Typology and structural characterisation of suckler cow farming system in Central Macedonia, Greece

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ABSTRACT

The aim of this study was to establish a farm typology of the suckler cow sector, based on a stratified sample of 66 farms in the region of Central Macedonia, Greece. The method of hierarchical cluster analysis has been used to typology and characterisation of the farming system. The farm size was determined by the number of suckler cows and total livestock units. The degree of intensification of the farming system was classified based on the stocking rate of available pastures, labour efficiency, housing system and level of infrastructure. Cow productivity was evaluated as the weaned calves to cows’ ratio. The profitability and the dependence of farms on subsidies were estimated by using gross profit with or without the addition of total subsidies. Following the results, four principal farming systems and one diversified were highlighted: firstly, a traditional, pasture-based, semi-extensive system with low profitability and strong dependence on subsidies was identified. Secondly, a viable and relatively profitable, despite the lack of pasture land, semi-intensive system was revealed. The third one was also a semi-intensive system with high pasture availability and low reliance on subsidies. The intensive farming system that was represented by the fourth case was unsustainable due to the absence of available pastures. The semi-intensive one, which characterised as ‘diversified’ was not a pure suckler cow farming system as it was mainly based on purchased calves fattening.

HIGHLIGHTS

- The lack of pastures constrains the development of suckler cow farming sector in Central Macedonia, Greece.
- The low percentage of weaned calves (62%) leads to low capital outputs.
- Semi-intensive systems are best suited to ensuring the future viability of suckler cow farms with or without receiving subsidies.

Introduction

In the Mediterranean basin, suckler cows farming have traditionally been related to grazing, in regards to the increased exploitation of non-cultivated agricultural areas (Ligios et al. 2005). In some cases, the extensive suckler cows farming systems show a higher level of viability than the more intensive ones (Garcia-Martinez et al. 2009; Choisi et al. 2012). However, despite the positive aspects of grazing, they tend to become more intensified (Ruiz et al. 2008) due to the modernisation and intensification of agriculture and the abandonment of livestock farming in remote rural mountainous areas (Bernués et al. 2011).

The Greek beef cattle sector with 178 thousand suckler cows represents only 2.22% of the total EU-27 suckler cow population (EUROSTAT 2013). The annual beef meat production does not exceed 34% of the country’s needs, although suckler cow population has increased by 12% over the past five years due to the EU’s premiums. The organised cattle breeding in Greece was not popular due to the mountainous terrain of the country, the climatic conditions and...
socioeconomic reasons. Thus, no ‘bovine tradition’ has been developed in the country (Kitsopanidis 2004). In the last few decades, a new period for cattle breeding began by systematical replacement of indigenous cattle breeds with improved breeds, by building and using stables, and hired work (Zervas 2008). This led to changes in the traditional extensive cattle breeding system that was based on the grazing of semi-mountainous and mountainous pastures, as the renewed-improved cattle population was less resistant to the adverse environmental conditions. Thus, the restricted use of grasslands by cattle herds and the competition for available land by other grazing animals and by the crop production sector (Ragkos et al. 2015; Yiakoulaki and Papanastasis 2014) has gradually led to an intensification of livestock production with consequences in grasslands such as shrubs’ encroachment (Zarovali et al 2007) and reduction in plant and animal diversity (Papoulia et al. 2003; Papadimitriou et al. 2004).

Significant redevelopments have also occurred with regard to the size of holdings, following the 1992 European Union (EU) Common Agricultural Policy (CAP) implementation and increasing inputs, either through direct subsidies per capita or by joining development projects (Karagiannis and Sarris 2002). Successive CAP reforms have brought about significant developments in the beef cattle sector, such as a reduction in the number of farms alongside with a large increase in the size of the herd and a dependence on subsidies (Bernués et al. 2011). However, the 1992 reform also adopted measures to promote the extensification of non-productive livestock farming for environmental reasons (organic farming) and the conservation of rare breeds (Pardos et al. 2008). Thus, the non-intensified farms were encouraged to keep their animals not only to receive subsidies but also to produce a distinguished final product (Canali 2006).

The sustainability of extensive suckler cow farms (Bernués et al. 2011) is determined by a complex of variables such as the degree of intensification (management and infrastructures of farms), labour characteristics, land use policies (grasslands and cultivated area) and economic performance (productivity, profitability and dependence on subsidies). In this regard, the intensification process is mainly related to maximised productivity based on either rational management or on improved infrastructure. Also, the labour factor has to face the reluctance of the workforce to work in unfavourable conditions. Nevertheless, the evolution of more intensified management practices in many rural areas has been found to increase the productivity of labour (Kazakopoulos et al. 1996). On the other hand, the land use is affected by several parameters such as the seasonality and adequacy of available pastures and the ability to cultivate supplementary forages and concentrates on agricultural land during the winter (Milán et al. 2006). A high dependence on European Union subsidies has also been observed in Greece (Kitsopanidis 2005) as the outputs from sales were not sufficient to cover the production costs.

The typology and classification of suckler cow farms are necessary for the assessment of the current level of productivity and the viability of the beef cattle sector. Typologies are able to identify which holdings require structural changes to become viable and useful for anticipated future changes (Daskalopoulou and Petrou 2002). According to our knowledge, such data for the suckler cow farming systems in Greece is very restricted.

Within this context, the objective of this study was to establish a typology about the suckler cow farming sector and highlight the differences between applied farming systems.

Material and methods

Study area and data collection

The region of Central Macedonia is located in Northern Greece and includes seven regional units. In this area, the largest livestock farming activity of the country has been developed as 11.90% of all suckler cows and 25.74% of the total beef cattle population are raised (Hellenic Statistical Authority 2017). This reason along with the soil and climate conditions, the land use and the existence of urban centres have led to the choice of this particular region as a representative area of this study. A further reason for this choice was the possibility to record and assess the dual tendency of extensification-intensification of suckler cows farming that takes place in all Mediterranean countries (Caraveli 2000). Particularly, while in the mountainous regions mainly extensive and semi-extensive farming systems with seasonal grazing are applied, in the lowlands are used intensive or semi-intensive systems which include the animal access to pastures. Suckler cows farming systems in the study area focussed on fattening calves production.

The total sample, which included 66 farms in, was calculated by Neyman allocation. This methodological approach is generally used to allocate sample to strata based on the strata variances (Wright 2014). The stratified sampling method is a classic research technique used to effectively evaluate the
parameters of a population, which exhibit significant variation among its subpopulations (Neyman 1934; Cochran 1977). Stratification criteria were the farm size, which included three classes (1st: from 19 to 50 cows, 2nd: from 51 to 100 cows and 3rd: higher than 100 cows), and each one of the seven Regional Units (Thessaloniki, Serres, Chalkidiki, Pella, Kilkis, Imathia, Pieria) that are included in the Region of Central Macedonia. The optimal sample size for stratum \( h \) is determined by the following equation in the Neyman allocation:

\[
\frac{\left( \sum N_h S_h \right)^2}{NPD^2 + \sum N_h S_h^2}
\]

where \( n \) is the total sample size, \( N \) is the total population size, \( n_h \) is the sample size for stratum \( h \), \( N_h \) is the population size for stratum \( h \), \( S_h \) is the standard deviation of stratum \( h \) and \( D \) is the desired standard error.

In order to collect the primary data, a questionnaire was drawn up after taking into account similar surveys (Kitsopanidis 2005; Milán et al. 2006; Usai et al. 2006; Choisi et al. 2012; Madry et al. 2013). The survey was carried out in 2013–2014 and was based on interviews with the farms owners at their farms. In the statistical analysis, only data from the last reference year were used as there were no great differences between the data collected in both years. In general, the total beef production in Greece shows a significant decrease of 27% in the last decade (the 60,690 tons produced in 2007, decreased to 44,110 tons in 2017) according to Hellenic Statistical Authority (2017). This can be attributed to the decrease of the native beef population and to the high prices of young calves purchased for fattening. The reduction in the number of beef cattle has also brought down the degree of self-sufficiency in Greece that barely covers 28%. The average selling price of native fattened calves per kilogram of live weight in 2006 was €2.94 while in 2013 and 2014 it was €3.5. This was the highest price ever recorded in EU-27 and was maintained up to 2017 (Eurostat 2013; Hellenic Statistical Authority 2017). All the above mentioned were crucial for the further development of the sector as well as for suckler cow farmers to continue receiving either direct or indirect subsidies through the Rural Development Programs 2014–2020 of the Greek Ministry of Rural Development and Food. Additionally, through the same programs suckler cow farmers are enhanced to adopt alternative practices (e.g. autumn cultivation of legumes for fodder crops) in order to reduce the feeding cost. The questionnaire included questions and sub-questions that were either closed (mainly qualitative questions with yes/no answers, questions with 1–5 rating scale or multiple-choice questions with suggested answers) and open type (mainly quantitative questions). The above information was divided into 6 topics with continuous and categorical variables.

The herd size was determined by the number of suckler cows (Livestock Units; LU) and the number of Total Livestock Units (TLU) and was estimated by the assumption of 1 LU for each adult bovine, 0.6 LU for calves & heifers from 6–24 months and 0.2 LU for calves up to 6 months (Table 1). The number of weaned calves to the number of suckler cows’ ratio expresses the cows’ productivity and categorised as low, moderate and high. The labour was estimated by TLU and LU per Total Annual Work Units (TAWU). The latter includes family (fAWU) and hired labours (hAWU). The characteristics of pastures included the type of pastures based on the dominant vegetation (grasslands, shrublands, phrygana, wooded grasslands and mixed), the total pasture area (ha) and the stocking rate (SR) based on grasslands and expressed as Total Livestock Units per unit area (TLU/ha), as well as the safety of pastures for grazing animals. The assessment of the latter characteristic was based on a 1–5 rating of the questions: (1) very safe pastures: flat areas (0–10% slope) with no threat of predators (bears and wolves), (2) safe pastures: areas with gentle slopes (10–20%) with no threat of predators, (3) unsafe: pastures with moderate slopes (20–30%) bordering streams and creeks with no threat of predators, (4) dangerous: mountainous pastures with steep slopes (30–40%) and presence of predators and (5) very dangerous: pastures with rough terrain, very steep slopes (>40%) and habitat for predators. The stable facilities comprise the total surrounding area (ha), the housing system (free, restricted and mixed), the mechanical equipment (feedstuff mill, mechanical supplier of feedstuffs, artificial ventilation, mechanical waste disposal, liquid-solid mechanical separator) and the specified facilities (electric fence, yard, footbath, individual positions, separate fattening room). In the last two above mentioned variables, the applied assessments ranged from 1 to 5. Genetic material included the cows’ breed parameter classified into three classes (composite autochthonous cattle, foreign cattle and crossbreed). The main indicator used to highlight the differences among clusters, in terms of their economic
Hierarchical cluster analysis

Cluster analysis was used in order to develop the typology and the structural characterisation of the suckler cow farming sector. The algorithm that was used was based on Ward’s method and the Euclidean distances (Norusis 2011). One-way ANOVA
and Tukey indicator was used as statistical tests (p ≤ .05). Pearson’s chi-square test applied to categorical variables to observe the differences between the clusters.

Results

Characteristics of farming type clusters

The hierarchical cluster analysis classifies the farms into 5 clusters (C1, C2, C3, … and C5). The characteristics of clusters of the suckler cow farming system in Central Macedonia, Greece, are presented in Tables 2 and 3, and discussed below.

Clusters attributes

Cluster 1 (C1). Large, semi-extensive farms with low productivity and strong dependence on subsidies (n = 23).

Table 2. Characteristics of variables of suckler cow farming system in Central Macedonia, Greece according to farming type.

| Variables’ characteristics | Mean variable value | Clusters |
|----------------------------|---------------------|----------|
|                            |                     | C1 (n = 23) | C2 (n = 24) | C3 (n = 5) | C4 (n = 12) | C5 (n = 2) | F Value | p Value |
| Total Livestock Units, TLU | 148.000             | 123.950a   | 116.250a   | 425.060b  | 139.350a   | 165.100a  | 9.814   | .000    |
| Livestock Units, LU        | 92.750              | 86.170a    | 68.080a    | 246.600b  | 95.250a    | 65.000a   | 8.303   | .000    |
| Number of weaned calves/number of suckler cows | 0.620 | 0.550a | 0.700a | 0.770b | 0.600a | 0.800b | 5.600 | .001 |
| Family Annual Work Units, fAWU | 1.180 | 1.170a | 1.210a | 1.400a | 1.000a | 1.500a | 0.622 | .648 |
| Hired Annual Work Units, hAWU | 0.470 | 0.430a | 0.460a | 1.200a | 0.250a | 0.500a | 1.605 | .185 |
| Exploitation of Labour for TLU, TLU/TAWU | 2.440 | 1.430a | 3.460b | 2.000a,b | 2.750a | 1.000a | 10.654 | .000 |
| Pasture area, ha based on grasslands | 48.140 | 46.870a | 23.190a | 282.000b | 5.210a | 35.000a | 24.480 | .000 |
| Stocking rate, LU/ha | 17.960 | 10.670a | 8.730a | 15.660a | 53.640a | 4.400a | 3.896 | .007 |
| Veterinary and zootechnical support (1–4) | 2.890 | 2.300a | 2.880a,c | 3.400a,b,c | 3.500b | 5.000c | 5.764 | .001 |
| Gross profit/LU, € | 405.740 | 80.940b | 112.470b | 304.740b | 2548.270c | 26.618 | .000 |

Clusters with a different letter in the same row differ significantly.

LU: Suckler Cows Livestock Units; TLU: Total Livestock Units; TAWU: Total Annual Work Units.

Table 3. Characteristics of categorical variables of suckler cow farming system in Central Macedonia, Greece according to farming type.

| Variables’ characteristic | Total farms | Clusters |
|---------------------------|-------------|----------|
|                           | %           | C1       | C2       | C3       | C4       | C5       |        |        |
| *(1) Cow breed            |             |          |          |          |          |          |        |        |
| Composite autochthonous breed | 68.2       | 82.6     | 75.0     | 60.0     | 25.0     | 100.0    |        |        |
| Foreign cattle breed      | 19.7        | 8.7      | 12.5     | 40.0     | 50.0     | 0.0      |        |        |
| Crossbreeds               | 12.1        | 8.7      | 12.5     | 0.0      | 25.0     | 0.0      |        |        |
| *(2) Pasture type         |             |          |          |          |          |          |        |        |
| Grassland                 | 25.8        | 30.4     | 16.7     | 60.0     | 25.0     | 0.0      |        |        |
| Shrubland                 | 6.1         | 0.0      | 4.2      | 0.0      | 16.7     | 50.0     |        |        |
| Woodyed grassland         | 30.3        | 47.8     | 20.8     | 20.0     | 25.0     | 0.0      |        |        |
| Mixed                     | 13.6        | 4.4      | 29.2     | 4.0      | 33.3     | 50.0     |        |        |
| *(3) Housing system       |             |          |          |          |          |          |        |        |
| Free                      | 18.2        | 30.4     | 12.5     | 0.0      | 16.7     | 0.0      |        |        |
| Restricted                | 24.2        | 8.7      | 12.5     | 40.0     | 58.3     | 100.0    |        |        |
| Mixed                     | 54.6        | 60.9     | 75.0     | 60.0     | 25.0     | 0.0      |        |        |

*p(1) χ2(2) = 13.70, p = .008 < .05. **(2) χ2(4) = 12.94, p = .012 < .05. ***(3) χ2(2) = 17.82, p = .000 < .05.

C1 comprising 34.8% of the sample holdings consisted of large holdings, as shown by the average LU(86) and the smallest total area surrounding the stable (1.11 ha) compared to the other clusters. Cow's productivity is low (weaned calves/cows = 0.55). Labour efficiency is moderate for TLU as well as all for LU. The number of TAWU (1.60) is considered rather high for the size of farms. The average area of available pastures is large (46.87 ha), and the stocking rate is moderate (10.67 TLU/ha). Woodyed grasslands were the dominant vegetation of the total area followed by grasslands and phrygana. The majority of farms (60.9%) have a mixed housing system. All the above, combined with the semi-modernised farm level, indicate that it is a semi-extensive farming system.

The livestock of C1 farms is adapted to this manner of management as these farms hold mainly (83%) cows of composite Greek cattle breeds. The pastures of C1 farms are classified as very dangerous for the
grazing cattle. C1 holdings show low average profitability, which returns to loss if total subsidies are not taken into account. Therefore, according to the above and with the amount of obtained subsidies (TSb/LU = €355.69), C1 farms have a strong dependence on subsidies.

Cluster 2 (C2). Medium, semi-intensive farms with moderate productivity and profitable with or without subsidies (n = 24).

Cluster 2 representing the majority (36.4%) of the sample, includes medium-size farms (TLU = 116, LU = 68). The area surrounding the stable is considered to be high (1.87 ha). Cow productivity is classified as moderate (0.70). Both TLU/TAWU and LU/TAWU ratios are characterised as moderate high (TAWU = 1.67). The average available grassland area is of medium size (23.19 ha) and stocking rate is moderate (8.73 TLU/ha). The fact that the majority (75%) of farms use the mixed housing system combined with the semi-modernised level of farm infrastructure, the moderate availability of pastures and the moderate labour exploitation, suggests that C2 is a semi-intensive farming system.

In C2 farms the majority of livestock (75%) belongs to composite Greek cattle breeds. The veterinary and zootechnical support of these farms is of low level while the pastures are considered to be safe for the grazing cattle. This cluster shows a satisfactory average profitability, significantly affected by the received subsidies (TSb/LU = €471.22). However, the absence of subsidies gives on the C2 farms a positive marginal gross profit as well.

Cluster 3 (C3). Large, semi-intensive farms with moderate productivity and dependence on subsidies (n = 5).

This cluster includes 5 large-scale farms, (TLU = 425 and LU = 246.6). The area surrounding the stable is large reaching 4.06 ha. The C3 farms show satisfactory cow yields (weaned calves/cows = 0.77). Regardless the high average TAWU (2.60) the efficiency of labour is high both for TLU and LU. The average area of the available pastures is large (282 ha) and, is mainly comprised of grasslands stocked at high stocking rate (15.66 TLU/ha). The above mentioned, in combination with the modernised farm infrastructure level, suggest that it is a semi-intensive farming system (however, more intensive than C2).

Three out of five C3 farms hold cows of composite Greek cattle breeds and receive moderate veterinary and zootechnical support. The pastures of C3 farms are characterised as unsafe for the grazing cattle. C3 farms show satisfactory average profitability for their size, which is affected by subsidies (TSb/LU = €224.02). The farms of this cluster are classified as competitive with moderate dependence on subsidies.

Cluster 4 (C4). Large, intensive farms with low productivity which shows liabilities instead of profitability either with or without the addition of subsidies (n = 12).

Cluster 4 represents 18.2% of the total sample, comprising large farms, (TLU = 139.35, LU = 95.25 and the area surrounding the stable 1.97 ha). The average ratio of weaned calves/cows is low (0.60). Labour efficiency is high for TLU as well as for LU and family work is mainly used (fAWU = 1.00 and hAWU = 0.25). The average area of available pastures is small (5.21 ha) and the stocking rate is very high (53.64 TLU/ha). The majority (58.3%) of farms apply the restricted housing system and the level of farm infrastructure is modernised. All the above suggest that the C4 farming system is intensive.

The livestock of this cluster is characterised as improved since 50.0% of farms hold certified and improved foreign cattle breeds, such as Limousin, Blonde d’Aquitaine and Charolais. The pastures of C4 farms are considered unsafe for the animals. C4 farms show negative profitability (−€59.06 per LU), which will be further reduced if the subsidies are not taken into account (TSb/LU = €219.56). Based on the extraordinary situation of the evaluated farms in 2014, the viability of this type of farming is problematic and irreversible.

Cluster 5 (C5). Medium, semi-intensive farms with ‘diversified’ productive orientation (n = 2).

This group includes 2 medium-size farms (LU = 65). The big difference between TLU and LU is due to the fact that the two farms are breeding a significant number of purchased fattening calves. The average surrounding the stable area is the largest among the clusters reaching 11 ha. Cow productivity (0.80) is relatively high. Labour efficiency is also low only for LU/TAWU. The average available area of pastures is large (35 ha) and the stocking rate is low (4.40 TLU/ha). The two farms apply the restricted housing system. The above mentioned, in combination with the highly modernised farm infrastructure, suggest that C5 farms follow a semi-intensive farming system.

The livestock of C5 farms is improved and the veterinary and zootechnical support is of very high level. The pastures of C5 are considered to be safe for the grazing cattle. The average profitability of this cluster for its size is very high and cannot be affected by subsidies (TSb/LU = €558.33). A significant percentage of
profitability of this cluster derives from the sales of purchased fattening calves. In addition, it should be noted that in these farms almost all the used forages and concentrates are self-produced. Consequently, C5 has a ‘diversified’ management strategy from all other clusters.

Average gross profit

The GP/LU characterises the productivity of farms and it was €405.75 on average, which is considered relatively satisfactory mainly due to the contribution of TSb, as highlighted in Figure 1. In case when the subsidies come out of the GP calculation, the GP-TSb/LU was €36.62. Therefore, it appears that the total sample has a strong dependence on subsidies, which, in particular, in the case of the C2 reaches 80.7% (TSb/GP) and culminates in C1, where it reaches 177%. On the contrary, in C3 and C5 the TSb/GR ratio was relatively low (42.4% and 18%, approximately).

Discussion

The classification of farms shows heterogeneity among clusters, while producing homogeneity in every cluster (Köbrich et al. 2003). The basic classification of farms resulting from the clustering analysis is estimated by a combination of variables related to the farm size and the used farming system. Van der Ploeg et al. (2009) suggest that the most important relations who indicate the structure of farm type are stocking rate, number of calves to number of suckler cows’ ratio, number of cows per employee ratio and quantitative data such as number of cows, grazing area, arable area and total annual work units.

The most important variables in the classification with respect to herd size were the total LU, cows LU and the total surrounding the stable area. The variables used to distinguish the degree of intensification-extensification of farming systems focus on the relation of animals to their living environment (Milán et al. 2006). These variables include the usual land variables (Serrano-Martínez, Lavin González, et al. 2004; Usai et al. 2006; Sturaro et al. 2009) such as the total pastures’ area, the stocking rate, as well as the dominant vegetation of pastures and their safety for the grazing cattle. In extensive and semi-extensive cattle breeding systems studied in the Mediterranean zone, the calculation of stocking rate were based on the total available pasture area used for grazing by all kind of animals while in our study only the public and private pastures that grazed by cattle were used. In other European studies (Michaličková et al. 2015) it is also visible that mostly rented land is used in the suckler cow herds and direct allocation of animals per pasture is not always possible due to the wide range of activities (dairy, beef, sheep) within the farm to diversify the business risk.

The relative low stocking rate (4.40) of C5 farms could be explained by the high availability of pastures, which is in agreement with the findings of Milán et al. (2006) for the small and medium-sized farms. In the C2

Figure 1. Illustration of subsidies participation rate in the gross profit of the five clusters. n = number of farms. LU: Suckler Cows Livestock Units; GP: Gross Profit; TSb: Total Subsidies.
and C1 farms stocking rate was moderate ranging from 8.7 to 10.7 LU/ha. The very high pasture availability of C3 farms was not associated with a low stocking rate, due to the very large size of their livestock population.

The beef cattle production in the study area is based mainly on family work (FAWU/TAWU = 0.72), in contrast to the findings of other researchers (Milán et al. 2006; Perea et al. 2014) where production is based on hired work (0.29 and 0.57, respectively). In our study the LU/TAWU and TLU/TAWU ratios had average values of 56.71 and 87.45, respectively, which is in agreement with the results of Milán et al. (2006).

On the contrary, other researchers (Serrano-Martínez, Giráldez García, et al. 2004; García-Martínez et al. 2009) observed a significant increase in the number of total LU managed by each AWU compared to the past surveys, suggesting a trend of intensification. The tendency to intensify labour is captured in C4 farms and culminates in the C3 one. On the contrary, the clusters 1 and 2 that include the most numerous farms, display low labour exploitation.

Additionally, the rating of the specified facilities and mechanical equipment score of infrastructure were important variables for the classification of farms. These two variables are indicators of modernisation and maximisation of productivity, but also of capital investment, the cost of which is balanced in the farms with the reduced labour costs. These results are in agreement with the findings of Milán et al. (2006) for the less mechanised holdings that are more dependent on pasture grazing and García-Martínez et al. (2009) where the workforce shortage has led to advanced mechanisation of work. From the processing of the study data, it appears that C3 and C4 farms show a greater modernisation trend than the other ones, while the C5 farms have already been modernised.

In our case the average cow productivity index was based on the ratio of weaned calves/cows in contrast to other relevant surveys where either the number of sold calves per cow (Gaspar et al. 2009) or the combination of the number of calves born and sold per cow (Serrano-Martínez, Giráldez García, et al. 2004; Michaličková et al. 2015) was used. The value of this index is relatively low (0.62) probably due to the high calf losses (9%) before the weaning age. These losses, according to the records of farmers, are attributed to the unsafety of pastures for the grazing cattle and the low level of veterinary and zootechnical support provided when animals are kept on pastures, especially during transhumance on summer pastures, where they stay for 5–6 months. Thus, the low productivity of cows may be due to the very dangerous state of pastures for the C1 farms and to the low level of veterinary and zootechnical support on pastures of the C2 and C4 farms. Also, for the C3 and C5 farms where the pastures are relatively safe and the support is good, the productivity of cow is improved from 0.77 to 0.80, respectively. Similarly, in Central Europe the cow productivity of 0.80 weaned calves in herds kept on safety pastures with regularly veterinary treatment (Michaličková et al. 2015).

The whole above mentioned categorisation, which takes into account the factors that form the degree of intensification of the farming system, displays that the C1 farms demonstrate a traditional attitude by applying the semi-extensive system, while the C2 and C3 farms have started their modernisation process, but greatly maintain their dependence on natural resources applying thus a semi-intensive system as well.

The genetic material and the progress of its improvement are recorded by the variable ‘breed of cow’, since, as mentioned above, the bulls or semen used derived from efficient cattle breeds with a pedigree in order to receive subsidies. The choice of farmers to improve genetic material seems to be primarily related to the receipt of subsidies, as only 12.1% of farms maintain crossbreed cows. Also, the choice of farmers (68.2%) to use the composite with high adaptability Greek cow breeds shows their reluctance to change their management practices. Additionally, it is very important that breed composition should be well adapted to given natural conditions otherwise it can lead to deteriorated fertility, prolonged calving interval and worse financial outcomes (Michaličková et al. 2015). From the above, it is apparent that the farmers wish to improve the productive characteristics of their animals and the quality characteristics of the final product through the improvement of the genetic material, but they prefer to match the genetic potential in their managerial conditions.

Economic indicators such as outputs from animal sales and variable costs are increased according to the size of farms. In order to have a comparable indicator of economic results among farms, in our study we used the gross profit/cow (GP/LU) and the gross profit without the contribution of total subsidies per cow (GP-TSb/LU). Our results highlight the strong dependence of suckler cow farms on subsidies as the ratio of the mean values of TSb/GP was 71%. In this regard, García-Martínez et al. (2009) and Escribano et al. (2016) have reported lower values (61% and 42%, respectively). Kitsopanidis (2005) in his technical and economic analysis found losses instead of profit and a marginal profit with the contribution of subsidies. Also, it seems that the strong dependence on
The reason behind the tendency of Greek farmers to put less effort into their farming activities (Karagiannis and Sarris 2002). Similarly, in the Central European suckler cow herds (Michalicková et al. 2015) the loss per cow was calculated when direct payments per livestock were only taken into account. Moreover, the economic result in Slovak and Czech Republic suckler cow farms was –€980 and –€1381 per cow and per year, respectively without considering of subsidies (Michalicková et al. 2016). This probably attributed to the low prices received per kg of live weight in these countries (€2.42 and €2.35, respectively). Also, in our study, the average labour productivity (GP/AWU=€26232.0) depends in a similar way on subsidies (GP-TSb/AWU=€8556.0).

Using the cluster analysis, four principal farming systems and one ‘diversified’ were highlighted. The first system is represented by the traditional semi-extensive C1 farms with low structural and productive levels, mainly based on the exploitation of mountainous pastures. This system illustrates the most diverging trend of extensification in the suckler herd linked to the use of natural resources. Family labour and low or medium stocking rate are the important factors that allow the future existence of this system. The genetic material seems to be adapted to applied management practices by the farmers. Therefore, farms of these clusters show a low profitability only due to the contribution of subsidies. It seems that direct subsidies have not improved the productivity of this farming system. The second system represented by the most numerous and semi-intensified C2 farms is the dominant type of farming systems as it achieves satisfactory economic results and becomes more viable despite its lack of grasslands. Nevertheless, the medium size of C2 herds allows the optimum exploitation of grazing areas. The strong dependence of C2 farms on subsidies affects its viability and may hinder their future competitiveness and sustainability unless they improve the efficiency of work and infrastructure and use the know-how of specialist scientists. The C3 farms constitute the third type of semi-intensive farming system. Its main difference from the previous system is the high availability of grasslands that makes the land factor non-limiting. These farms have increased the scale of their activities by optimising labour efficiency and cow productivity. Although they have met the lowest dependence on subsidies, they failed to combine it with a better income due to high operating cost resulting from the increased farming size. The forth farming system expressed by the intensive C4, faces difficulties to achieve its viability, with or without subsidies, due to the complete lack of grazing area. Finally, the C5 farms represent a mixed and ‘diversified’ farming system that is mainly based on purchased calves fattening, thus it cannot be considered as a pure suckler cow breeding system.

Conclusions
Cluster analysis highlights pastures as the main scarcest factor in the Central Macedonia region. The insufficiency of pastures leads inevitably to the intensification of suckler cows farming systems.

The viability of the first semi-extensive system could be enhanced by a better cow productivity using improved cow breeds. In the second farming system, the amelioration of profitability may be achieved by a higher rational labour efficiency. Due to the fact that in grazing-based farming systems the factor ‘work’ is mainly depended on seasonal workers, the majority of which is basically unskilled, their working efficiency could be improved by technical training. The third semi-intensive farming system cannot be applied in a large number of holdings with large-sized herds, as requires a high availability of pastures. Therefore, the solution for the viable development of such large farms is the application of designed rational management plans for the proper utilisation of grasslands, which takes into account the stocking rate, the carrying capacity as well as the nutritive value of the available forage.

The intensive farming systems, such as those of the forth case, seem to have no long-term prospects due to high annual variable costs and the lack of available pastures. Additionally, these systems require a greater veterinary and zootechnical support to achieve its viability. Breeders of the diversified farming system have to focus on better-purchased calves fattening activities rather than on suckler cow farming.

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No potential conflict of interest was reported by the authors.

Ethical approval
The authors have read the policies relating to animal ethics and confirm that the research complies with them.

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