

TERRITORIAL PATTERNS OF COMMON AGRICULTURAL POLICY AID IN EXTREMADURA (SPAIN) THROUGH MULTIVARIATE CLUSTERING ANALYSIS

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Abstract: The research analyzes the distribution of Common Agricultural Policy aids in Extremadura (Spain) between 2000 and 2020, to identify territorial patterns at the municipal level and to assess aid information together with socioeconomic and agricultural variables, and Multivariate Cluster Analysis techniques were applied together with Geographic Information Systems to relate these factors. The results show that, although the reforms have contributed positively to the strengthening of Extremadura's agricultural sector, the areas affected by depopulation and aging require more effective support. Although these measures have boosted rural development, it is still necessary to strengthen the sector to prevent territorial inequalities from persisting and worsening in the most vulnerable territories.

Keywords: Agricultural sector, Reforms, Rural areas, Multivariate cluster analysis

Resumen: La investigación analiza la distribución de las ayudas de la Política Agraria Común en Extremadura (España) entre 2000 y 2020, con el objetivo de identificar patrones territoriales a nivel municipal y evaluar el impacto de las reformas aplicadas. Para ello, se construyó una base de datos que integró información sobre las ayudas junto con variables socioeconómicas y agrarias, y se aplicaron técnicas de Análisis de Agrupación Multivariada junto con Sistemas de Información Geográfica para relacionar estos factores. Los resultados muestran que, aunque las reformas han contribuido positivamente al fortalecimiento del sector agrario extremeño, las zonas afectadas por despoblación y envejecimiento requieren un apoyo más efectivo. Si bien estas medidas han impulsado el desarrollo rural, todavía es necesario reforzar el sector para evitar que las desigualdades territoriales persistan y se agraven en los territorios más vulnerables.

Palabras clave: Sector agrícola, Reformas, Áreas rurales, Análisis de Agrupación Multivariada

Highlights

- Extremadura is one of the regions that receives most CAP aid in Spain.
- The analysis identifies territorial inequalities in CAP aid.
- The reforms have prioritised rural development, but without significant demographic impact.
- The CAP is still insufficient to ensure the long-term sustainability of agriculture.

1. Origin and development of the common agricultural policy

The Common Agricultural Policy (CAP) was established in 1962 with the adoption of the First Mansholt Report by the European Commission, marking the beginning of a productivist approach in response to Europe's food needs (Hill, 1984). This framework was built on the foundations previously laid by the Treaty of Rome, signed in 1957, which laid the foundations for an agricultural policy aimed at solving the structural problems of the agricultural sector.

In the 1980s, CAP went through a significant turning point. At that time, the European Economic Community (EEC) had overcome the supply problems that had arisen after the Second World War, achieving self-sufficiency in many basic products (Larrubia Vargas, 2020). However, this achievement brought with it a significant increase in agricultural spending due to the high costs generated by production surpluses (Escudero Zamora, 1991). It is also important to point out the problems associated with pollution, intensive agriculture, and food quality, as well as the high-cost overruns of the CAP, which represented a significant burden on the Community budget (Parlamento Europeo, 2025). Moreover, in most territories, these policies did not achieve the expected effects, such as the preservation of the rural population (Lechi, 1987).

When Mediterranean countries joined the EEC, Greece in 1981, and Spain and Portugal in 1986, the production of Mediterranean products such as wine, olive oil, vegetables, and fruit increased (Sotte, 1996). This productive expansion not only pushed for a reorientation of agricultural policy but also increased the existing problems in CAP, due to the incorporation of a large agricultural population and a higher production of these crops. In response to this new reality, agricultural policy began to adapt to these products and proposed the creation of a specific Common Market Organisation (CMO) for them (Alonso Fernández, 1987; Parra López & Calatrava Requena, 2005).

As a result of the above-mentioned approaches – agricultural surpluses, containment of expenditure (which at the time represented more than 75% of the Community budget), environmental risks, and pollution – a process of adaptation and the implementation of new strategies in the CAP began, to achieve sustainable agricultural development (García Delgado & García Grande, 2005). The Cork Declaration of 1996 marked a turning point in the perception of the role of agriculture within the European economy, by contributing to the reduction of its relative weight in overall economic development. Furthermore, it laid the foundations for a practical application of its principles by designing a new policy to promote rural development, encouraging the integration of other economic activities beyond agriculture in these territories (Von Meyer, 1997). In this document, the objective was to transform rural areas into more economically and socially attractive spaces. To this end, it was proposed to integrate rural development as a strategic axis linking agricultural productivity with environmental, cultural, and social factors (Lacambra Gambau, 2001; Moyano Estrada, 2005).

Figure 1 presents the main milestones in the evolution of the CAP up to the present day. These reflect the progressive transition towards a more sustainable agricultural policy, characterized by a reduction in spending on direct production support and a focus on rural development. It also highlights the incorporation of economic activities complementary to agriculture to diversify sources of income, strengthen economic and social sustainability, and favor demographic stability in Europe's rural areas.

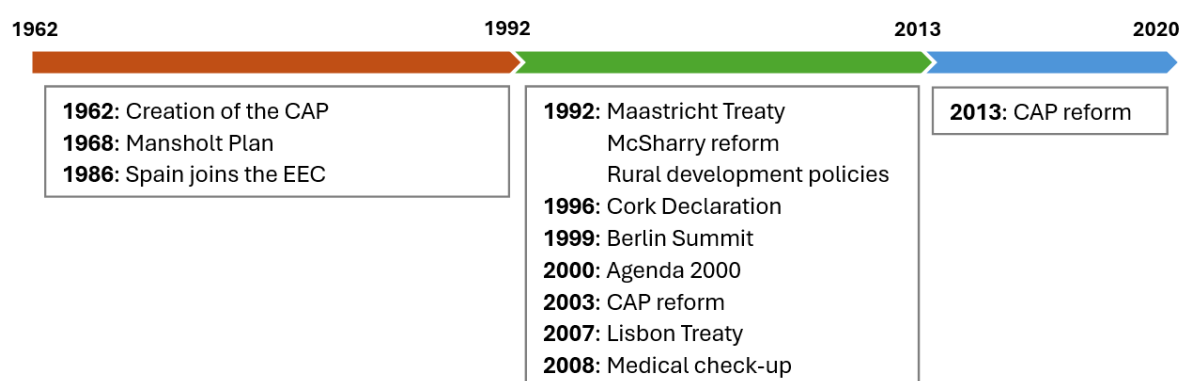


Fig 1. Main CAP milestones. Source: own elaboration

At the end of the 20th century, the introduction of direct payments to farmers marked a fundamental change in EU agricultural policy. This change was consolidated after the Berlin Summit with the implementation of Agenda 2000, a significant reform that marked a turning point in the orientation of the CAP (Gonzalo & Velarde, 2000). This change reflected how Community interests were progressively distancing themselves from the agricultural sector, which generated debates on the relevance of maintaining this activity within European budgets (Martinho, 2017). As a result, there was a continuous need to reform the CAP to adapt it to new realities and challenges (Caballer Mellado et al., 2010; Hall & Rosenstock, 1998).

2. Changes in cap since agenda 2000

Over the last septenniums², various reforms and regulations have been implemented to simplify and facilitate the implementation of the CAP. However, in practice, these measures have had the opposite effect, increasing regulatory complexity and associated administrative procedures (Pulido García et al., 2009). During the years of operation of this policy (Figure 2), the CAP has undergone structural changes through successive reforms, leaving behind its productivist approach and moving towards environmental conservation and the multifunctionality of rural areas (Hauck et al., 2015; Segrelles Serrano, 2020). This change has materialised through the decoupling of aid from production, prioritising an allocation of resources oriented towards specific objectives. These include the maintenance and conservation of the environment, support for young farmers and the promotion of the role of women in rural areas (Segrelles Serrano, 2020).

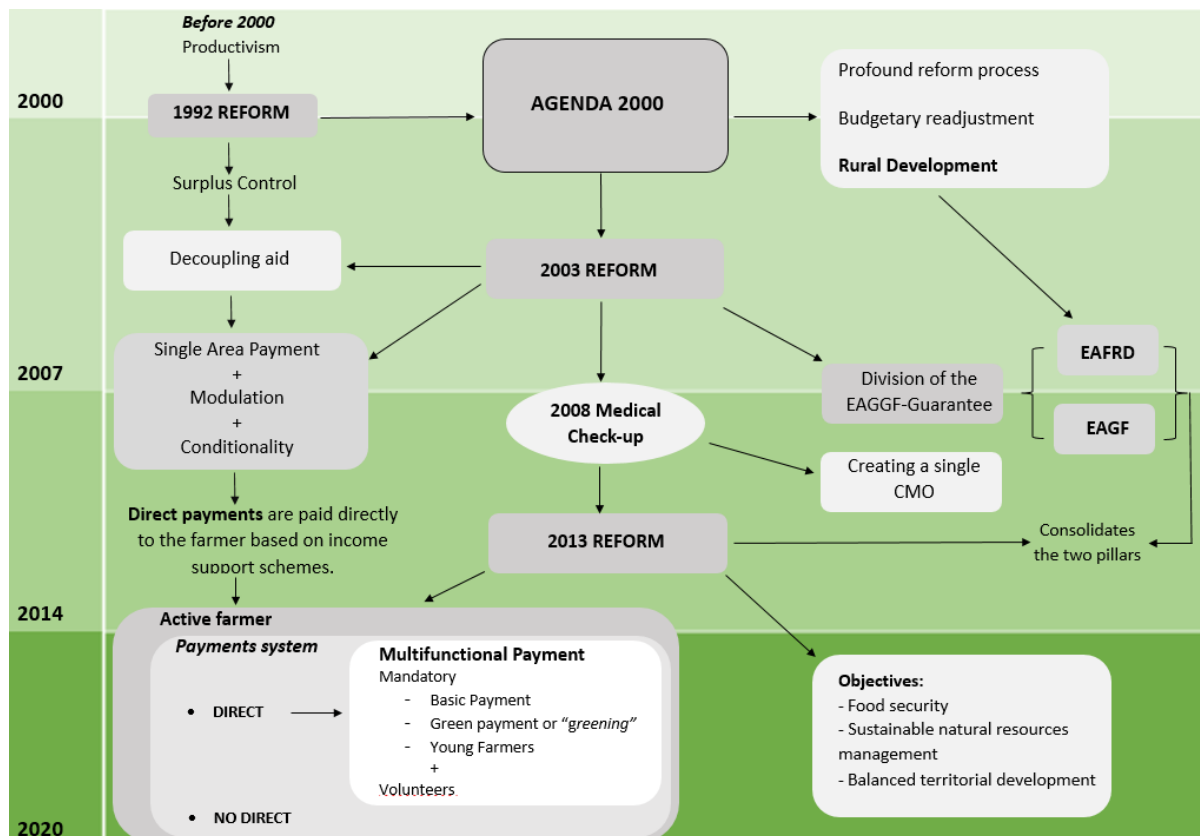


Fig 2. Flow chart of the evolution of the CAP from 2000 to 2020. Source: own elaboration

As mentioned above, the publication of Agenda 2000 marked a turning point in the evolution of the CAP by establishing rural development policy as its second pillar. This approach encouraged the implementation of support meant to diversify economic activities in rural areas, complementing traditional agriculture with initiatives like tourism, heritage conservation, and the establishment of small and medium-sized enterprises (SMEs). These measures sought to foster greater territorial cohesion and improve the standard of living in rural regions (Arnalte Alegre, 2002), as well as to try to combat the socio-economic problems related to the loss of population affecting these territories (Velaltia Sebastiá & Miguel de Diego, 1999), as is the case in Extremadura. Subsequently, the 2003 reform introduced the single payment system, decoupled from production for the first time in the history of the CAP (Schmid et al., 2007). This change marked a radical shift in agricultural policy, as farmers began to be remunerated for the environmental benefits they generated in rural areas and coupled payments were reduced (Cejudo García & Maroto Martos, 2010; Erjavec et al., 2009).

² Since Agenda 2000, CAP reforms have been structured in seven-year cycles (2000–2006, 2007–2013, 2014–2020), known as Multiannual Financial Frameworks, which coincide with EU budgets.

The changes introduced in 2008 did not constitute a new CAP, but rather an effort to rationalise and modernise existing measures (Borges et al., 2010; Martínez García et al., 2024). The 2008 Health Check-up consolidated the framework of the 2003 Reform, allowing for the revision of a wide range of measures implemented after that reform (Brenes, 2009; Martinho et al., 2022). Through this process, CAP measures were established around two pillars: the first focused on farm-related payments and the CMO for agricultural products, while the second was dedicated to rural development policy. Both funds were previously financed by the EAGGF, through its Guarantee and Guidance sections, which, following this restructuring, was split into two main funds: the European Agricultural Guarantee Fund (EAGF) and the European Agricultural Fund for Rural Development (EAFRD). The EAGF is implemented through joint management by the Member States and the EU, financing measures aimed at regulating or supporting agricultural markets, as well as direct payments to farmers under the CAP, in addition to information and promotion actions for agricultural products on the EU internal market and in third countries (Parlamento Europeo, 2018). On the other hand, EAFRD acts as the financing instrument for the EU's rural development policy. This fund finances both the Rural Development Programmes (RDPs) of the Member States and those of their regions (Tolón Becerra & Lastra Bravo, 2007). Its objectives include promoting the competitiveness of agriculture, ensuring the sustainable management of natural resources and action against climate change, as well as achieving balanced territorial development in rural economies and communities by introducing new economic activities that complement agriculture, including the creation and maintenance of employment (Nieto Masot & Cárdenas Alonso, 2015).

With the reform of the CAP in 2013, the aim was to revitalise activity in the EU's rural territories, recognising the need to renew the use of resources to achieve sustainable and inclusive growth in the agricultural sector (Biagini et al., 2023; Nazzaro & Marotta, 2016; Nicholas et al., 2021). The main objective of this reform was to redirect support towards active farmers, while environmental aspects were emphasised through targeted payments, such as the green payment, evolving towards a more sustainable CAP (Malang & Holzinger, 2020; Slabe-Erker et al., 2019; Száltekei et al., 2024). In addition, significant changes were introduced at the institutional level compared to previous proposals. These innovations included a new decision-making procedure between the Member States and the European Parliament, greater flexibility in management in favour of the States, the implementation of new budgetary adjustments in the 2014–2020 financial framework and the integration of the CAP within the European 2020 Strategy (Massot Martí, 2009; Minotti & Zagata, 2020). This reform also supported the Europe 2020 Strategy, promoting smart growth through the use of new technologies and training for the sector, as well as promoting sustainable agriculture that effectively manages the land and protects the environment (Bercean, 2015; Olagunju et al., 2022; Westhoek et al., 2012).

The incorporation of Spain into the EEC, now the European Union (EU), significantly transformed the Spanish agricultural sector, particularly in inland regions (Iráizoz Apezteguía et al., 2000; Mora & San-Juan, 2001). In this context, the CAP has represented a major support for farmers and livestock farmers in Spain, with relevance in the region of Extremadura, where the agricultural sector plays a crucial role in the regional economy due to its predominantly rural character. Following its incorporation into the CAP, Extremadura began a process of reconversion and modernisation of its agricultural sector, moving towards a more competitive and sustainable model (Martínez García et al., 2023a). Thus, this autonomous community was chosen as the study area of this research because it is highly dependent on the CAP and structurally vulnerable, making it representative of the challenges faced by many rural regions in the EU.

Consequently, the objective of this research is to identify and compare territorial patterns at the municipal level in the distribution of Common Agricultural Policy (CAP) aid in Extremadura between the different financial frameworks 2000–2006, 2007–2013, and 2014–2020. The analysis focuses on the spatial variation in aid resulting from the reforms implemented, with consideration given to changes in the volume of funds, the type of aid (direct versus rural development) and its relationship with socioeconomic and agricultural indicators at the municipal level. It explores the possibility that the reforms may have influenced a redistribution of funds towards territories characterised by different levels of socio-economic dynamism, ageing, depopulation or unemployment, using variables such as population growth rate, ageing rate, agricultural land use and the weight of agricultural employment. As an added value, demographic and socio-economic context variables have been incorporated to identify

the areas that benefit most and to determine whether there is positive discrimination of aid in dynamic territories, as has been observed in other types of European subsidies (Nieto Masot & Cárdenas Alonso, 2017). In this context, the study revolves around two key research questions: Has the CAP contributed to reducing territorial disparities in Extremadura between 2000 and 2020? And is there a significant relationship between the allocation of aid and factors such as population ageing or depopulation? Based on these questions, the hypothesis is that the allocation of CAP funds has not been fully aligned with the structural needs of the territory, which has limited its capacity to address the regressive dynamics affecting much of rural Extremadura.

To carry out this analysis, a database was designed that integrates cartographic and alphanumeric information on CAP subsidies broken down by municipality, as well as socio-economic and agricultural data. The methodology employed includes Multivariate Clustering Analysis, which allows for the identification of clusters or concentration patterns of these variables. This approach facilitates a deeper understanding of territorial dynamics and their relationship with the distribution of CAP support.

For the development of this research, an extensive bibliography was compiled, enabling us not only to identify previous studies on the CAP carried out across Europe, Spain, and Extremadura, but also to critically assess their findings and methodologies. These studies highlight varied impacts of CAP support depending on regional characteristics and agricultural sectors. For instance, several authors (Jambor & Szerletics, 2022; Žičkienė et al., 2022) found that CAP payments significantly influence regional economies but with heterogeneity linked to local agricultural structures and demographic factors. Research in Slovakia (Vozárová et al., 2020) and Bulgaria (Sarov & Kostenarov, 2019) revealed that CAP support affects farm structures differently depending on geographic and economic contexts, suggesting the importance of including variables related to both production type and land characteristics. At the socio-economic level, other studies (Galluzzo, 2021; Grodzicki & Jankiewicz, 2022) underlined how CAP subsidies contribute to rural development but also stress the varying effectiveness depending on local conditions, including demographic and infrastructural factors. Nationally, it has been shown that the efficiency and impact of CAP programmes are conditioned by regional policies and the heterogeneity of agricultural territories (Baraja-Rodríguez et al., 2021; Blanco et al., 2021). Specifically, in Extremadura, it has also been shown (Martínez García et al., 2023a, 2023b, 2024) how CAP aid interacts with local socio-economic development, highlighting the importance of integrating demographic, economic and agricultural variables for a comprehensive analysis.

This synthesis of previous literature informed our variable selection, balancing indicators related to aid amounts, agricultural land use, and demographic characteristics. This multidimensional approach aligns with the complexity revealed in prior studies and aims to capture the nuanced effects of CAP support across diverse regional contexts. Our study thus contributes to the literature by providing a dynamic, period-based analysis of CAP evolution in Extremadura, with potential applicability to similar regions.

3. Study area

The region of Extremadura (Figure 3), located in the south-western part of the Iberian Peninsula, has been selected for this study. This region has been chosen because of its relevance as one of the main recipients of amounts associated with the CAP in Spain, both in terms of volume of investment and in relation to its population, which makes it an area of special interest for the analysis. It is bordered to the north by Castilla y León, to the east by Castilla-La Mancha, to the south by Andalucía and the west by Portugal. Extremadura is made up of the two largest provinces in Spain, Cáceres and Badajoz, covering a total surface area of 41,635 km² and a perimeter of 1,184 km, characterised by a varied relief that includes mountains, valleys, and an extensive network of rivers, such as the Tagus and Guadiana, which have a strong influence on the agricultural development of the sector in the region. The irrigated areas are mainly located around the Guadiana and Tiétar rivers, where the availability of water infrastructures allows for intensive and highly productive agriculture. The areas of Don Benito, Mérida, Badajoz, and some municipalities of Navalmoral de la Mata and Olivenza stand out, with crops of high economic value. The unirrigated areas, which cover a large part of the territory, are characterised by crops adapted to the scarcity of water, where counties such as Azuaga, Castuera, Llerena, Puebla de Alcocer, Cáceres, Trujillo and Brozas present

landscapes of wide plains, in some cases combined with extensive livestock farming systems. In these unirrigated areas, the Almodralejo county (Tierra de Barros) stands out as an area of high productivity, thanks to the profitability of its crops, mainly vines and olives. Agroforestry areas, present in counties such as Albuquerque, Jerez de los Caballeros and Herrera del Duque, are dominated by extensive livestock systems based on pastureland, characterised by the presence of holm oaks and cork oaks. In the municipalities of the agricultural counties of Hervás, Coria, Plasencia, Logrosán and Jaraíz de la Vera, crops are grown on terraces to adapt to the abrupt relief, with smaller farms predominating in these areas.

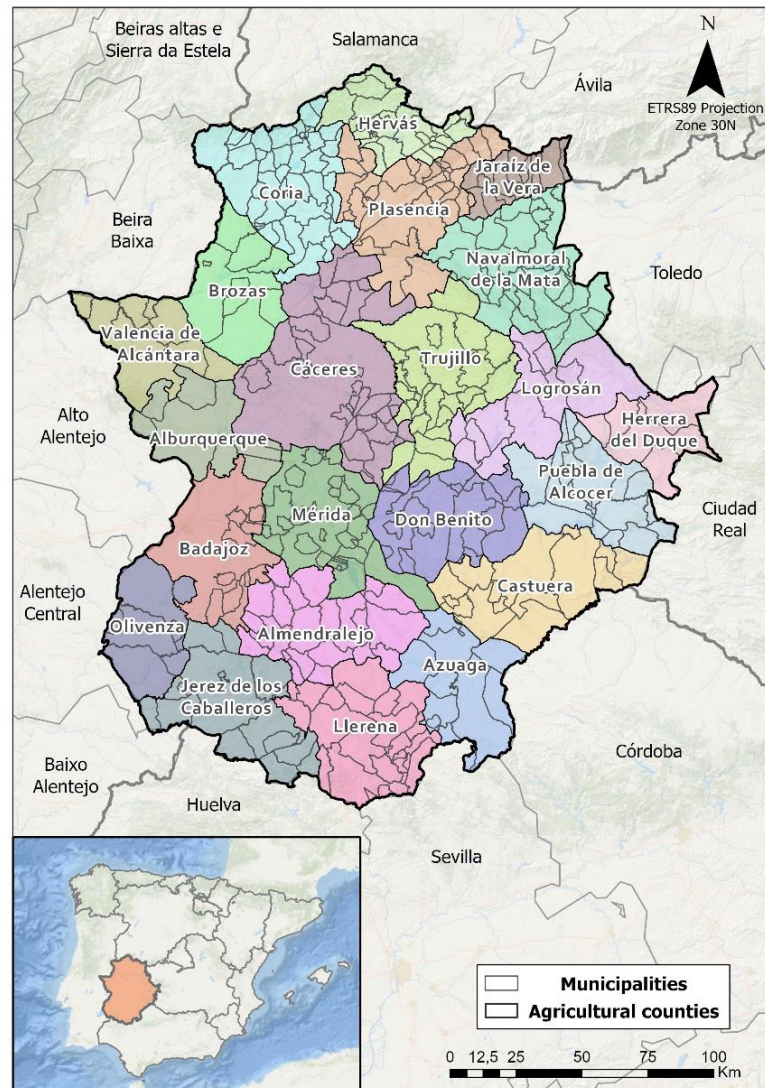


Fig 3. Research study area. Source: own elaboration

For the territorial analysis, both the municipalities and the agricultural counties of Extremadura have been considered. This choice responds to the need to place the municipalities in a broader agricultural context, providing a global and specific perspective of the territory. The agricultural counties represent areas that share characteristics of homogeneity in terms of productive potential, cropping systems and farming practices. They also reflect similar economic development, which allows for a more accurate assessment of territorial dynamics and their relationship with CAP support.

Agrarian regionalization in Spain was promoted by the former Ministry of Agriculture in the 1970s. This process materialised with the publication of the document 'Agrarian Regionalization of Spain' by the General Technical Secretariat in 1976, where 322 agricultural counties were established. The main objective of this territorial division was to adapt to the country's agrarian reality, creating a uniform structure that would facilitate better planning and execution of the Ministry's policies. In addition, this

division allowed a more efficient implementation of CAP measures in the national territory. In 1996, this regionalization was revised and 326 agricultural counties were defined throughout the country, following the new publication of the General Technical Secretariat of the Ministry of Agriculture, Fisheries, and Food (MAPA). This structure is still in force today and provides a solid basis for agricultural management and planning in Spain.

Extremadura is divided into 22 agricultural counties, of which 12 are located in the province of Badajoz (Ministerio de Agricultura Alimentación y Medioambiente, 2012b) and 10 in the province of Cáceres (Ministerio de Agricultura Alimentación y Medioambiente, 2012a). This division not only reflects the agricultural diversity of the region but also allows for more efficient management adapted to the specific characteristics of each area, facilitating the development of strategies that promote sustainability and economic growth in the agricultural sector. The identification of these counties is essential to understand the local and regional dynamics of the agricultural sector, as well as to design more effective policies that respond to the needs of farmers and the wider community.

4. Methodology

This study first required the compilation of documentary sources to facilitate the understanding of the different aspects and changes developed in the CAP since 2000. In this sense, we proceeded to select relevant documents that addressed both the evolution of the policy and its impact on the different territories. Special attention was paid to studies analyzing the presence of agricultural economic activities as defined elements of rural areas, as well as the role of European rural development programs in the transformation of these territories. Subsequently, a process of compiling information on the CAP was carried out to consider both the distribution of aid and the regulatory framework that governs it (Figure 4). Next, an alphanumeric database was created to be able to analyze CAP aid quantitatively. The data used was obtained from two main sources. On the one hand, the data corresponding to the period 2002–2016 were provided by the Department of Agriculture, Rural Development, Population, and Territory of the Regional Government of Extremadura. Until 2006, these funds belonged to the EAGGF, using the data on the FOGA-Guarantee, whereas, from that date onwards, they came to be managed through the EAGF and the EAFRD. EAGGF-Guidance aids have not been included due to the lack of availability of data on this section. On the other hand, the data corresponding to the years 2017, 2018, 2019 and 2020 were obtained from the portal for open data information of the Spanish Agricultural Guarantee Fund (FEGA). This information is available thanks to the regulation on transparency of information on beneficiaries of EAGF and EAFRD funds, contained in Articles 111 to 114 of Regulation (EU) No. 1306/2013 of the European Parliament and of the Council of 17 December 2013 on the financing, management and monitoring of the Common Agricultural Policy; and Articles 57 to 62 of Commission Implementing Regulation (EU) No. 908/2014 of 6 August 2014, laying down detailed rules for the application of Regulation (EU) No. 1306/2013. Therefore, the first analysis raised in this work consists of studying the evolution of aid since 2000, to determine whether there have been changes in economic allocations over time.

To complete the analysis and to be able to relate CAP subsidies with other contextual variables that may be related to their distribution and amount, other sociodemographic and agricultural variables obtained from different public data repositories corresponding to the different study periods at the municipal level have been added.

It was decided to conduct the analysis in two periods to assess the effects of the various CAP reforms and to be able to better determine the progressive changes in the allocation of aid. Period 1 covers changes between the 2000–2006 and 2007–2013 programming periods, while Period 2 analyzes changes between 2007–2013 and 2014–2020. For the first period, a total of 16 variables have been analyzed, while in the second period two additional EAFRD variables have been incorporated, reaching a total of 18 variables. The inclusion of these new variables responds to the evolution of rural development policies following the CAP reforms, which expanded the scope of this fund with new investment lines. This justifies their incorporation to provide a more complete view of the impact of aid on the territory.

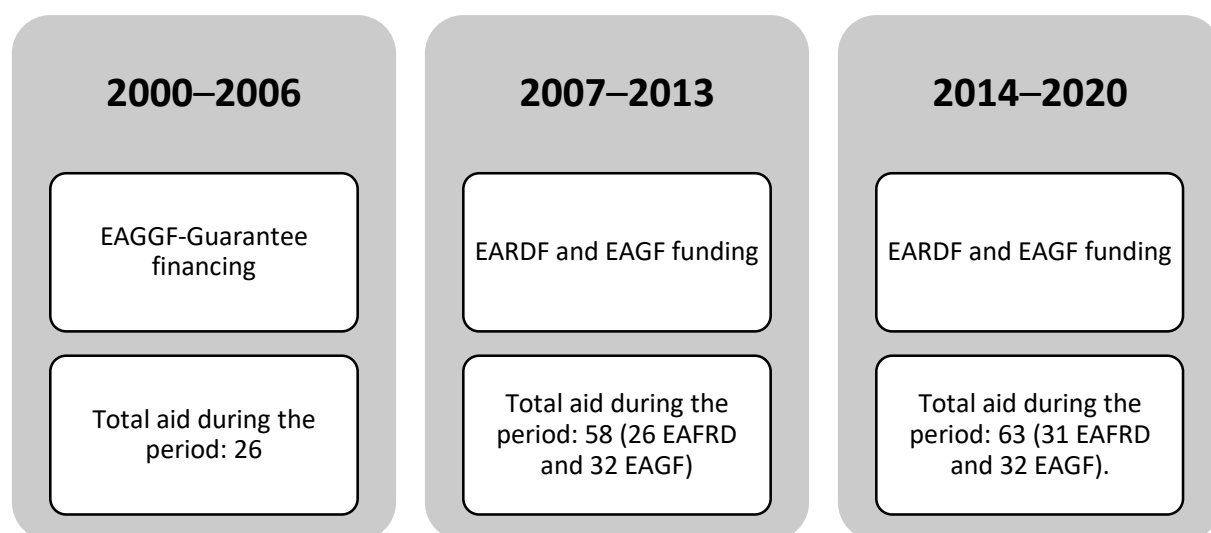


Fig 4. Aid according to the budgetary framework applied in Extremadura. Source: own elaboration

The selection of variables has been carried out to identify the municipalities with the greatest volume of investments, guaranteeing a balanced and representative analysis. For this purpose, both absolute variables, which allow for the identification of areas with the highest total volume of aid received, and variables normalised according to population and agricultural land area have been considered. That dual methodological approach makes it possible to avoid biases associated with the demographic or territorial size of municipalities, establishing a more equitable basis for comparison and promoting a more robust and representative multivariate analysis. (Dax & Oedl-Wieser, 2016). This facilitates the detection of significant patterns in the distribution of aid, not only in terms of absolute magnitude, but also to the productive capacity and agricultural population density of each area, which is essential for a fairer and more effective assessment of the impact of the CAP at the regional level (Grodzicki & Jankiewicz, 2022; Nicholas et al., 2021; Žičkienė et al., 2022). The variables used in the clustering analysis are detailed in Table 1, whose methodology is described in the following section, and which have been listed and named using acronyms to facilitate interpretation of the results.

Tab 1. Variables used for the Multivariate Clustering by periods. Source: own elaboration

Variable	Acronym	Period 1	Period 2
1	AvgCAP	Annual average amount of CAP payments (€)	
2	VarCAP	Variation in CAP payments between periods (%)	
3	CAPinh	Annual average amount of CAP payments per 1,000 inhabitants (€)	
4	CAPrain	Annual average amount of CAP payments per hectare of rainfed agricultural land (€)	
5	CAPirr	Annual average amount of CAP payments per hectare of irrigated agricultural land (€)	
6	EAGGFfarm	Annual average amount of EAGGF/EAGF payments per hectare of average agricultural holding (€)	
7	EAGGFinh	Annual average amount of EAGGF/EAGF payments per 1,000 inhabitants (€)	
8	varEAGGF	Variation in EAGGF/EAGF payments between periods (%)	
9	PopG	Population growth	
10	AgeingR	Ageing rate (%)	
11	NMR	Net Migration Rate	
12	UnempR	Unemployment rate	
13	AgriEmpC	Agricultural sector employment contracts (%)	
14	UAA	Utilized Agricultural Area (UAA) (Ha)	
15	AvgFarmS	Average farm size per municipality (Ha)	
16	LU	Livestock Units (LU)	
17	EAFRDinh		Annual average amount of EAFRD payments per 1,000 inhabitants (€)
18	varEAFRD		Variation in EAFRD payments between periods (%)

4.1 Multivariate clustering

Multivariate clustering is a GIS tool that allows examining spatial entities and their characteristics, identifying groupings or clusters in the data and assigning each entity to a specific group through its cartographic representation. The central objective of this analysis is to generate groups with uniform patterns, identifying similarities between the variables used in the model. This function allows grouping similar elements within a spatial dataset, using multiple variables simultaneously, to facilitate the detection of patterns and complex relationships between the analyzed features (Venkatramanan et al., 2015). During this process, the entire variance is considered to ensure that the groups are as homogeneous as possible, basing this homogeneity on the set of attributes selected for analysis.

The clustering effectiveness of each set is assessed using the Caliński-Harabasz pseudo-statistic F , as this statistic provides a measure of similarity within each cluster and is expressed as a ratio reflecting the internal consistency of the cluster (Caliński & Harabasz, 1974).

$$\frac{(R^2/n_c - 1)}{(1 - R^2)/(n - n_c)}$$

where:

$$R^2 = \frac{SST - SSE}{SST}$$

SST is the total sum of squares obtained for the variable considered, reflecting the differences between groups, while SSE is the sum of squares explained and shows the level of similarity within each group (Núñez et al., 2021). These two parameters are calculated using the following formula:

$$SST = \sum_{i=1}^{n_c} \sum_{j=1}^{n_i} \sum_{v=1}^{n_v} (V_{ij}^k - \bar{V}^k)^2$$
$$SSE = \sum_{i=1}^{n_c} \sum_{j=1}^{n_i} \sum_{v=1}^{n_v} (V_{ij}^k - \bar{V}_t^k)^2$$

Where n is the number of characteristics; n_i the number of characteristics in group i ; n_c the number of groups; n_v the number of variables used; V_{ij}^k the value acquired by the k^{th} variable in the j^{th} characteristic within the i^{th} group; $\bar{V}^k$, the average of the k^{th} variable; and $\bar{V}_t^k$ the average value of the k^{th} variable in group i (Ríos Rodríguez et al., 2023).

Therefore, multivariate clustering analysis was developed using ArcGis Pro software, following the parameters established by the K-means algorithm for the grouping of spatial data into homogeneous sets, which aims to divide the entities in such a way as to minimize the differences between them in all clusters (Rodríguez et al., 2024; Sánchez Martín et al., 2017). Thus, the objective of the K-means algorithm is to divide the entities into smaller groups, identifying for them entities called “seeds”. The selection of the first seed is random; however, for the selection of the remaining seeds, a weighting is applied that favors the selection of subsequent seeds (average K++ values). After establishing these seeds, those with a value closest to the data are identified to determine to which group each entity belongs (Engelmo Moriche et al., 2021).

5. Results

5.1 Budgetary evolution of the CAP in Extremadura (2000–2020)

Over the last 20 years, there have been three periods of budgetary frameworks that have been modifying the CAP paradigm. In this sense, the graph below (Figure 5) shows the evolution of the funds allocated to the Extremadura region through CAP aid from 2000 to 2020. The data corresponding to the 2000–2006

period are framed within the EAGGF-Guarantee, the fund that managed CAP aid before its restructuring. Since 2007, there has been a differentiation in the distribution of funds due to the division between the EAFRD (rural development aid) and the EAGF (aid to the agricultural sector).



Fig 5. Total amount of CAP aid (2000–2020). Source: own elaboration

Thus, there was an increase in the budgetary amounts for Extremadura up to 2006, reaching the maximum amount in this year, which was close to €700 million and with an increase of approximately 30% with respect to the year 2000. During these first years, there were fluctuations in the amounts in the region, with the years 2000 and 2002 showing values of around €500 million, being below the amounts for the rest of the years.

With the start of the 2007–2013 budget period, the EAGGF was separated into two new funds: the EAGF for agricultural measures and the EAFRD for rural development aid. Thus, from 2008 the graph shows a differentiation between the two funds. Considering both funds, the evolution of investments shows a relatively stable trend, with values exceeding €600 million in most of the years analyzed. A notable increase is observed in 2014 and 2015, when allocations exceed €650 million, which coincides with the transition to a new budget period. This increase, close to 13% compared to 2007, reflects the implementation of the new funds established as of that date, marking a change in the CAP financing structure. This change, by no longer linking aid to production, has led to a reduction in EAGF funds as part of a strategy to improve farm profitability. However, the incorporation of EAFRD contributions has allowed total annual aid to exceed 600 million euros in all the years analyzed. After these years, a progressive decrease in total amounts was observed until 2017, this being the only year in which aid fell below €600 million since 2008. It is worth mentioning that, in the last three years, there has been an upward trend, with an increase of 6.4% between 2017 and 2018 and 10.5% in 2020 compared to 2017.

Focusing on the amounts per fund, it can be seen how EAFRD shows a growing trend since its application in Extremadura in 2008, increasing its representativeness year by year, in contrast with the decrease in the aids associated with agricultural measures. These aids started representing 6% of the total CAP budget in Extremadura in 2008 until reaching its highest representativeness in 2014 with 23%. Therefore, since the appearance of the two funds in 2007, FEADER has achieved a remarkable increase in total amounts, being the highest in 2014 with more than €156 million, representing 77.1% compared to 2008. However, compared to 2014, the EAFRD budget has experienced a decrease, being reduced by approximately 30% in 2020, although with a percentage of over 200% with respect to the initial year in which this fund began to be applied in the region.

Finally, it is necessary to mention that the annual distribution of this aid is conditioned by various external and administrative factors that generate variability in its allocation. These factors include the economic situation, which determines the priorities in the distribution of funds, the budget availability of the regional government, which may vary according to the financial context of each period, and administrative deadlines, which influence the management and delivery of aid.

5.2 CAP subsidy amounts per inhabitant at the municipal level

Analysis of the impact of the CAP at the local level requires calculating the amounts of aid by municipality and subsequently quantifying them by population to analyze their territorial distribution. The results of this are expressed cartographically in Figure 6, with the municipal distribution of both variables, which makes it possible to identify production patterns and the relative impact of this policy on the different areas of the region.

Therefore, the distribution of CAP aid amounts at the annual level is mainly concentrated in the most populated areas of the region, reaching an average of more than €10,000,000 per year between 2000 and 2020. The municipalities with the highest average amounts during this period have been Badajoz, Cáceres, Mérida, Don Benito, Almendralejo, Miajadas, Villafranca de los Barros and Talayuela. This analysis shows a clear concentration of this aid in the areas with the greatest agricultural activity, especially in the municipalities located in the agricultural counties of Don Benito, Mérida and Badajoz around the Vegas del Guadiana. This concentration is linked to the intensive irrigation model, a system of high economic profitability that favors the attraction of this aid. In addition, this model is developed mainly in the municipalities with the largest population in the region, including the provincial capitals, the capital of the autonomous community and the main county capitals.

In the province of Cáceres there is a greater dispersion in the distribution of aid, although some municipalities stand out for receiving significantly higher amounts than the rest. These include the capital city of Cáceres, the towns close to it, the municipalities of the agricultural county of Navalmoral de la Mata and the county capitals of Plasencia, Jaraíz de la Vera and Coria. On the contrary, there is a high concentration of municipalities in the province of Cáceres that receive amounts of less than €1,000,000 per year during the study periods, because in the province of Cáceres nearly 70% of the municipalities have less than 1,000 inhabitants, which reflects large territorial differences between the two provinces. On the one hand, Badajoz has larger populations and large plains, favoring a more homogeneous and sustained demographic growth. In contrast, the municipalities of Cáceres, which are smaller and located in mountainous areas, in many cases face significant challenges due to their geographic isolation, which has favored regressive demographic dynamics and a high rate of population ageing, contributing to greater depopulation and a lack of economic and social opportunities.

With respect to the analysis by population, the relative differences in the impact of the CAP between rural and urban municipalities stand out. The largest municipalities, such as Cáceres and Badajoz, stand out, since the relationship between the variables analyzed does not reflect the demographic relevance of these cities. These municipalities, which are more urbanized, present amounts of less than €500,000 per 1,000 inhabitants, since they have more diversified economies and higher population densities, which reduces the relative impact of the agricultural funds on their economic structure. It is important to highlight municipalities such as Jerez de los Caballeros, Olivenza and Valencia de Alcántara, which, despite having an important agricultural base and large livestock farms in their pastures, show low values in the aid received. As for the municipalities with high values of amounts per inhabitant, their distribution is uneven, but concentrations are observed in the southeast of Extremadura, especially in the agricultural counties of Castuera, Puebla de Alcocer and Azuaga. Areas such as the counties of Brozas and Jaraíz de la Vera, in the north of the region, and Almendralejo and Llerena, in the south, also stand out for receiving high amounts per inhabitant. Many of the municipalities that make up these counties are characterized by an economy that is highly dependent on the agricultural sector, which allows them to show high per capita aid figures. In addition, the growing focus of the CAP on rural development has favored these areas, significantly increasing the amounts received during the different study periods with the establishment of aid of this type in the new CAP reforms. An outstanding case is Miajadas, with

a population of nearly 10,000 inhabitants and an economy based mainly on intensive irrigated agriculture, which has high value due to the importance of the sector in its economy. When quantifying aid according to population, we find some cases with the presence of municipalities with smaller populations that tend to exaggerate the impact of this aid.

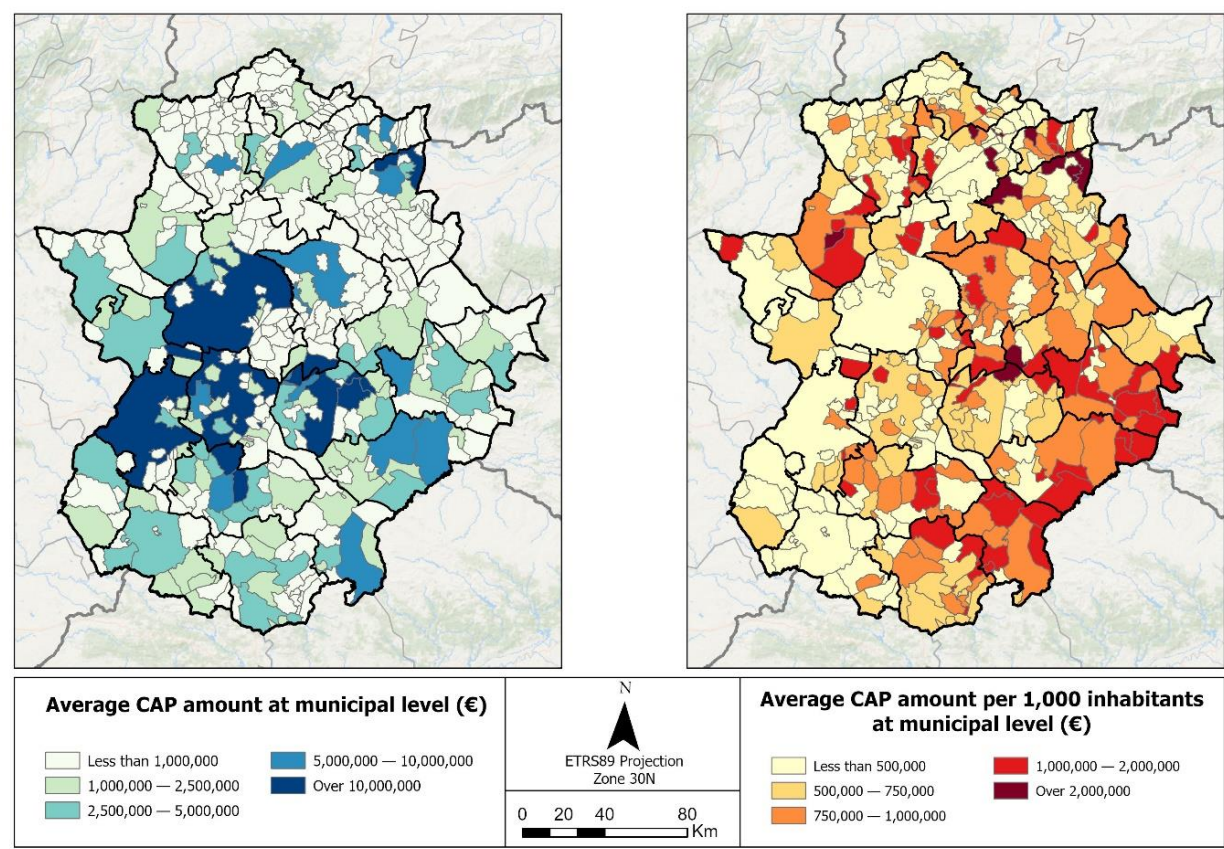


Fig 6. Average CAP amount and average CAP amount per 1,000 inhabitants (2000–2020). Source: own elaboration

Figure 7 shows the percentage variation between different periods, which allows us to delve deeper into the structural changes that this policy has undergone in recent decades and its impact on the region's municipalities. To better understand this evolution, it is necessary to analyze CAP aid, since its structure has changed significantly over time. In the initial years of the study periods, the EAGGF was composed of two sections: Guidance and Guarantee, with functions like those currently performed by EAGF and EAFRD. However, with the restructuring of the CAP, these funds were replaced by the EAGF, focused on direct aid to production and markets, and the EAFRD, aimed at rural development. This differentiation in the administration and objectives of each fund has led to changes in the distribution of aid, which justifies the need for a global analysis to identify trends and evaluate their impact on rural territories.

The most significant increases are observed in the agricultural counties in the north of the region, mainly in the agricultural counties of Hervás and Jaraíz de la Vera. These significant increases are due to the changes introduced by the 2003 CAP reform, applied from 2008 on, which implemented new aid modalities, such as decoupled payments and rural development measures, which especially benefited less developed rural areas. Likewise, municipalities in more ruralized agricultural counties and with a more critical socio-demographic situation, experienced significant increases, between 50% and 100% of the average annual amounts of the previous period. This is the case of localities in the counties of Coria, Castuera, Alburquerque or Llerena. The transformation brought about by the CAP reform implied a structural change for many Extremadura municipalities, some of which had received significant amounts of aid in the past. An outstanding case is Talayuela, which in the first period of the study benefited from important CAP budgets due to tobacco production in the area. However, subsequent reforms caused a drop in aid of more than 70% between 2000–2006 and 2007–2013. In contrast, traditionally agricultural

municipalities, such as Don Benito and Villanueva de la Serena, suffered slight increases during the first period. This indicates that municipalities with a strong agricultural production system were less impacted by the change in the structure of the CAP during those years. It is observed that the greatest changes in the aid received by most of the municipalities occurred in the first period analyzed, reflected in the first map, where the difference between 2000–2006 and 2007–2013 was more significant. In contrast, in the second map, corresponding to the 2014–2020 period, the amounts have stabilized, showing less variability compared to previous periods.

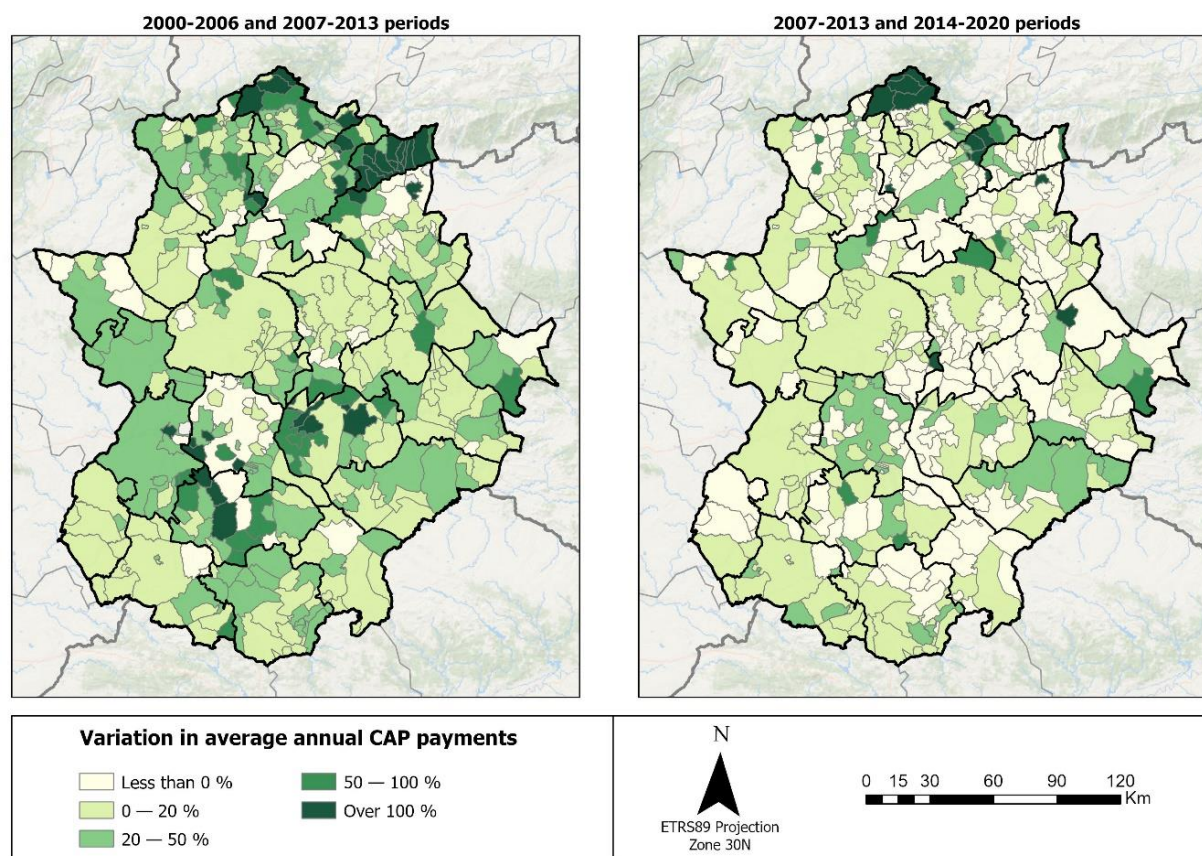


Fig 7. Variation in annual average aid. Source: own elaboration

In the second period, the variations in the amounts of CAP aid show a less significant trend compared to previous periods, indicating a stabilization of aid per municipality. The municipalities of the agricultural county of Hervás were the ones that maintained the positive trend of previous years, experiencing a significant increase in the amounts. This pattern is also reflected in municipalities in the north of the agricultural county of Plasencia, especially in the Jerte valley, where the diversification of agricultural products and support for sectors such as cherry trees have favored an increase in aid. In the agricultural counties of Vegas del Guadiana, there is a slight increase with respect to the previous period, which suggests that, although these areas have a significant agricultural development, aid continues to increase to support the modernization of agricultural infrastructures and the maintenance of irrigated crops. There is a concentration of agricultural aid in the most economically productive sectors, as well as in those areas where the main population centers are located.

A significant change with respect to the previous period is the case of the city of Mérida, which previously showed a negative variation in the amounts, but which has experienced a considerable increase in this period. It is important to consider that the city of Mérida is allocated a significant proportion of management aid because it is home to the Regional Agricultural Department. Therefore, its case should not be interpreted as a reflection of changes in the territory, but rather as a variation in management processes. In contrast, the agricultural district of Jaraíz de la Vera shows a low variation in aid, and even negative values, making it one of the districts with the largest decreases compared to the previous period.

This is largely due to the continued reduction in aid to the tobacco sector, a crop of major importance in the area. In this context, changes are proposed to avoid dependence on these crops, as changes in CAP aid and policy guidelines could have negative repercussions on the local economy.

5.3 Grouping of municipalities in different time periods

The multivariate clustering analysis in ArcGIS Pro has resulted in 5 groups that bring together, each one, municipalities with similar demographic, socioeconomic, agricultural and CAP distribution characteristics, being able to identify patterns. The results have been cartographically represented in Figure 8, with the municipal distribution during 2000–2006 and 2007–2013 (Period 1) and 2007–2013 and 2014–2020 (Period 2). In addition, in Table 2, the results of each variable (coded as in Table 1) are presented for each group and for the two joint periods considered. The results are described in detail below, highlighting the economic differences that explain this grouping.

- **Group 1:** This group includes the municipalities with the largest population in Extremadura during both periods analysed, comprising 9 municipalities in the first period and 8 in the second. It includes the main urban municipalities in the region, such as Badajoz, Mérida, Don Benito, Villanueva de la Serena, Miajadas and Talayuela, mostly located in irrigated areas with high agricultural productivity, except for Cáceres and Almendralejo, where rainfed crops are the most important. In economic terms, this group has the highest annual average CAP aid (1), exceeding €20 million in both periods. The aid per farm (6) is significantly higher compared to the municipalities in other groups, reaching values of more than €10,000 in the first period and more than €21,000 in the second. This reflects the strategic importance of these urban municipalities in the region's agricultural activity.

About the distribution of aid according to type of agricultural area, there was a decrease in the amounts allocated to rainfed farms (4), with values of over €14 million in both periods, although with a reduction between the two periods. In contrast, aid for irrigated areas (5) increased significantly, reaching almost €7 million in the second period. This change reflects the growing weight of irrigated farms, which are concentrated in the river valleys where many of these municipalities are located. The productivity of irrigated farms, driven by their efficiency and financial support, has been a key factor in their expansion. This agricultural dynamism is also related to the extensive UAA (14), which on average exceeds 50,000 ha. Furthermore, the agricultural sector has a significant impact on employment, with employment contracts (13) exceeding 30% of the total in these municipalities, underlining its economic relevance. From a socio-demographic perspective, these municipalities stand out to have the most positive demographic indicators, being the only ones to experience a population increase in both periods. They also show lower ageing rates (10) and a slightly positive migration balance (11) in the second period, although this contrasts with the very favourable migration balance recorded in the first period. This pattern correlates with CAP aid, with a concentration of aid in areas with greater dynamism and demographic concentration.

- **Group 2:** The municipalities in this group are mainly located in the central areas of the province of Cáceres and in the centre-south of the region. While the group included 108 municipalities in the first period, it was reduced to 41 in the second, reflecting a significant change in the spatial structure and intensity of the impact of the aid received. These are regions where extensive livestock farming and rain-fed crops play a crucial role in economic sustainability. The agricultural counties with the highest representation in this group include Olivenza, Jerez de los Caballeros, Llerena, Castuera and Alburquerque in the province of Badajoz, as well as Valencia de Alcántara, Brozas and Trujillo in Cáceres. Although the geographical distribution of these municipalities is diverse, there was a reduction in the number of municipalities in this group between the first and second periods analysed. Demographic deterioration has led to the transfer of municipalities from this group to Group 4, where demographic indicators are more regressive.

In terms of CAP aid (1), the municipalities in this group received significant average annual amounts, over €1,500,000 in the first period and over €3,500,000 in the second. This is the group with the third-largest volume of investment, both in absolute and per capita terms, with a significant difference in volume of investment compared to the next two groups. The proportion of aid earmarked for rainfed crops (4) stands out, reaching more than €3,000,000 in the second period, which shows the relevance of this type of agricultural production in the economic structure of the group. Furthermore, a significant increase in CAP (2) and EAGGF/EAGF aid per 1,000 inhabitants (7) can be observed, consolidating the agricultural structure of these municipalities, and reaffirming their importance in the rural economy. This financial growth may have supported the productive fabric of the farms, despite the socioeconomic constraints. The sociodemographic situation of the municipalities in this group is not alarming, being only more unfavorable than that of Group 1. This group is made up of localities with a certain socio-economic attractiveness and a larger population, which means that their ageing and demographic growth rates are not as worrying as those of Groups 3, 4 and 5.

- **Group 3:** This group is made up of municipalities located mainly in the north and northeast of Extremadura, including agricultural counties such as Coria, Hervás, Plasencia, Navalmoral de la Mata and Logrosán, most of them located in mountainous areas. They are also represented in some municipalities of the southern counties, such as the counties of Almendralejo and municipalities of Mérida which are located far from the more influential area of the Vegas del Guadiana, known for its high agricultural productivity, as well as areas of Llerena and Azuaga. In the first period, this group comprised 170 municipalities, increasing to 185 in the second, reflecting a slight expansion in its territorial scope. The municipalities in this group share specific economic and demographic characteristics, including high ageing rates (10), high levels of unemployment (12) and lower overall economic activity compared to other groups in the region. Despite these limitations, municipalities in this group receive relatively high CAP support per inhabitant, highlighting the influence of CAP support in areas with low population (less than 1,000 inhabitants), which magnifies its impact when calculated on a per capita basis. Moreover, the growth in average annual CAP amounts (2) was considerable, second only to Group 5. During the first period, an increase of more than 35% was recorded, while in the second period, this increase was also significant, although it was reduced to around 20%. In terms of EAGGF/EAGF support per farm (6), this group had the lowest average values in both periods, at around €4,000, which, together with its moderate figures in the overall CAP average amounts, suggests a less productive socio-economic and agricultural structure, with smaller farms (typical of mountain areas) and a limited capacity to attract significant financial resources for agricultural markets. However, a relevant aspect of this group is the high proportion of agricultural contracts (13) in relation to its active population. During the second period, more than 55% of the contracts were linked to the agricultural sector, showing a significant increase compared to the first period, reflecting an upturn in agricultural activity and a greater dynamisation of the labour market in the agricultural sector, despite the structural difficulties of these municipalities. This absence of an increase in aid and the relatively low aid values can be attributed to the fact that the demographic and economic variables of these municipalities are not as favourable as those of Group 1.
- **Group 4:** This group demonstrates significant dynamics in terms of CAP support in both periods, suggesting shifts in the allocation or impact of aid over time. It included 80 municipalities in the first period and expanded to 116 in the second, pointing to an increasing presence of these territories in the aid distribution landscape. During the first period, there is a considerable increase in CAP amounts (2), while in the second period this trend is reversed, reaching negative values. In the first period, fewer municipalities benefited due to the high aid values, while in the second period, with the reduction of the amounts, the territorial homogeneity and the geographical scope of the group is consolidated.

Distribution of aid shows a higher proportion of going to rainfed farms (4), showing the importance of this type of agriculture in the region. They also receive large amounts of aid

per inhabitant (3), with an average of close to €1 million in both periods, underlining the importance of the agricultural sector in their local economy. However, the municipalities in this group face important socio-demographic challenges. They have high ageing rates (10), which increase in the second period, and show the worst values in population growth (9), with negative rates in both periods. The migration balance (11), initially negative, worsens significantly in the second period, indicating a population exodus that may be related to the lack of economic opportunities. These municipalities, characterised by regressive demographic variables, experience an amplified impact of per capita aid due to the low population density in many of them. In addition, there is a predominance of rainfed or smallholdings, which, being less profitable, do not favor an upturn in their demographic indicators, contributing to some of the worst results in terms of population growth and sustainability. In addition, the unemployment rate (12) also shows an increase in the second period, reflecting a decline in local economic activity. This socio-economic situation is reflected in the subsidies per holding (6), which show a notable decrease between the first and second periods, which may be linked to a reduction in the number of active holdings. Despite this, the average size of holdings in this group is still above 50 ha, with the importance of large agricultural areas (15) standing out in some of these municipalities.

In terms of territorial distribution, Group 4 expands in the second period towards new areas in the centre-north of the region, especially in the province of Cáceres. Among the counties where these municipalities are concentrated are Valencia de Alcántara, Brozas, Cáceres, the south of Plasencia, Trujillo and Navalmoral de la Mata. These areas are heavily devoted to dry farming, which reinforces the importance of this type of crop in the agricultural context of these municipalities.

- **Group 5:** In the first period, this group consisted of 16 municipalities, primarily concentrated in the agricultural county of Jaraíz de la Vera. However, in the second period, the group expanded to include 38 municipalities, reflecting a broader geographical distribution. Although these municipalities continued to share similar characteristics, they became more dispersed across the region, indicating a shift in the spatial pattern associated with this profile. However, a notable concentration persists in the areas originally represented in the first period, suggesting a continuity in the agrarian and socio-economic dynamics that define this group for the attraction of these aids. This group stands out as the third in terms of the number of amounts received per 1,000 inhabitants (3), exceeding €1,500,000 during the second period. In the first period, it already showed high values, above €1,000,000, which indicates a high intensity of aid in relation to the demographic density of the municipalities. This underlines the economic dependence on these subsidies for their sustainability. However, despite the magnitude of the aid, the small population of these municipalities, most of which have less than 500 inhabitants, limits their capacity to generate profitable farms that favour growth or at least the maintenance of the population. Thus, although the aid is significant in relative terms, it is not sufficient to reverse the downward demographic trend and ensure long-term economic viability.

As far as EAFRD support is concerned, Group 5 stands out notably. It is the group with the highest amounts per inhabitant (17) in this category, showing a prioritisation of support for rural development and agricultural infrastructure. Moreover, the positive variation (18) in this aid compared to the previous period is significant, being only surpassed by the municipalities in Group 3. This fact reinforces the relevance of EAFRD in the promotion of economic activity and territorial development of the municipalities included in this group.

From the territorial aspect, the municipalities present characteristics that reflect important structural limitations in their agricultural activity. This group registers the lowest UAA values (14) among the five groups, with farms with an average size of less than 20 ha during the first period. However, in the second period, an increase in average farm size is observed, reaching close to 40 ha, suggesting a trend towards farm consolidation. Despite this increase, the limited average farm size (15) remains a limiting factor for agricultural development in these municipalities.

However, this is a marginal group, with a low territorial representation, where agricultural economic activities have not been able to consolidate the maintenance of the population or reduce ageing rates.

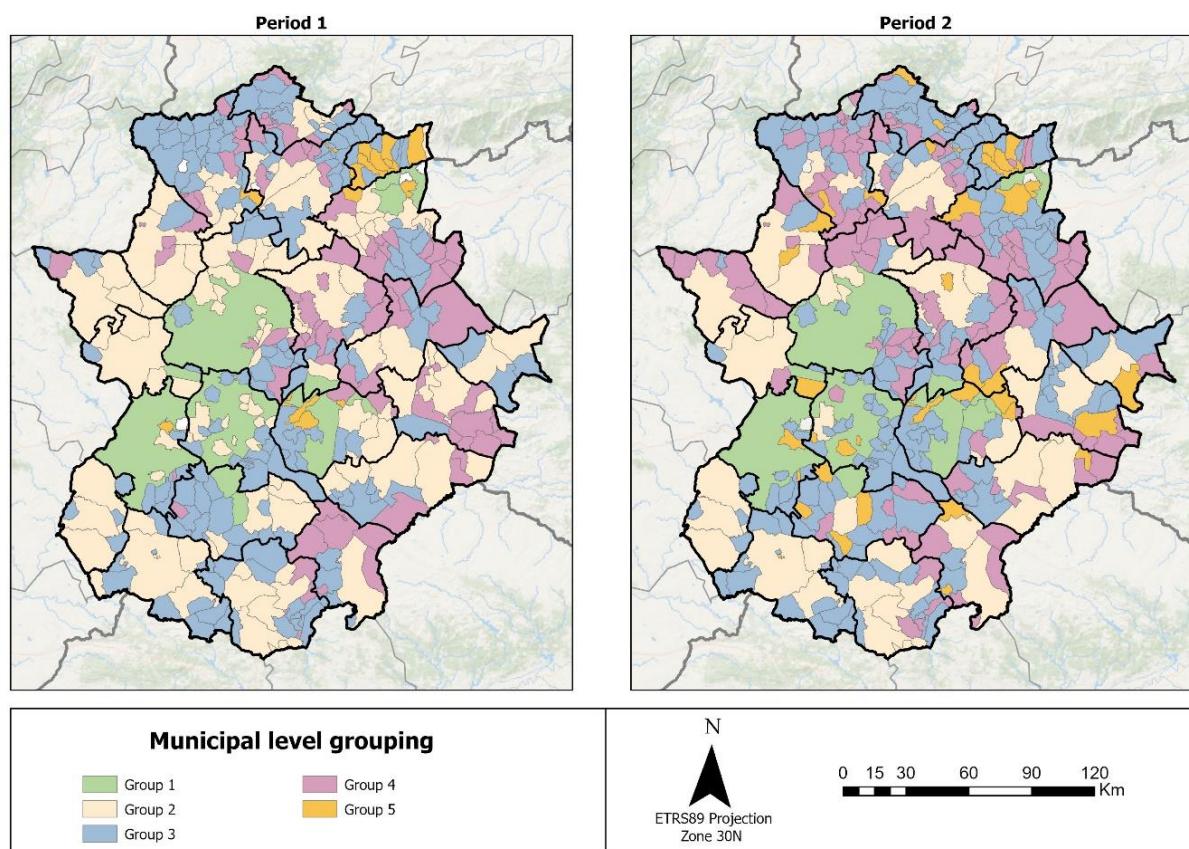


Fig 8. Multivariate clustering by period. Source: own elaboration

Tab 2. Results of the Multivariate Clustering variables by period. Source: own elaboration

Variable	Acronym	Period 1				
		Group 1	Group 2	Group 3	Group 4	Group 5
1	AvgCAP	€21,646,000	€1,542,866	€639,880	€686,169	€1,995,899
2	VarCAP	-2.7	20.6	37.5	16.8	347.1
3	CAPinh	€1,044,964	€540,999	€453,763	€1,037,263	€1,029,431
4	CAPrain	€16,853,401	€1,341,188	€576,521	€610,403	€1,343,281
5	CAPirr	€4,792,599	€201,678	€63,359	€75,766	€652,618
6	EAGGFfarm	€11,574	€7,074	€3,440	€6,585	€7,760
7	EAGGFinh	€1,002,346	€515,436	€424,425	€990,367	€936,548
8	varEAGGF	-14.8	8.0	16.7	4.8	300.3
9	PopG	6.5	-0.5	-5.4	-11.1	-0.8
10	AgeingR	79.6	202.9	235.4	511.8	156.1
11	NMR	6.0	4.4	-1.8	-6.0	0.7
12	UnempR	13.0	14.5	12.8	12.4	9.3
13	AgriEmpC	34.8	25.2	44.1	36.4	52.5
14	UAA	49,610	13,340	5,531	6,396	3,682
15	AvgFarmS	63.0	66.0	24.6	50.8	15.3
16	LU	19,167	11,292	2,853	1,801	1,068
17	EAFRDinh					
18	varEAFRD					

Variable	Acronym	Period 2				
		Group 1	Group 2	Group 3	Group 4	Group 5
1	AvgCAP	€21,138,260	€3,535,608	€735,218	€471,125	€2,834,042
2	VarCAP	7.3	5.0	19.3	-0.9	16.6
3	CAPinh	€742,462	€727,451	€522,969	€838,566	€1,814,600
4	CAPrain	€14,166,386	€3,128,373	€621,461	€448,033	€2,019,653
5	CAPirr	€6,971,874	€407,235	€113,757	€23,093	€814,389
6	EAGGFfarm	€21,155	€8,838	€4,065	€4,261	€17,832
7	EAGGFinh	€602,188	€626,653	€444,233	€731,225	€1,546,947
8	varEAGGF	-10.2	-4.9	-4.3	-11.9	4.7
9	PopG	1.2	-3.9	-2.9	-9.8	-3.9
10	AgeingR	87.6	167.6	259.2	572.0	257.6
11	NMR	-1.2	-1.1	2.9	-2.0	0.3
12	UnempR	15.5	17.1	16.1	17.9	15.7
13	AgriEmpC	21.4	18.2	55.8	34.7	35.2
14	UAA	52,720	24,785	4,348	5,287	4,589
15	AvgFarmS	61.0	77.1	31.8	60.7	43.3
16	LU	16,886	12,941	1,983	2,133	1,883
17	EAFRDinh	€140,274	€100,798	€78,736	€107,341	€267,653
18	varEAFRD	121.4	106.4	202.9	109.1	123.0

6. Discussion and conclusions

Extremadura has historically stood out for being one of the regions that receives the largest amounts of CAP aid, which is why the analysis of this European policy in a region such as Extremadura is over-justified.

Since the restructuring of the EAGGF into the EAGF and EAFRD in 2007, CAP funds have shown a trend towards greater stability, albeit with some fluctuations in some years due to various circumstances. The impact of the CAP reforms is evident, especially with the change of budgetary periods, which has influenced the variations in the aid distributed. In this sense, this study has shown how the different CAP reforms have increased the importance of rural development as a key pillar in European agriculture. However, although there has been a gradual increase in aid earmarked for this second pillar, this increase is still insufficient to generate significant complementary incomes that favor a population recovery in our territory.

CAP subsidies have shown differentiated trends according to the size of the municipalities and the agricultural and livestock productivity of the areas where they are located. Previous studies (Martínez García et al., 2023a, 2023b) have shown a direct relationship between population size and CAP amounts received, observing that the highest allocations are concentrated in more populated municipalities, although the agricultural sector does not play a prominent role in them. Similar results have been reported at national (Leco Berrocal & Pérez Díaz, 2019) and regional level, such as in Castilla y León, where aid is mainly targeted at municipalities with high population and a lower dependence on agriculture (Baraja-Rodríguez et al., 2021). However, some studies indicate that these subsidies do not always have a positive impact on agricultural production, as discussed by Žičkienė et al. (2022). This study, at a general EU level, does not consider success stories in specific areas where the impact of support may be more significant. Similarly, Jambor & Szerletics (2022) highlighted the negative effect of direct payments on agricultural productivity in EU member countries, differentiating between old and new members. Although this general approach may not reflect specific success cases where CAP support has positive effects on the most profitable agricultural areas at the municipal level, as demonstrated in our analysis of Extremadura, CAP support has not been able to reverse socio-economic and demographic difficulties in all municipalities analysed. Although the analysis reveals that certain municipalities continue to face persistent socio-economic and demographic challenges, the results suggest that CAP support alone may not be sufficient to reverse these trends in all contexts. This observation aligns with the idea that the effectiveness of CAP aid varies significantly by region. For instance, Galluzzo (2021) found that in Romania, CAP support was associated with reductions in out-migration and rural poverty, while Grodzicki & Jankiewicz (2022) reported improvements in socio-demographic conditions in rural areas of the Baltic countries during the 2000–2020 period. These contrasting regional patterns highlight the importance of contextual factors and suggest that the relationship between CAP support and rural development outcomes is complex and heterogeneous.

The results obtained are consistent with studies carried out in other European contexts such as Romania, the Baltic countries and various Spanish regions, allowing parallels to be drawn and certain patterns observed to be generalised. Extremadura thus presents itself as an illustrative case of the differentiated effects of the CAP in territories with high dependence on agriculture and common structural challenges in rural peripheral Europe. Using Multivariate Cluster Analysis, complex patterns and dynamics have been identified in the rural territories of Extremadura, which has made it possible to assess the inequalities and trends linked to the impact of CAP aid in the periods analysed. The results show a clustering of aid in urban municipalities and the main county seats of the region, Group 1, mostly located in irrigated areas and characterised by socio-economic stability and where the largest amounts of CAP aid are accumulated. They also have the best demographic figures, with population growth and less ageing. The municipalities that make up Group 2 also stand out as important recipients of CAP aid, which reflects the importance of the agricultural sector in the economic structure of these territories. In these areas, where rainfed farming and extensive livestock farming predominate, despite receiving significant CAP aid, regressive demographic dynamics are observed (although less worrying than in Groups 3, 4 and 5). Moreover, some municipalities move to Group 4 in the second period due to a greater deterioration of demographic variables.

In both Groups 3 and 4, the limited variation in subsidies and the relatively low subsidy values in these municipalities reflect the influence of less favorable demographic and economic factors compared to Groups 1 and 2. Group 3 groups together municipalities, mainly located in mountain areas, with high rates of ageing and unemployment. Despite receiving large per capita subsidies, their agricultural structure is less productive. On the other hand, Group 4 concentrates municipalities with the worst demographic indicators, characterised by high levels of ageing. Their economy depends mainly on rainfed farming, but the decrease in subsidies and unemployment aggravate their population decline, evidenced by negative population growth, a high degree of ageing, high unemployment rates and a negative migratory balance. These municipalities are characterised by regressive demographic structures, where the impact of population aid is magnified due to their low population density. However, the predominance of rain-fed or smallholdings, with lower profitability, limits their capacity to improve their economic and demographic indicators. As a result, although the relative volume of aid may seem significant, it is not sufficient to promote sustainable development or to reverse the processes of depopulation and socio-economic deterioration affecting these areas. In these areas, changes were observed in the characteristics of the variables used, especially in those areas where the amounts of support decreased significantly during this period. Group 5 shows the greatest differences between the first and second period analysed, reflecting the reform of the CAP, which restructured its focus from exclusive support for production to a policy oriented towards the economic diversification of rural areas and the maintenance of agricultural areas. These are sparsely populated municipalities, most of them with less than 500 inhabitants, where support is magnified in relative terms; however, it is not sufficient to ensure the profitability of farms, which makes them socio-demographically difficult.

Although the CAP provides support tools for the agricultural sector in the EU, the results in Extremadura have not managed to improve the critical situation suffered by the agricultural sector and society in all rural areas of the region. Although these aids have strengthened the agricultural economy, competitiveness, and innovation in the region, their unequal distribution continues to favor more dynamic areas while disadvantaging less developed ones, making it essential to address the specific challenges faced by smaller municipalities to improve their access to and effective use of CAP support. Furthermore, the results of this study can be extrapolated to other rural regions in Europe with similar socio-demographic and economic characteristics (low population density, ageing, agricultural dependence or limited economic diversification), thus providing a useful basis for assessing the extent to which the current CAP model contributes to the balanced and sustainable development of the agricultural sector in rural Europe. Although this study provides an overview of the distribution and impact of CAP aid in Extremadura, it does not carry out a specific analysis broken down by social groups such as women and young people, due to limitations in the availability of data. However, the strategic importance of these groups in the modernisation, generational renewal and sustainability of the agricultural sector is recognised. In this regard, future research should focus on examining the role of women and young people in receiving and using this aid, as well as identifying the structural and administrative barriers that could limit their access. Furthermore, it is considered essential to study in greater depth the role of cooperatives as a tool for revitalising the regional agricultural economy. This associative model can be key not only to strengthening the productive fabric but also to facilitating access to aid, promoting innovation and improving the competitiveness of the sector. Furthermore, studying the impact of these contributions on public administration and policymaking would provide valuable information on their effectiveness and could guide future strategies to position the agricultural sector as an effective tool in the fight against the problems of Europe's rural societies.

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