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Farm Typology and Land Suitability in Terceira Island (Azores:Portugal)

Tipologia de Explorações Agrícolas e a Aptidão do Solo na Ilha Terceira (Açores: Portugal)

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Abstract/ Resumo

The aim of this paper is to categorize farm types and relate them with the land suitability classes suggested for Terceira Island (Azores: Portugal). The study included a set of 64 indicators for 1,366 farms contained in the databases that comprise the Integrated Administration and Control System for direct support schemes under the Common Agricultural Policy. Using principal component analysis and cluster analysis, a farm typology system was built up based on eight principal components that characterized 81.4% of the total variance between farms. As a result, the farm sample was divided into seven different categories: dairy farms (50%), meat production farms (23%), non-specialized animal farms (9%), arable crop farms (2%), wine-growing farms (5%), fruit and vegetable growing farms (8%) and banana farms (3%).

The mapping drawn from the categories of farms was crossed with thirteen land suitability class combinations for five alternative land uses. We confirmed that the distribution of different farm types changes according to the land suitability proposed for each zone.

O objetivo deste artigo consistiu em classificar os diferentes tipos de explorações agrícolas e relacioná-los com as classes de aptidão do solo referenciadas para a Ilha Terceira (Açores: Portugal).
O estudo abrangeu um conjunto de 64 indicadores aferidos para 1.366 explorações constantes das bases de dados que compõem o Sistema Integrado de Gestão e Controlo para os regimes de apoio direto no âmbito da Política Agrícola Comum. Com o recurso à análise de componentes principais e à análise de clusters, foi desenvolvida uma tipologia de explorações agrícolas, baseada em oito componentes principais que caracterizaram 81,4% da variância total observada. Como resultado, as explorações constantes da amostra foram divididas em sete categorias diferentes: explorações leiteiras (50%), explorações de bovinos de carne (23%), explorações animais não especializadas (9%), explorações de culturas arvenses (2%), explorações vitícolas (5%), explorações hortofrutícolas (8%) e explorações de banana (3%).

O mapeamento das explorações resultante da tipologia foi cruzado com treze classes de combinações de aptidão do solo para cinco usos alternativos. Confirmou-se que a distribuição dos diferentes tipos de exploração varia de acordo com a aptidão do solo referenciada para cada zona.

Keywords: farm typology, principal components analysis, cluster analysis, land suitability, Terceira Island

JEL Codes: C38, Q15

Palavras- chave: Tipologia de exploração agrícola, análises de componentes principais, análises de clusters, sustentabilidade do solo, Ilha Terceira

Códigos JEL: C38, Q15

1. INTRODUCTION

The efforts to define farm typologies are quite usual (Gaspar et al., 2008) and not new (Köbrich et al., 2003). Their aim is not only to facilitate the analyses but also to support policy making. Nevertheless, because most of the data on farms are referenced to administrative entities (parishes, municipalities and regions) and not take into account the geographical differences within those areas, there is a lack of relational data that allow us to understand with more detail the associations between the local biophysical environment and the farm typologies. The lack of this connection creates serious problems in the development of agri-environmental policies.

The purpose of this paper is to develop a method to differentiate the local farming systems prevailing in Terceira Island (Azores: Portugal) and then analyze their spatial distribution across the different land suitability classes.

We assume land suitability as the fitness of a given parcel of land for a defined use (e.g. urban/touristic, horticulture, arable farming, pasture and forest). The process of land suitability classification proposed by Silveira and Dentinho (2010) comprises the grouping of specific areas of land in terms of their suitability for different combinations of uses. Their land suitability classes were defined based on the interaction of four main biophysical factors (i.e. temperature, precipitation, slope and soil capability).

Consequently, the spatial distribution of the different categories of farm typology is reported, according to the biophysical environment that vary over space (Vaz et al., 2014).

Therefore this study also intends to assess the role of the biophysical constraints - expressed through a land suitability classification system - on farm typology spatial distribution. In this case the arising question is: How do local agricultural systems depend on the biophysical environment?

2. MATERIALS AND METHODS

2.1 Area of study

Terceira Island is located in the North Atlantic Ocean, between the coordinates 38º38'–38º47'N and 27º02'–27º23'W and is one of the nine volcanic islands of the Azores archipelago. The island has an area of 402.2 km^2 for a total population of 56,437 inhabitants (INE, 2011). The climate is temperate oceanic, but strongly influenced by the island topography. Most of Terceira land is devoted to agriculture (mainly for grass and forage crops). Regarding forage, two main crops stand out: maize (*Zea mays*) and Italian ryegrass (*Lolium multiflorum*), both grown for silage and generally interspersed in short crop rotation. These crops support the activity of cattle livestock farming, as the animals stay outdoor all year round.

The island economy relies heavily on milk production and the industry associated with the dairy products processing. Even though, beef production has experienced significantly positive developments in recent years (INE, 2011 b).

2.2 Farm typologies

Developing a method to classify farms according to typologies is an interpretation process that reduces the number of individual cases, to a diversity expressed by a small number of types, which enable us to carry out the concerned analysis (Pardos et al., 2008). In spite of a typology being a simplification of the reality, together, the chosen variables provide a framework that bridges technological, socioeconomic, environmental, policy and cultural aspects of farming (Andersen et al., 2006). So, in building models for portraying farm decision-making situations, typifying and classifying farming systems should be considered a fundamental step (Köbrich et al., 2003).

The theoretical framework defines the purpose of classification and establishes the hy pothesis to guide the process of typification. The inputs required at the beginning are considered the researchers' previous experience and knowledge of the area, the objectives of the typification exercise and, the quantitative information that is available about the study area's agriculture (Escobar and Berdegué, 1990).

In general, the use of structural or productive characteristics (e.g. farm size, capital, labour, productive orientation, stocking rate, intensification level, soil quality, etc.) allow the discrimination among groups and the establishment of farm typologies (Escobar and Berdegué, 1990; Milán et al., 2006).

Grounded on this assumption several authors characterized the typology of farms from surveys based on structural variables, technical indicators, economic results or socio-economic characteristics, depending on their objectives (Castel et al., 2010, 2003; Gaspar et al., 2008; Gelasakis et al., 2012; Köbrich et al., 2003; Laval et al., 1998; Martínez et al., 2004; Milán et al., 2006; Pardos et al., 2008; Ruiz et al., 2008; Solano et al., 2000; Sraïri and Lyoubi, 2003).

Clearly, the 'best' typology of farms will have to show a maximum amount of heterogeneity between the types, while obtaining maximum homogeneity within particular types or categories, for it to be truly representative of the categories represented (Köbrich et al., 2003). The multi-variate statistical techniques provide a means of creating the required typologies, particularly when an exhaustive database is available (Köbrich et al., 2003) and are ideal tools for the characterization and classification of farms for one main reason: the concept of the farm system is multivariate, in the sense that its essence is the idea of several components or subsystems interacting in time and in space as well as in connection with various kinds of supra-systems (Escobar and Berdegué, 1990).

In order to undertake studies at local level, several specific farm typologies have been developed in the recent decades in the Azores. Aiming the selection of homogenous groups of farms to analyze the effects of agricultural policies, Avillez (1991) proceeded to the choice of criteria used in the identification of agricultural production systems considered most representative of S. Miguel and Terceira Islands, namely: systems based on crops, traditional production systems and livestock production systems (dairy, mixed and beef). For this purpose, farms were grouped based on the nature of the main products, the degree of specialization of activities and their size. From the analysis of the Farm Structure Survey for the Azores, Barreira et al. (1998) identified a pattern of production units differentiation, based on three criteria: family's income resulting from holding, number of family members whose main activity occurs outside the farm and main type of labor used on the farm (family or employee). Barreira et al. (1998) also analyzed the specialization pattern for major production systems practiced in the Azores, aggregating them into three types of production systems: specialist cattle, polyculture and specialist crops.

Based on data from 113 farms from the Farm Accountancy Data Network (FADN), Enes (1999) appealed to cluster analysis to group the holdings of Terceira in five different typologies. She recorded a clear differentiation of the groups when analyzing the relationship between specialization and intensification factors, given the size of holdings. To develop a decision model for different types of farmers in the Azores, Silva (2006) adopted a typology based only on the intensity of the farming productive system.

In all cases, the reported analysis focused on a limited number of farms subject to specific inquiries. However the information provided in these surveys is not readily available to the majority of farms nor is georeferenced. So, in order to reach the largest possible number of farms, it was necessary to consider new variables in the analysis. In our study we decided to appeal for administrative variables contained in the databases of the Integrated Administration and Control System (IACS) for direct support schemes under the Common Agricultural Policy (CAP). This choice was due to the fact that IACS offers accurate and up-to-date information about the growers aid applications, processing and payments, integrated in a Geographic Information System - the Land Parcel Identification System (LPIS) - that holds the detailed land parcels annually declared by farmers.

2.3 Data collection

Terceira Island farms structure and typology were characterized for the year 2011 from a survey on the administrative data from the

Integrated Administration and Control System (IACS) for direct support schemes under the Common Agricultural Policy (CAP). IACS provide accurate and up-to-date information about grower CAP aid applications, and the respective processing and payments in the European Union. Thus, the object of this study is the CAP support requesting farms.

Even though there are 2,316 farms referenced in IACS (from a total of about 3,000 present in the island), as our goal was to anchor the typology on the territory, only the information of 1,366 holdings which had parcels identified in the aid applications was used.

The database thus formed provides a true observatory of farms in the region (status, age of operator, location, area, livestock, amounts of aids, etc.). Nevertheless, there are some limits on the use of these data (Benoteau et al., 2010): (1) CAP does not cover all areas (e.g. arboriculture, pig, poultry, beekeeping, etc.) or farmers; (2) the statement made by the operator, whose purpose is to obtain assistance, may contain inaccuracies voluntary or not. However, these limits, which require some precautions in the interpretation, should not affect the overall quality of results.

The creation of classes for land suitability is based on the work done by Silveira and Dentinho (2010) that used GIS-based analysis to group all the combinations of four biophysical factors: average temperature, annual accumulated precipitation, slope and soil capability (Table 1); that are suitable for alternative land uses and land covers (i.e., Urban/touristic, Horticulture, Arable farming, Pasture and Forest). This methodology classifies the territory on 13 different classes (Table 2).

Table 1 Biophysical restrictions, Silveira and Dentinho, 2010

	TMP (ºC)	PRC (mm)	SLO (%)	CAP (I-VII)
Urban/touristic	≥ 16	≥ 0	0-25	I-VII
Horticulture	≥ 16	≥ 1000	0-25	I-VI
Arable farming	≥ 10	≥ 750	0-15	I-IV
Pasture	≥ 12.5	≥ 1300	0-25	I-V
Forest	≥ 0	≥ 750	0-50	I-VI

Average annual temperature (TMP), annual accumulated precipitation (PRC), slope (SLO) and soil agricultural use capability (CAP)

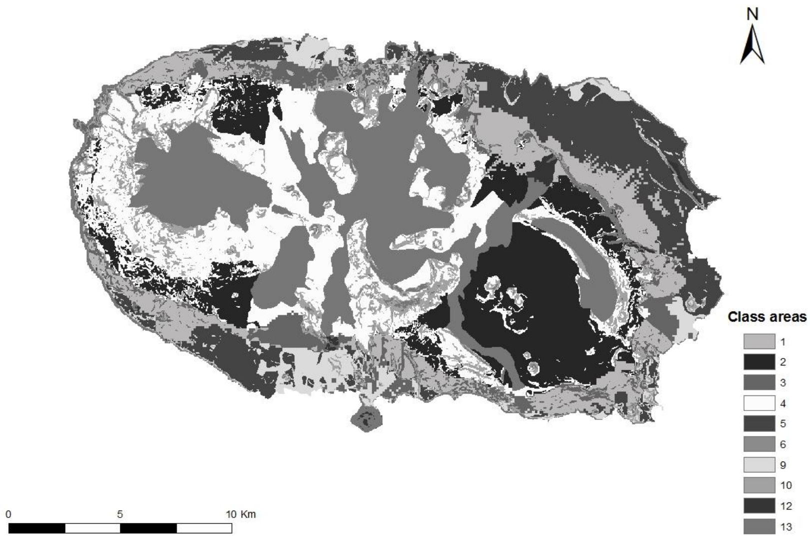
Table 2 Areas distributed according to land suitability classes in Terceira Island

	Suitable activities[1]	Area (ha)	Area (%)
Class 1	U, H, A, P, F	4 069.25	10.14%
Class 2	A, P, F	6 393.44	15.93%
Class 3	U, H, P, F	2 295.38	5.72%
Class 4	P, F	8 294.31	20.66%
Class 5	U, H, A, F	4 824.75	12.02%
Class 6	H, A, F	2.00	0.00%
Class 7	U, A, F	0.00	0.00%
Class 8	A, F	0.00	0.00%
Class 9	U, H, F	1 687.50	4.20%
Class 10	F	3 218.88	8.02%
Class 11	U, F	0.00	0.00%
Class 12	U	245.38	0.61%
Class 13	-	9 107.25	22.69%

[1]Adapted from Silveira and Dentinho (2010): Urban and touristic (U), Horticulture (H), Arable farming (A), Pasture (P) and Forest (F).

Although class area No. 13 is not suitable for any of the activities considered, it can be related to environmental uses for water supply or nature conservation (Silveira, 2009). Figure 1 shows the distribution of land suitable classes in Terceira Island.

Figure 1. Terceira Island land suitability map (25 x 25 m^2 grid)



Silveira, 2009

3. DATA ANALYSIS

The IACS data were introduced into an Excel matrix after checking for missing and abnormal data. Subsequent treatment was performed using Excel and SPSS (version 20.0) programs.

3.1 Selection of variables

We selected 64 indicators from the IACS databases. The selection was made by removing binary variables, those which were not answered in all cases, and those not supplying relevant information.

Although high correlations were found between some variables (redundant variables), we chose to consider all of them in the statistical analysis.

Variables 1 to 17 directly stem from grower aid applications, 18 to 31 are the holding land use data registered on LPIS, and 32 to 64 were retrieved from IACS processing and payment systems.

3.2 Principal component analysis

The purpose of the factor analysis is to reduce the number of variables and thus the 'dimensionality' of the problem. Factor analysis is often used when the study variables are known to be correlated (Köbrich et al., 2003). The principal components analysis (PCA) is a form of factor analysis which first looks for a linear combination of variables that extracts maximum variance from them and then identifies a second linear combination to explain the remaining variance, leading to new orthogonal (statistically uncorrelated) variables, usually called factors. Each principal component (PC) in PCA is such a dimension, called a factor, interpreted in the category of a subset of original variables, which are mostly correlated with the principal components (Castel et al., 2010).

To eliminate the effects of differences in magnitude between the variables and those associated with the scale of measurement units, the variables were normalized before performing the statistical procedures. In this way, variables values ($X_{i,0\ to\ 1}$) assumed values from 0 to 1, as a proportion of the variables range:

$$X_{i,0\ to\ 1} = \frac{X_i - X_{Min}}{X_{Max} - X_{Min}}$$

Where:
X_i = initial value of the variable
X_{Min} = minimum value recorded for the variable
X_{Max} = maximum value recorded for the variable

With the normalized data a Varimax Rotated Principal Components Analysis on the 1,366 farms was performed. The PC variability was measured by associated eigenvalues. The first PC was associated to the higher eigenvalue. The next PCs were associated to decreasing eigenvalues. The principal component analysis supplied eight PCs that explained 81.4% of the variance and the relative proportion of variance was: 41.5% for the first component, 17.7% for the second, 5.1% for the third, 4.6% for the forth and 12.4% for the last 4 relevant components considered.

Table 3 gives the principal components selected on the basis of the PCA and the variance that each explained.

Table 3 Eigenvalues of the principal components (PC) and percentage of variance they explain

PC	Initial Eigenvalues			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	580.2	42.5	42.5	566.9	41.5	41.5
2	247.6	18.1	60.6	242.2	17.7	59.2
3	73.4	5.4	66.0	69.3	5.1	64.3
4	61.6	4.5	70.5	62.8	4.6	68.9
5	59.2	4.3	74.8	54.4	4.0	72.9
6	57.0	4.2	79.0	52.3	3.8	76.7
7	33.0	2.4	81.4	40.3	2.9	79.7
8	26.5	1.9	83.3	23.6	1.7	81.4

3.3 Hierarchial cluster analysis

Subsequently, the first 8 principal components of the PCA were subject of a hierarchical cluster analysis. These principal components were chosen because they represented different variables, which were linked together with collinearity.

The used cluster algorithm has been the Ward hierarchical method, which classifies farms that are similar to each other, but different from others, by maximizing intra-group homogeneity and inter-group diversity based on Euclidean distance.

Concerning the number of clusters determination, the literature does not provide fixed rules. Therefore, this decision should be based on the experience and objectivity of the researcher (Castel et al., 2010). As a result of the cluster analysis, seven groups with perfectly distanced centroids were obtained. Figure 2 shows the distribution of farms in clusters, according to the first two principal components (PC1 - Dairy production based on forage crops and PC2 - Male bovine rearing).

3.4 Farm typology: classification and description of production systems

The characteristics distinguishing the seven groups are the following:

Group 1 - Dairy farms (50% of farms): Farms with the largest Milk Producers Premium quotas and values determined in Milk Producers Premium; largest number of applicant and checked animals for Dairy Cow Premium; largest applicant and determined areas and values for Aid for Arable Crops Producers and Dairy Cow Premium Supplement; the largest size farms in terms of Utilized Agricultural Area (UAA), forage area, Temporary Crops land use and number of cows per farm; higher proportion of fodder crops on UAA and the largest applicant area for Payments to Farmers in Areas with Handicaps.

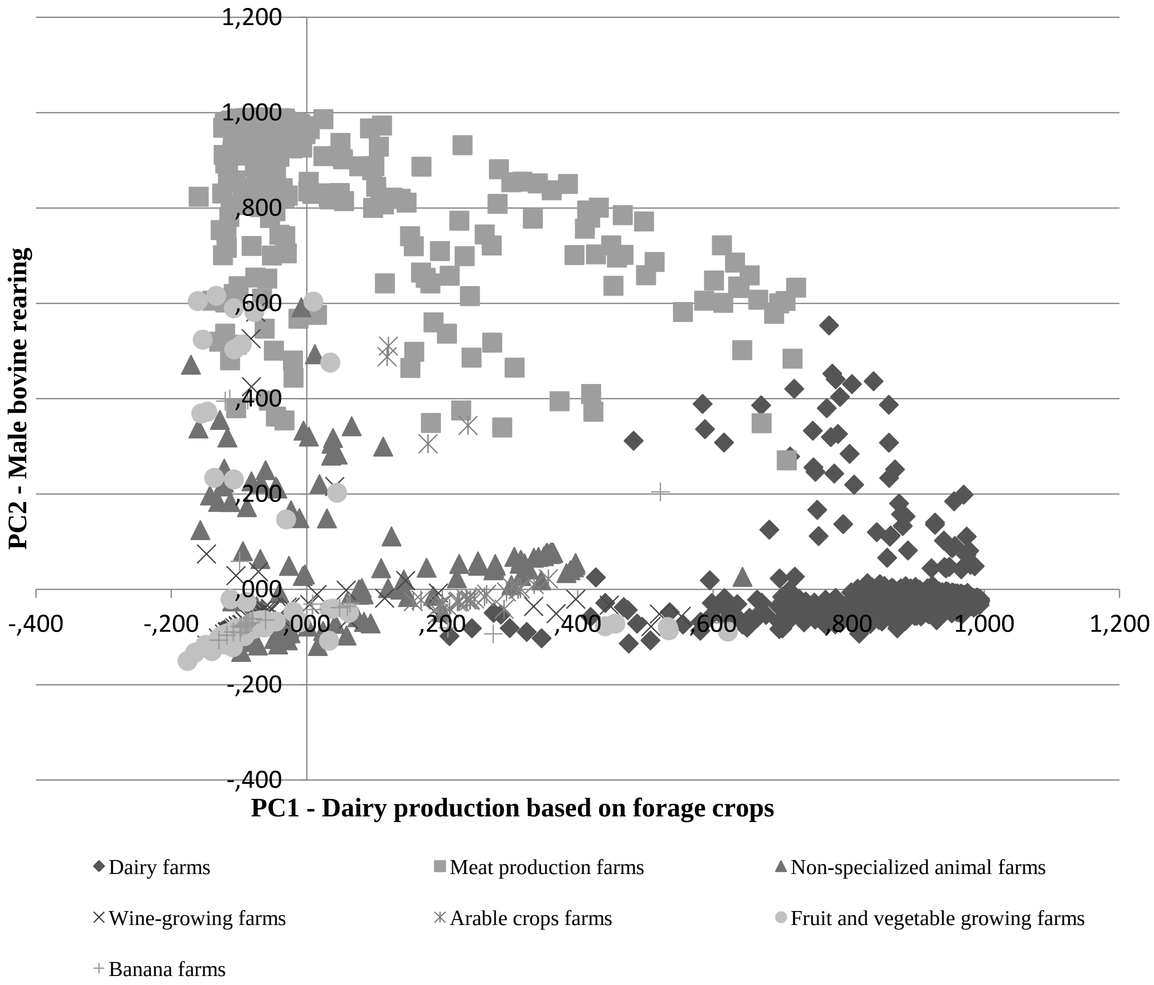
Group 2 - Meat production farms (23% of farms): Farms with the largest number of applicant, checked and determined steers to Male Bovines Premium; largest determined number and value to Male Bovines Extensification Supplement; largest number of animals eligible for non-PGI Bovines Slaughter Premium over 8 months and a high value determined in Bovines Slaughter Premium.

Group 3 - Non-specialized animal farms (9% of farms): Farms with the largest Suckler Cow Premium rights, largest number of applicant and checked animals in Suckler Cow Premium, and highest Suckler Cow Premium determined, as well as the largest number of animals and value determined in Suckler Cow

Extensification Supplement; largest number of applicant animals for Protection of Autochthonous Cattle Breeds Premium; high value determined in Bovines Slaughter Premium; largest number of animals eligible and value determined in the Aid for the Sale of Young Bovines out of the Azores; largest number of applicant animals and goat checked in Sheep and Goats Producers Premium; largest number of animals checked and value determined in Sheep and Goats Slaughter Premium; the largest applicant area for Extensification of Livestock Production, largest permanent pastures land use areas and largest proportion of permanent pastures on UAA; lowest dairy cows proportion in the herd.

Group 4 - Wine-growing farms (5% of farms): Farms with the largest vineyards land use areas; largest applicant area in the Aids for the Maintenance and Conservation of Vineyards; the largest value determined in the Aid for Maintenance of Vineyards.

Figure 2. Farms score (PC1×PC2) by cluster membership

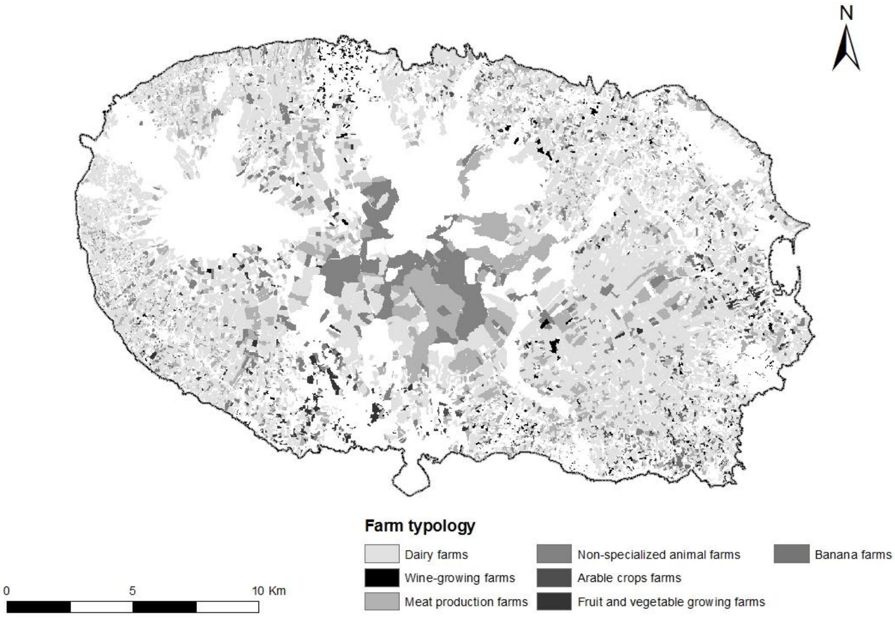


Group 5 - Arable crops farms (2% of farms): Farms with the largest applicant area and determined area and value in the Aid for Arable Crops Producers; high proportion of fodder crops on UAA.

Group 6 - Fruit and vegetable growing farms (8% of farms): Farms with the largest applicant area and determined area and value in the Aid for Producers of Fruit, Vegetables, Flowers and Ornamental Plants; larger applicant area for Banana Aid, Organic Farming Aid and Aid for Conservation of Hedgerows; largest Permanent Crops and Other Agricultural Crops land use areas.

Group 7 - Banana farms (3% of farms): Farms with larger applicant area for Banana Aid; largest applicant area for the Aid for Conservation of Traditional Orchards; largest Fruit Orchards land use areas.

Figure 3 Shows the distribution of farms according to typology.



Terceira Island farm typology map (25 x 25 m^2 grid)

3.5 Distribution of farm typology categories by the different classes of land suitability

The occurrences of farm categories were computed for each land suitability class as well as their respective Location Quotients (LQ), a number derived by comparing the percentage of area of typology *i* in a land suitable class *j* with the percentage of the area of typology *i* in the total surveyed area:

$$LQ = \frac{x_{ij}/X_j}{X_i/X}$$

Where:

x_{ij} = Area of typology i in land suitable class j

X_j = Total area of land suitable class j

X_i = Total area of typology i

X = Total area

'Dairy farms' are the main farm category observed in all land suitable classes combinations, indicating the high level of agricultural specialization in the island. Table 4 also reveals a significant component of agricultural marginal areas - such as areas of exclusive forest (class No. 10) or urban and touristic suitability (class No. 12), or designed for nature preservation (class No. 13) – belonging to farm systems, mainly on animal farms.

Values reached for 'dairy farms' in land classes combination No. 1 and 2, both suitable for arable farming, pasture and forest should be highlighted. 'Meat production' and 'non-specialized animal' farms succeed 'dairy farm' in terms of land occupation. They have a similar distribution pattern and their main LQ ratios occur in land class combination No. 4 only suitable for pastures and forest use, and No. 10 only suitable for forest. 'Wine' growing farms are particularly represented on class No. 9 and 'Arable crops' farms on class No. 1. 'Banana' and 'Fruit and vegetables' growing farms present higher relative distribution on classes No. 1, 3, 5 and 9, all suitable for horticulture.

The LQ ratio of non-farming areas grows along the sequence of class combination No.1, 3, 5, 9 successively less suitable for agriculture uses. The same applies in the sequence of classes No. 2, 4, 10 and 13.

Table 4 Farm categories occurrences per land suitability class, 2011 (in ha) [1]

	Class combination No.	1	2	3	4	5	6	9	10	12	13
Land suitability	Urban and touristic	x		x		x		x		x	
	Horticulture	x		x		x	x	x			
	Arable farming	x	x			x	x				
	Pasture	x	x	x	x						
	Forest	x	x	x	x	x	x	x	x		
Farm categories	Dairy	1934.4	4111.4	590.2	3324.7	1705.3	0.4	223.8	998.8	53.8	982
		1.37	***1.85***	*0.74*	***1.16***	***1.02***	*0.58*	*0.38*	*0.89*	*0.63*	*0.31*
	Meat production	454.4	807.3	165.9	1335.2	473	0	91.3	435.8	15.6	712.
		1.00	***1.13***	*0.65*	***1.44***	*0.88*	*0.00*	*0.48*	***1.21***	*0.57*	*0.70*
	Non-spec. animal	124.9	304.8	58.8	750.9	125	0	24.7	229.1	1.4	700.
		0.53	*0.82*	*0.44*	***1.57***	*0.45*	*0.00*	*0.25*	***1.23***	*0.10*	***1.33***
	Wine-growing	36.5	38.3	14.4	38.9	36.6	0	29.8	13.3	0	8.6
		1.66	***1.11***	***1.16***	*0.87*	***1.41***	*0.00*	***3.28***	*0.77*	*0.00*	*0.18*
	Arable crops	43.6	19.3	9.6	12.1	28.4	0	1.4	3.2	1.6	2.4
		3.54	*1.00*	***1.38***	*0.48*	***1.94***	*0.00*	*0.27*	*0.33*	***2.15***	*0.09*
	Fruit & vegetable	74.5	38.3	72.1	59	104.4	0	65.1	26.1	4.5	19.6
		1.59	*0.52*	***2.72***	*0.62*	***1.87***	*0.00*	***3.34***	*0.70*	***1.59***	*0.19*
	Banana	30.1	20.1	14.8	5.2	27.8	0	7.1	5.3	0	15.3
		2.36	*1.00*	***2.06***	*0.20*	***1.84***	*0.00*	***1.34***	*0.53*	*0.00*	*0.54*
	Non-farm areas	1370.9	1054.1	1369.6	2768.4	2324.1	1.6	1244.4	1507.3	168.4	666
		0.73	*0.36*	***1.30***	*0.73*	***1.05***	***1.74***	***1.60***	***1.02***	***1.49***	***1.59***
	Total	4069.3	6393.4	2295.4	8294.3	4824.8	2	1687.5	3218.9	245.4	910
		1.00	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*

[1]The number in italics is the Location Quotient (in bold LQ ratio greater than 1:1).

4. DISCUSSION

As cluster analysis allows grouping any collection of individuals or observations according to any set of variables, it is necessary to attest if the generated typology represents an observable classification and not the one imposed on the data by the cluster analysis itself (Köbrich et al., 2003).

Farm systems classified and typified as a result of multivariate analysis must be validated by comparing it with the original theoretical framework and project objectives, in contrast with the research team perception, regarding diversity of farming systems empirically observable.

Indeed, the obtained typology can be inconsistent or may be an inadequate reduction of existing real diversity (Escobar and Berdegué, 1990). To be meaningful, and useful, the classes or categories have to be related to the purposes for which they are being created; therefore, the fact that they serve the purposes for which they are intended provides the most meaningful way of testing their conceptual validity. It is also important to ensure that these groups are 'real' and not merely imposed on the data by the method being used for classification (Köbrich et al., 2003).

On this perspective we found that the average size of 15.16 ha of utilized agricultural area (UAA) - for the 1,366 analyzed farms - is expressively greater than the average farm size of 7.8 ha UAA - for the 2,993 farms reported on the agricultural census conducted by Statistics Portugal (INE, 2011 b). This discrepancy suggests that a significant number of small farms have been excluded from the analysis carried out. It was assumed that these small farmers did not request CAP support, or were excluded from the analysis because they declared to have no area in their application forms. However, in view of the aim of the work 'Farm typology and land suitability', we consider that the seven categories found are fairly representative and it did not affect the overall quality of results.

We realize that our categories have a good adherence with the European Union classification of agricultural holdings by farming type. However when compared with the numbers of Terceira Island 2009 Agricultural Census (Table 5) the following differences were identified: 'Dairy farms' category represent 50% of the farms, while the correspondent ‘Specialist dairying’ type only represents 23% and the ‘Arable crops’ farms category only represent 2% of farms, while the correspondent ‘Specialist field crops’ represents 10%. Considering the universes of both systems (1,366 versus 2,993 farms), the different percentages are justifiable by the fact that whereas almost all ‘Specialist dairying’ holdings apply for CAP aids, a significant part of ‘Specialist field crops’ apparently do not. It is also emphasized the difference between the 314 farms in the ‘Meat production’ category and the correspondent number of 812 holdings registered in ‘Specialist cattle - rearing and fattening’ type of farming. This aspect can be attributed to the fact that some farmers did not apply for CAP aids or did not identify any parcels in their aid applications. Nevertheless, we strongly suspect the prevalence of the latter.

Table 5 Terceira Island 2009 Agricultural Census data (by EU types of farming)

Type of farming	Holdings		UAA[1]	
	No.	(%)	(ha)	(%)
Total Terceira Island	2.993	100	23.367	100
1. Specialist holdings	2.581	86	22.916	98
1.1. Specialist field crops	304	10	339	1
1.2. Specialist horticulture	71	2	130	1
- **Specialist horticulture indoor**	9	0	4	0
1.3. Specialist permanent crops	452	15	239	1
- **Specialist vineyards**	125	4	39	0
- **Specialist fruit and citrus fruit**	264	9	163	1
- **Specialist olives**	0	0	0	0
1.4. Specialist grazing livestock	1.687	56	22.144	95
- **Specialist dairying**	697	23	15.949	68
- **Specialist cattle — rearing and fattening**	812	27	4.214	18
- **Cattle — dairying, rearing and fattening combined**	75	3	1.156	5
- **Sheep, goats and other grazing livestock**	103	3	825	4
1.5. Specialist granivores	67	2	65	0
- **Specialist pigs**	24	1	45	0
- **Specialist poultry**	29	1	17	0
2. Mixed holdings	366	12	447	2
2.1. Mixed cropping	116	4	124	1
2.2. Mixed livestock holdings	88	3	138	1
2.3. Mixed crops — livestock	162	5	185	1
3. Non-classified holdings	46	2	5	0

(Source: SREA - Regional Statistics Service of the Azores, personal communication, July 22, 2013)

1Utilized agricultural area

Considering the context in which it was constructed, the typology proved to be useful to design the geographic distribution of farm categories throughout the island (information required to assess the effect of biophysical factors on farm distribution). In this regard the obtained results confirm that farms are located mainly in areas suitable for arable farming and pastures, despite also occupying other areas, including areas without any agricultural suitability.

While the more intensive dairy farms occupy, preferentially, the areas with joint suitability for arable farming, pasture and forest, the other animal holdings have a distinct pattern of occupation, with particular incidence in areas with marginal use for agriculture such as the ones suitable for pasture and forest, just forest, or even without any suitable use for man.

The ‘Wine’ and ‘Fruit and Vegetables’ growing farms categories prevail on land suitability combination areas compatible with horticulture, but without the complement of arable farming suitability, where such crops are replaced by livestock production.

The rationality of this study can also be verified by the fact that *ceteris paribus*, the weight of total farms in land use increases progressively to areas with suitability for pasture, further on for arable farming, and finally for both.

5. CONCLUSION

The methodology of Principal Component Analysis (PCA) and Cluster Analysis proved to be suitable for defining farm typologies. These typologies enabled seven homogeneous groups of farms to be considered in land-use patterns and dynamics analysis at local scale.

The use of data from the Integrated Administration and Control System for direct support schemes, under the Common Agricultural Policy, proved to be adequate to support the methodology with the benefit of being updatable annually and have a geographic expression (Vaz et al., 2012).

The spatial intersection of the found typologies with the map of land suitability confirmed that the distribution of different farm types is constrained by the biophysical factors prevailing in each zone. Consequently, the development agri-environmental policies based on spatial models for agricultural land use changes at local scale should take into account the farm types which, in turn, are dependent on the biophysical factors that vary among the territory.

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