in France the population increased with 10 % and in Romania with 59 %.

The distribution of livestock populations of different species by countries in 2014 is shown in table 1. There are some striking differences which are likely to be the result of different natural resources, climate, culture and socio-economic conditions (FAO, 2009).

In 2014, looking at EU Member States, France, Germany and the United Kingdom held the largest number of bovine animals. In Germany and Estonia there are mainly goats (4.2 and 2.7 million heads respectively), in UK and Spain sheep (23 million heads and 15.4 million heads) and in Germany and Spain pigs (28.3 million heads and 26.5 million heads respectively) as shown in figure 1.

The environmental and climatic aspects of livestock numbers are a focus of attention and critique, not least by FAO in the report “Livestock’s Long Shadow - Environmental Issues and Options”, due to overgrazing and greenhouse gas emissions (Steinfeld et al., 2006). However, the large numbers of livestock in developing countries could be reduced by increasing the productivity per animal. By doing that, the negative impacts of livestock on environment and climate can be reduced, while still increasing the output of animal products and meeting the growing demands for these. Increased productivity will be realized through a combination of improved husbandry and careful utilization and development of existing and new combinations of livestock genotypes of different species.



**Figure 1. EU member states livestock populations in 2014**

Source: Eurostat (online data codes: apro\_mt\_lscatl, apro\_mt\_lspig, apro\_mt\_lssheep and apro\_mt\_lsgoat)

### 3. Methodology and data

The central objective of the paper is to evaluate the performances of the 28 EU member states in 2014 from the perspective of livestock production using the hierarchical cluster analysis.

The analysis is based on the 28 EU countries using the livestock production (number of animals of cattle, goats, sheep and pigs) expressed in thousand heads (animals) considered in December 2014. The main source of data used is the Agriculture Eurostat Database.

Cluster analysis is used in many disciplines for different purposes, but with the same aim of creating groups; cluster analysis is an umbrella-term for different algorithms that generate groups of statistical cases whose members are similar to other members of the same group on the basis of a certain criteria.

The basic data needed as input for the cluster analysis is thus a matrix  $X$  containing the variable values for each of the objects under investigation, which in the present work correspond to the EU-28 countries.

The purpose of cluster analysis in this case is thus to group the countries, represented by the  $n$  rows of  $X$ , according to similarities (or proximities) reported in the  $p$  columns of  $X$ , which in our case are the values for each of the indicators considered.

Different methods are available to proceed with the analysis, but in the case of hierarchical agglomerative clustering, which is used in this study, the classification consists of a series of partitions of the data where the first consists of  $n$  single-members clusters, while the last is made by a single group containing all  $n$  individuals: at each step individuals or groups of individuals which are closest are fused together (Everitt, 1993).

The basic criterion is the distance analysis. The other side objects should belong to the same cluster, while countries at large distances should be divided into different clusters. In the cluster analysis we used hierarchical ascending classification based on centroid clustering and in order to evaluate the distance between individuals we have used square Euclidean distance.

### 4 Empirical results

The main objective of this section is to evaluate the performances of the 28 EU member states in 2014 from the perspective of livestock production using the hierarchical cluster analysis.

In Figure 1 above are reported the results of the hierarchical agglomerative clustering carried out on the EU-28 countries using livestock production by type of animals for the year 2014.

The clusters described here were obtained by choosing the point of the dendrogram with the longest distance between two consequent iterations. The dendrogram was derived using the statistical analysis program SPSS, by running the hierarchical clustering process on the distance matrixes described previously.

Analyzing the dendrogram of countries, the clusters formed are the following:

Cluster 1: France

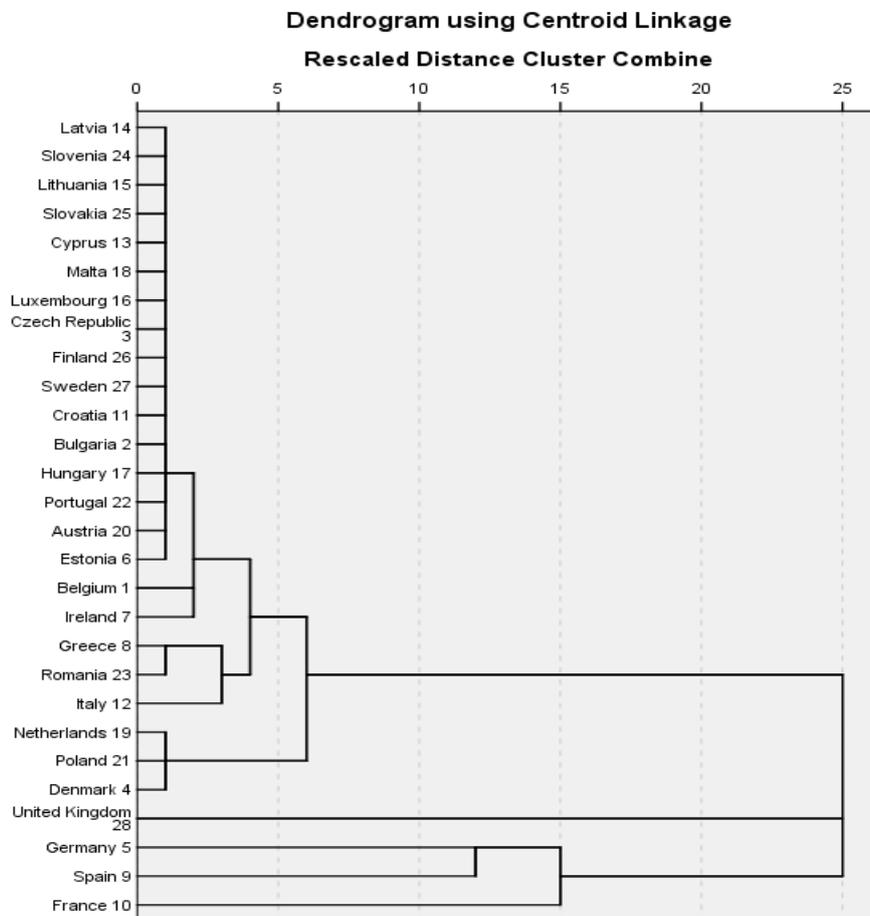
Cluster 2: Germany

Cluster 3: Spain

Cluster 4: United Kingdom

Cluster 5: Netherlands, Poland and Denmark

Cluster 6: the rest of the countries. Romania belongs to this group, being in the same class as Greece and Italy.



### Conclusions

At national level the livestock production domain is passing through severe changes as it needs to adapt to the European framework promoted in the European Union. The micro farms are lowering their importance and are replaced by larger

facilities which have a higher economic competitiveness and also an increased sustainability.

In this context, revealing the performance gap between Romanian livestock production and other EU member states is regarded by the policymakers with an increased attention.

This paper aims to evaluate the performances of livestock production management of 28 EU countries in 2014 using the hierarchical cluster analysis and to analyze the performance gap between Romania and the other EU states. In order to do that, data for livestock production by type of animals is used.

The empirical results revealed the existence of six clusters of countries. France, Spain, Germany and United Kingdom are the main actors in the field, forming each a separate class. There is a separate cluster formed by Netherlands, Poland and Denmark and the rest of the countries.

From the livestock production perspective, Romania forms a subclass with Greece and Italy.

Further developments of this study could include a deeper sensitivity analysis, for example through the use of different cluster analysis and ranking techniques, and the comparison of the obtained results. If forecasted data was available, it would also be possible to carry out the same analysis for future years, thus contributing to the creation of possible scenarios and future planning.

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