

Segmenting farms in the European Union

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Abstract: The main objective of this work is to characterize and segment the farms of the twenty-seven Member States of the European Union (EU). For this purpose, the techniques of cluster analysis and cluster of cases segment the farms, based on a sample of farms of the Farm Accountancy and Information Network. The results show the existence of four types of farms in the EU that are distinguishable by their (i) structural characteristics, in particular, for their Utilized Agricultural Area, the total output, by the percentage of contract work and the total work, (ii) by their financial characteristics, i.e., by their total assets and the cash flow of the EU farms, and (iii) by their guidance and the importance of subsidies on these farms. These results thus suggest the definition of the Common Agricultural Policy differentiated and adapted to the existing four clusters of countries. We suggest the development of typologies of farms in the EU, with a more robust database involving different EU regions that constitute the different countries in order to obtain the robust types of farms from different European regions.

Key words: CAP, cluster analysis, farms, typologies

There is a wide range of literature that characterizes and segments farms in different specific areas of the European Union (EU). Most of these studies attempt to understand the structural changes in these regions, in particular, changes in employment, agricultural production and the impacts of the Common Agricultural Policy Reform (Iraizoz et al. 2007). However, there are no specific studies that segment and simultaneously characterize farms of twenty-seven Member States in homogeneous groups of farms with the exception of the Farm Accountancy Data Network (FADN), the purpose of which is purely economic in essence.

The main aim of this study is to characterize farms in the EU, getting to the effect robust typologies of farms according to the structural and financial criteria.

This article is divided into seven sections. The next section briefly describes the classification of the farms conducted by the FADN. Section two makes a brief characterization of the farms in the EU. Section three presents the methodological approaches to segmenting farms. Section four details the methodological approach used in this analysis and presents and justifies the use of variables used in cluster analysis. Finally the section five presents the main results of the analysis and Section six presents the main conclusions of this study.

An economic approach for typologies of farms: the EU farm typology by the FADN

In 1965 the EU decided to create the FADN to collect the necessary data for the annual determination of incomes of agricultural farms and for an analysis of farm management (Regulation 79/65/EEC). The FADN consists of an annual survey conducted in all EU Member States that collects data of physical and financial characteristics of the farms, to evaluate the performance and analysis of agricultural activities. The FADN aims to provide representative data on the regions, their economic size and type of farms. It covers about 90% of the agricultural area (UAA) of the EU and over 90% of the total agricultural production. The farms covered are all those whose size presents market orientation (Podruzsik et al. 2008).

The economic results mean for each Member State are influenced mainly by its internal structure i.e., the predominant production standard in the typology set individually for each Member State.

Later, within the EU decisions have been made to obtain a common typology to present and analyze the data from farms in the EU from a political perspective. In its current form, the typology of the FADN farms in the EU is based on the 1985 decision (Decision 85/377/EEC). This decision determines the purpose of the typology:

- (1) The typology should be designed to meet the information needs of the Common Agricultural Policy (CAP).
- (2) The purpose of the typology should be to provide an instrument at the EU level to carry out:
 - (a) analysis of the equity of the farms based on economic criteria;
 - (b) comparisons of the situation of farms,
 - (c) between the various classes in the typology;
 - (d) between the Member States or regions of the Member States, and
 - (e) between different periods (Decision 85/377/EEC).

The typology of farms in the FADN classified farms according to their production, farm size and is based on the portion that each section of farm production has in the creation of the standard gross margin (SGM). The SGM expressed the economic yield of a production unit for the individual sections of plant and animal production. Its value corresponds to the standard of production of 1 ha of the crop or the head of a particular animal species after deducting variable costs for its production (Bašek and Kraus 2011). The standard gross margin thus determines the economic gain of a production plant or animal (Divila and Sokol 1999).

In the EU, the presentation and analysis of agricultural statistics have been associated with a typology common to several decades. However, the logic behind the EU farm typology is purely economic. The main criterion for the division of the farms in different types is the relative distribution of agricultural income from different sources of production (crops, livestock activities, etc.). This reflects that these events were decided at a time when the main objectives of agricultural policies were related to agricultural production (Anderson et al. 2007). However, the current agricultural policy objectives have been expanded more strongly to the protection of landscape, environmental and rural sustainability (Dos Santos et al. 2010b). This was recently reinforced by the reform of the Common Agricultural

Policy, 2003 and the Health-Check (Commission of the European Community 2003).

With these changes in the CAP, the EU farm typology has to be reevaluated as an instrument for the evaluation and monitoring of policies. This paper emerges in this perspective.

Brief characterization of the farms of the European Union

The characterization of the farms in the twenty-seven Member States (MS) that comprise the European Union is done using data from the Farm Accountancy Data Network (FADN 2008), because the last available year was the year 2008.

From the graphical analysis of the average size of the farms included in the FADN sample (Figure 1), it results that the agricultural area (UAA) of the EU average is 78.6 ha. The large farms continue to predominate in the new EU member states, in particular in Slovakia in which they reached a maximum of 579.3 ha. There follows the Czech Republic, where the average is 227.8 ha and 131.6 ha in Estonia. According to Bašek and Kraus (2011), this means that the processes of restitution, restructuring and privatization have brought major changes in the participation of the private land ownership in these countries. The analysis also shows that the UK has about twice the average area of farms than the average in the EU (160 ha). There is also a reduced UAA in the Mediterranean countries which can be about half the EU average, like in Spain (35 ha), about three times lower, as is the case of Portugal (26 ha), or even 10 times lower than the European average, as is the case of Greece (7.1 ha).

The indicator UAA/AWU for the farms in the EU verifies that the UK exceeds 2.5 times the European average, which means a higher productivity of their

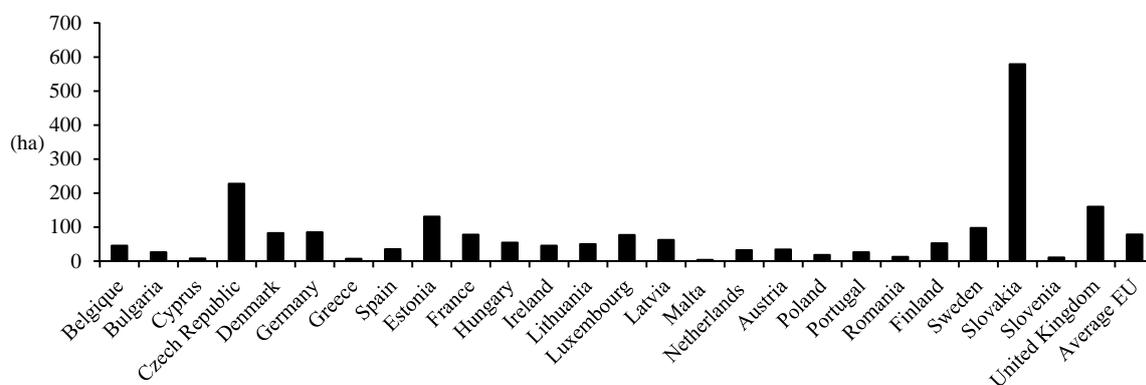


Figure 1. Utilized agricultural area average of the EU countries

Source: FADN (2008)

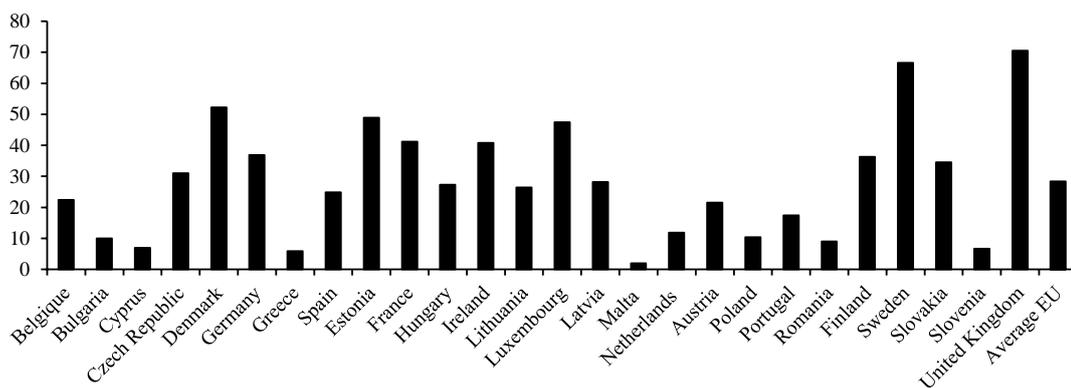


Figure 2. UAA/AWU average of the EU countries
 UAA – Utilized Agricultural Area, AWU = Annual Work Unit

Source: FADN (2008)

agriculture (Bašek and Kraus 2011). In the second and third place, there are Sweden and Denmark with the indirect indicator of productivity 2.3 and 2 times higher than the EU average which is about 28 (Figure 2).

European agriculture is also well subsidized. The average, agricultural subsidies emanating from the Common Agricultural Policy (CAP) accounted for approximately 23% of the total production in all EU countries. The countries that contribute most to this value are Finland that exceeds 2.5 times the EU average and Ireland where the value of subsidies out of the total production is about twice the EU average (43.3). The least subsidized countries are the Netherlands, Denmark and Romania, where the subsidies represent respectively 4.1, 10.8 and 10.5 % (Figure 3).

Methodological approaches for segmenting farms

The driving force for any farm typology and segmentation is diversity. The relevance of a farm typology

will therefore depend on its ability to capture the differentiation of farming systems, showing ‘a maximum amount of heterogeneity between the types, while obtaining maximum homogeneity within particular types or categories’ (Köbrich et al. 2003).

Previous typologies have followed one or a combination of two methods: the *a priori* approach and the quantitative typification techniques. The *a priori*, or what Rosenberg and Turvey (1991) refer to as the pre-specified method, relies on the knowledge and judgment of the researcher to define the characteristics for segmentation. The merit of this approach depends heavily on the choices made by the researchers and it has been heavily criticised for failing to make full use of the available data (Gloy and Akridge 1999). Moreover, due to the lack of statistical foundation, there is no evidence that any *a priori* based segmentation yields (fairly) homogenous groups (Gebauer 1987). The most common pre-specified approach to segmentation has been to group farms based on geographical areas, which ignores the heterogeneity of farming systems within the particular locations (Köbrich et al. 2003).

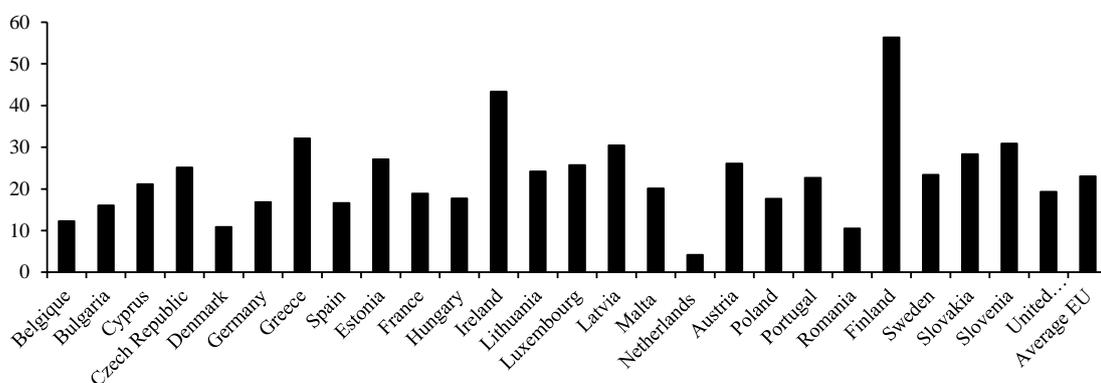


Figure 3. Subsidies/output average of the EU countries

Source: FADN (2008)

The second approach has been labelled the quantitative typification (Köbrich et al. 2003). The quantitative typification may be based on a small number of variables, such as followed by the USDA (2000; 2001), or employ multivariate statistical techniques. The USDA (2001) segmented family farms into seven categories based on just two variables: the occupation of operators and the volume of sales. When a classification is based on so few variables, there is a danger that the typology will fail to accurately capture and segment the state of farms (Iraizoz et al. 2007). For example, while the USDA (2001) seeks to understand the economic outlook of farms, by relying on such a limited number of indicators they ignore a number of factors that might influence the future performance, such as the degree of financial stress and asset ownership. Given this, some have preferred to adopt the multivariate statistical techniques so that a greater range of segmentation variables can be employed in producing a typology (Davidova et al. 2003; Köbrich et al. 2003; Iraizoz et al. 2007; Silva and Berbel 2007; Dos Santos et al. 2010a). Davidova et al. (2003) analyze the variations in the performance of farms in the Czech Republic in a decade after starting the transition process. These authors identified seven clusters of farms differed in relation to their productivity and profitability. Iraizoz et al. (2007), using the same variables in the previous study, analyze the trajectories of the Spanish farms of the area of Navarra. Dos Santos et al. (2010a) in order to know the attitudes of Portuguese farmers from the Alqueva Irrigation Scheme in the Alentejo form three homogeneous groups of farms in the Alentejo based on the cluster analysis of cases and the cluster analysis of variables and discriminant analysis.

MATERIAL AND METHODS

There is a large consensus among different authors about the importance of multivariate analysis in defining the typologies of farms through the multivariate analysis (Dos Santos et al. 2010a). Thus, for segmenting farms in the European Union and forming groups of a high internal homogeneity and a high external heterogeneity, there were used the multivariate analysis techniques, including the cluster analysis of cases and the analysis of cluster of farms.

The multivariate analysis was based on Davidova et al. (2003), Iraizoz et al. (2007) and Dos Santos et al. (2010a). The procedures included the analysis of cluster cases and the cluster analysis of variables. Cluster analysis is a multivariate analysis technique used to form homogeneous groups, i.e., that present a great

homogeneity of the intra-group characteristics and a large inter-group heterogeneity (Hair et al. 2005). This technique aimed to form homogeneous groups of farms in the EU states members. For this purpose, it was necessary to select the variables with explanatory power that allowed separating farms in different countries. Traditionally, this process is carried out with the use of the factorial analysis of components that is also intended to eliminate multicollinearity between the variables. Because it is a small number of observations (less than thirty countries), we used the cluster analysis of variables according to Hair et al. (1998). This analysis aimed at transforming a linearly higher original set of variables into fewer uncorrelated variables without any significant loss of information (Hair et al. 2005).

The previous procedures in the cluster analysis included the exclusion of the correlated variables by the correlation analysis, and their subsequent standardization through the criteria

$$Zscore = \frac{X_i - \bar{X}_i}{\sigma}$$

where X_i and \bar{X}_i and σ represent respectively the value of the variable, its average and σ the standard deviation for $i = 1, 2, \dots, n$.

The cluster analysis included as a measure of proximity to the squared Euclidean distance (d_{ij}). This measure calculates the distance between two points as the sum of the squares of the differences between i and j values for all variables ($v = 1, 2, \dots, p$).

$$d_{ij} = \sum_{v=1}^p (X_{iv} - X_{jv})^2$$

The aggregation criterion used was the Ward's method (Ward 1963). This criterion consists of: (a) calculating the averages of the variables in each group, (b) calculating the squared Euclidean distance between the means and the values of variables for each individual; (c) summing of the distances for all individuals, and (d) optimizing the minimum variance between groups.

Cluster analysis of the cases was based on the factors obtained in the cluster analysis of variables. The data used comes from the FADN database (FADN 2008), and refer to the year 2008 because it was the last year available.

Variables used in cluster analysis

The aim of this study is to identify the groups of farms in the member states that are homogeneous. The variables chosen for this purpose are those that have

traditionally been used to analyze the performance of farms. For this purpose, there was performed a review of the literature to help identifying these variables. The variables used in this study for segmenting farms are classified into four groups: structural variables, use of inputs, technology (intensification), and financial variables.

The structural aspects of the farms

The size of the farm is a factor to consider, because of their importance in the theories of structural change that highlight the existence of the economies of scale that can encourage the growth patterns, as evidenced in the empirical work by Paul and Nehring (2005) on the U.S. agricultural sector. Furthermore, some authors have reported that farmers who operate on bigger farms have a greater receptivity to change (Damianos and Skuras 1996) and more easily adopt technological innovations (Argilés and Slof 2003). The size of the property is usually measured in physical units, such as the number of AWU, livestock units, or in monetary terms by variables such as the total production, the total assets or the gross margin standard. However, the changes in the size of the property usually involve changes in the proportions of the factors and production technology used, as well as the changes in the production mix. Consequently, none of these measures, if used alone, can fully characterize the farm (Weiss 1999). As a result, other authors, namely the Argilés (2001),

Davidova et al. (2003) and Iraizoz et al. (2007), use more than one measure for the size of the property. In this work, the farm size is represented by four variables: the utilized agricultural area (SAUTOT), the total work (TOTALUTA), the value of the total production excluding direct subsidies (OUTTOT) and the total assets (TOTASSET).

Rented land and hired labour

The use of external factors, such as the surface of the rented land and labour hired, were also included to construct the typologies of the EU farms. According to Soule et al. (2000), the land is an important factor in the decisions of farmers, for example, the adoption of conservation practices and/or change in intensity of production. Furthermore, the percentage of rented land (PORREUAA) has been used as an indicator of predisposition for farmers to increase the risk (Daskalopoulou and Petrou 2002). The percentage of paid work (PORPALAB) has also been used by some researchers as Daskalopoulou and Petrou (2002); Davidova et al. (2003) and Iraizoz et al. (2007) to obtain the typologies of farms. Therefore, these two variables were included in the analysis.

Farm specialization

The agricultural specialization was another of the variables considered. Villatora and Langemeier (2005) concluded that the farms more specialized in crop production grew at a growth rate faster than the farms specializing in livestock. This variable is also included in the work developed by Davidova et al. (2003) and Iraizoz et al. (2007). Thus we include as the variable the percentage of crop production in the total output (PROCRO) and measure the degree of specialization of the farm in arable crops.

Intensification

The intensification factors were included in this work according to Davidova et al. (2003) and Iraizoz et al. (2007). Therefore, we include capital intensity, which was measured by the depreciation of capital per 1 annual work unit (DEPAWU). Higher values indicate that there is more capital available per 1 worker. We also included the intensification of the land factor, measured by the UAA per 1 annual work unit (UAA/AWU). Higher values mean low levels of intensification.

The financial component

On the financial component, the variables included were the cash flow (CASH-FLOW) following the methodology of the FADN and the leverage that followed the methodology developed by Davidova et

Table 1. Variables used in the analysis

Variable	Definition
SAUTOT	Total land (Utilized Agricultural Area)
OUTTOT	Output (excluding the net current subsidies)
TOTALUTA	Total labour
TOTASSET	Total assets
OUTUTA	Percentage of paid labour
PORREUAA	Percentage of rented land
PROCRO	Percentage of crop production
SAU/UTA	Land per unit of labour
DEPAWU	Capital (depreciation) per unit of labour
CASH-FLOW	Cash-flow
LEVERAGE	Leverage
RENGO	Rents and interest paid/gross output
SUBNET	Net current subsidies
SUBOUTP	Percentage of gross output coming from net current subsidies

Source: Made by the author (2011)

Table 2. Representation of clusters and their respective countries

Cluster	Country
I	Germany, Austria, Belgium, Cyprus, Finland, France, Lithuania, Malta and Sweden
II	Bulgaria, Estonia, Slovenia, Greece, Hungary, Latvia, Poland, Portugal and Romania
III	Slovakia, the Czech Republic
IV	Ireland, Luxembourg and the UK

Source: Results of the cluster analysis of cases (2011)

al. (2003) and Iraizoz et al. (2007). Also included, according to the same authors, was the variable rent paid/total output (RENGO). Since we consider that the degree of dependence on farm subsidies was also an important aspect that distinguishes the holdings in the EU, the variables included the total subsidies (SUBNET) and the percentage of subsidies in the total production (SUBOUTP).

The Table 1 presents the variables used in the analysis.

RESULTS AND DISCUSSION

The results of the cluster analysis of variables revealed that farms in the EU are distinguishable by

Table 3. Principal characteristics of the four clusters

Variable	Cluster			
	I	II	III	IV
Structural characteristics				
SAUTOT	50.54	38.46	403.61	79.57
OUTPUT/SAU	2 221.7	1 041.5	1 026.3	2 912.9
TOTALUTA	1.7	1.84	12.0	1.86
OUTUTA	21.7	29.5	86.9	31.8
SAU/UTA	28.9	18.8	32.7	44.5
DEPAWU	8 807.0	6 301.5	9 238.1	7 221.3
Financial characteristics				
TOTASSET	334 166.8	120 129.7	632 311.5	1 030 662.6
CASH-FLOW	22 642	10 181.5	2 056.5	37 328
LEVERAGE	0.79	0.81	0.76	0.76
RENGO	0.040	0.026	0.032	0.039
Productive orientation				
PROCRO	44.4	55.2	56.1	33.8
SUBOUTP	24.3	22.1	26.7	20.6

Source: Results of the cluster analysis of cases (2011)

three main factors: (i) the structural characteristics, namely, by their UAA (SAUTOT), the value of the total production excluding direct subsidies (OUT-TOT), the percentage of work hired (OUTUTA) and the total work (TOTALUTA), (ii) for their financial characteristics, i.e., their total assets (TOTASSET) and the cash flow of the EU farms, and (iii) the orientation of production and the importance of subsidies in the farm. So this factor includes the variables of the percentage of arable crops on the farm (PROCRO) and the percentage of subsidies in the total production (SUBOUTP).

Based on these results, there was carried out the cluster analysis of cases whose results allowed us to obtain four clusters respectively including the following EU countries. The Table 2 presents the clusters and the respective countries. The cluster I mainly includes the countries of Central and North Europe. The cluster II includes mainly the Mediterranean countries and some countries of Eastern Europe. It should be noted that Italy does not appear in the results, because there are no published data on the basis of the FADN data on this country. The cluster III includes partially countries of Eastern Europe. Finally, the cluster IV includes the UK, Luxembourg and Ireland.

Table 3 presents the principal characteristics of the four types of countries.

It is presented subsequently the analysis of their four clusters:

Cluster I

This cluster represents 36% of the EU countries. It is formed mainly by the countries in Northern Europe. The average size of their holdings is 50 ha, whose output/UAA is 2221 Euros/ha, which represents the second highest of the four clusters. The farms of this group have in average about 1.7 AWU of which only about 22% is contract work. The UAA/AWU of these holdings is 28.9 ha/AWU, which makes the second highest group of farms in the EU. These farms have higher values of capital per 1 worker (8807 Euros) measured by the depreciation of capital per 1 annual work unit, which means there is a greater capital intensity per worker in these farms.

With regard to their financial characteristics, these farms have the total assets of 334 166.8 Euros, which amounts to only 32% of the value farm in the cluster IV. The value of cash flow is about 22 642 Euros, which amounts to about 60% of farms in the cluster IV.

Cluster II

This cluster represents about 40% of the EU countries. It consists primarily of the countries in Eastern Europe and the Mediterranean countries, whose average size of farms is approximately 38 ha, the output/UAA is 1041.5 Euros/ha, which represents the second lowest of the four existing clusters, making up about 35% of the value of farms in the cluster IV. The farms of this group have in average about 1.84 AWU, of which only about 30% is contract work. The UAA/AWU of these holdings is 18.8 ha/AWU, which amounts to the lowest of the groups of farms in the EU, representing about one third of the value of farms in the cluster IV. This result indicates an intensive use of labour. These farms also have low levels of capital per 1 worker (6301.5 Euros), representing the lowest of the EU countries, which means there is less capital intensity per worker in these farms.

With regard to their financial characteristics these farms have the total assets of 120 129.7 Euros, which amounts to about 35%, 18% and 11%, respectively, of the farms of the clusters I, III and IV. The value of cash flow is approximately 10 181.5 Euros, a figure that amounts to about 45%, about five and four times of the holdings in the clusters I, III and IV, respectively.

Cluster III

This cluster represents about 8% of the EU countries, being formed by Slovakia and the Czech Republic. The average size of their holdings is 403.61 ha, the output per UAA is 1026.3 Euros/ha, which represents the lowest of the four existing clusters, representing about 35% of the value of holdings in the cluster IV. The farms of this group have in average about 12 AWU, of

which about 87% is contract work. These farms show the EU's most intensive use of labour beyond about 7, 6 and 6.4 times of the holdings of the clusters I, II and IV. The UAA/AWU of these holdings is 32.7 ha per AWU, which amounts to about 1.1, 1.7 and 0.73% of the value of the holdings of the clusters I, II and IV, respectively. These farms also have higher values of capital per 1 worker (9238.1 Euros), representing the highest of all EU countries, which means there is a greater capital intensity per worker in these firms.

With regard to their financial characteristics, these farms have the total assets of 632 311.5 Euros, which amounts to about 1.8, 5.2 and 0.61%, respectively, of the holdings of the clusters I, II and IV. The value of cash flow is about 2056.5 Euros, which amounts to about 9%, 20% and 5% of farms in the cluster I, II and IV, respectively. These farms are, together with the farms of the cluster II, those with a greater specialization in crop production, particularly in crops which represent about 55% and 56%, respectively.

Cluster IV

This cluster represents about 12% of the EU, being formed by Ireland, Luxembourg and the UK. The average size of their holdings is 79.5 ha, the output per UAA is 2912.9 Euros/ha, which represents the highest of the four existing clusters, totalling about 1.3 and 12.8, respectively holdings of the cluster I and II and III. The farms of this group have in average about 1.86 AWU, of which only about 31.8% is contract work. The UAA/AWU of these holdings is 44.5 ha/AWU, which represents the highest value of the groups of European farms indicating the lowest levels of the use of hand labour per hectare. These farms also have moderate amounts of capital per 1 worker (7221.3 Euros). This represents about 80%, one unit, one tenth and 0.78%, respectively, of farms in the clusters I, II and III.

With regard to their the financial characteristics, these farms have the total assets of 1 030 662.6 Euros, which amounts to about 3, 8.5 and 1.6 times, respectively, of the holdings in the clusters I, II and III. The value of cash flow is about 37 328 Euros, which amounts to about 1.6, 3.6 and 18 times the holdings of the clusters I, II and III, respectively. These farms are jointly presenting a lower specialization in crop production, particularly in the crops which represent approximately 33.8% of the total agricultural production.

CONCLUSION

This paper aims to identify and characterize the main types and farms in the Member States of the European

Union. For this purpose, the data were collected from the FADN. Then the multivariate analysis, including cluster analysis of cases and clusters farms, led respectively to identifying the main variables, typifying and identifying the representative farms of the EU countries, then four clusters were obtained. It is concluded that the farms in the EU countries are distinguishable by three main factors: the structural characteristics, for their financial characteristics and their productive orientation and the importance of subsidies on the farms.

The four clusters of farms obtained show that the farms in the EU broadly fall in the North and Central Europe, the Mediterranean and the East. This classification will allow the definition of agricultural policies better adjusted to these regions. However, further studies are needed, based on the regional data, allowing a more detailed classification in order to sectioning not only countries, but also the homogeneous European regions.

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