Profiling Goat Farm Enterprises Under The Prism Of Sustainability: The Role Of Financial Ratios, Socio-Demographic Characteristics And The Waste Management In Goat Enterprises

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ABSTRACT

Sustainable livestock farming is a hot issue worldwide. Last decade there is an intense transformation that affect all aspects of the sector like economic, social and environmental. This transformation has to deal with the increasing market globalization, the changes in Common Agriculture Policy and the new social awareness in environmental issues. The aim of this study is to profile and classify goat farms according to their performance using farm-level data that concerns economic, social and environmental sustainability. A combination of multivariate analysis techniques, such as Principal Component Analysis and Cluster Analysis were developed for the aggregation of synthetic indicators and for the creation of farm typologies. According to results, Greek goat farming achieves a low performance in almost all pillars of sustainability, but if the sector adopt sustainable practices there is the margin to become more elastic and competitive.

Keywords: Principal Component Analysis; Cluster Analysis; Goat Enterprises; Sustainability; Financial Ratios; Socio-Demographic Characteristics; Waste Management

1. INTRODUCTION

Sustainable livestock farming is a hot issue worldwide. The livestock sector is a pillar of the global food system that contributes to the reduction of the poverty, to the food security and to the agricultural development. In the next thirty years, the global population is expected to reach 9.6 billion, and global meat and milk consumption is expected to increase by 75% and 60%, respectively (Van Wagenberg et al., 2016). Livestock is an important sector, as it provides high-quality protein food to consumers and regular income to producers.

Sustainability issues are of high importance for goat sector in Europe, where it is produced 3 million tons of milk and 96 thousand tons of meat (FAO, 2020), contributing to the tackling of the poverty and to the creation of income in marginal areas. For Greece the goat farming sector is also very important because Greece is ranked fourth in goat's milk production among the world's countries, first in meat production among EU countries, and second in milk production. Goat farming has a major financial impact, because it produces large quantities of products and because it offers a stable income to the farmers and plays a special role from social and environmental perspective.

Last decade there is an intense transformation that affect all aspects of the sector like economic, social and environmental. This transformation has to deal with the increasing market globalization, the changes in Common Agriculture Policy and the new social awareness in environmental issues (Bartolini & Viaggi, 2013; Sandu & Mantea, 2017; Stock & Forney, 2014). Moreover, the worldwide goat industry has suffered from structural changes, such us

the change in farm size and in production systems, the majority of which are heterogeneous (Nehring, Sauer, Gillespie & Hallahan, 2016). In Greece the transhumant and small intensive farms have been significantly reduced and replaces from larger flocks implementing extensive farming systems (Gelasakis, Valergakis, Arsenos, & Banos, 2012). These systems are characterized by significant capital investment and from high-yielding foreign dairy goat breeds (Gelasakis et al., 2012). In the past years the most common breeds reared in the geographical area of Thessaly was Skopelos and Elliniki aiga goat breeds. These breeds are characterized by low milk production (250 kg/goat/year and 134kg/goat/year respectively). The breeds that dominate today are the well adapted Damascus, Saanen, and Apline breeds (500 kg/goat/year, 900 kg/goat/year and 700 kg/goat/year respectively) (Elgo, 2021).

Sustainability of goat farm enterprises is crucial in order to ensure their long- terrm viability and take advantages of the given opportunities, such as special way of life and market niches, which are flourishing (Peacock & Sherman, 2010) in combination with the benefits of particular management strategies. Due to the high degree of heterogeneity in the Greek livestock sector, sustainability assessments can provide information for improving goat enterprises (Tzouramani, Mantziaris & Karanikolas, 2020). The globalized and highly competitive market has pushed the farms with limited investments, which are located in disadvantages regions, to see their viability to be threatened, due to the fragile ecosystems, the reduction of young people occupying with the primary sector and the lack of public services (Góngora Pérez, Milán Sendra & López-i-Gelats, 2020). A sustainably farm in other words, can maximize profit, serve society's needs and protect the natural resources and the environment at the same time (Dillon et al., 2014).

Recent EU policy is concentrated in increasing sustainability with measurement and evaluating the livestock sector performance. There are many bibliography references about sustainability and many tools that analyze sustainability assessments using methodologies and frameworks (Zaralis et al., 2017). Some methods include Benchmarking as a means of assessing efficiency (Derks, Hogeveen, Kooistra, van Werven & Tauer, 2014; Galanopoulos, Abas, Laga, Hatziminaoglou & Boyazoglu, 2011), Life Cycle Assessment (LCA) tools, which calculate the material and the energy flows (Dolman, Sonneveld, Mollenhorst & de Boer, 2014; Paraskevopoulou et al., 2020; Weiss & Leip, 2012) or Environmental Impact Assessment (Crosson et al., 2011). Moreover, many researchers have composite indicators, which include information's from multiple indices (Firbank, Elliott, Drake, Cao & Gooday, 2013; Lampridi, Sørensen & Bochtis , 2019; Uthes, Kelly & König , 2020). Recent studies have emphasized the need for farm accountancy data networks (FADN), as a suitable platform to estimate farm-level sustainability (Poppe, Vrolijk, Dolman & Silvis, 2016; Kelly et al., 2018).

Zorn, Esteves, Baur and Lips (2018), studied the economic sustainability of Swiss dairy farms with the use of financial ratios. The financial ratios were related to profitability, liquidity, financial efficiency, stability, solvency and repayment capacity. De Olde, Oudshoorn, Sørensen, Bokkers and de Boer (2016) and Zapf, Schultheiß, Doluschitz, Oppermann and Döhler (2009), studied sustainability at farm level taking into consideration financial ratios and quantitative economic indicators. Micha et al. (2017), utilizing data on profitability, environmental efficiency, and social incorporation, profile and categorize livestock farms in Ireland based on their performance. The indexes used take into account profitability and productivity, GHG and Nitrogen emissions, household vulnerability, education level and work life balance. Chand, Sirohi and Sirohi, (2015), in their paper used indexes in order to study sustainability in small-holder dairy farms in India. In order to meet the three dimensions of sustainability the indexes that were used concerned production costs, input productivity, family labor income, gender equality, drudgery of work, animal waste management, greenhouse gas emission and maintenance of genetic potential of animals. Other studies that handle with economic sustainability, the economic indicators usually include, cash flow, investments and farm income (Häni et al., 2003; Sydorovych & Wossink, 2008). Other studies that handle with environmental and social sustainability are referred in water and air quality, farmer's health and food security (Ikerd, 2006; Rigby et al., 2000).

Studies that handle with dairy enterprises (Van Calker, Berentsen, de Boer, Giesen & Huirne, 2004; Van Calker, Berensten, Glesen, & Huirne, 2005; Van Huylenbroeck, 2000) have addressed issues related to economics and environment of livestock farms, while only a few researches cover the three pillars of sustainability in dairy farms (Häni et al., 2003; Mann & Gazzarin, 2004). Latruffe et al. (2016), suggested for the measure of sustainability some indexes that take into account all the aspects of sustainability. These indexes are representative, transferable, adaptable and are measured in an acceptable cost. Furthermore, in order to determine the economic sustainability, they referred to the FADN database. Lebacq, Christensen and Kjær (2012), studied sustainability indicators for livestock farming.

From available data they performed farm-level analyses. In another study there is a comparison between European sustainability in sheep and goat farms (Paraskevopoulou et al., 2020). Sustainability themes that used included soil management, biodiversity, manure management and nutrients, agricultural systems diversity, social capital and farm business economics.

However, questions arise which are the most appropriate tool for the measurement of sustainability. Almost no publications address the best possible tool selection and practical application of such tools with regard to small ruminants (Bernués, Ruiz, Olaizola, Villalba & Casasús, 2011; Gasparatos & Scolobing, 2012). Moreover, goat farming is characterized from diversity in terms of aims and size as well as the levels of intensification and the range of environmental and socioeconomic conditions (Theodoridis et al., 2016).

According to the literature review we conclude that the majority of the research that deals with sustainability issues don't develop composite indicators at a farm level (Arulnathan, Heidari, Doyon, Li & Pelletier, 2020). Most of the research use individual indexes and not combination of them in order to conclude in results (Van Passel & Meul, 2013) and they don't focus at the same time in the three pillars of sustainability (Bonisoli, Galdeano-Gómez, & Piedra-Muñoz, 2018; Röös, Fischer, Tidåker & Nordström -Källström, 2019) or they aren't relevant, practical and sufficient (Lebacq et al., 2012).

The objective of this study is a) to profile and categorize goat farms according to their behavior by using farm-level information of economic, social and environmental issues, b) to identify the economic, social and environmental strategies that contribute to the sustainability of dairy goat farms, c) to provide politicians and farmers with tools to improve managerial tasks taking into account all pillars of sustainability.

2. MATERIALS AND METHODS

2.1 Study Area

Larisa was the study area, which is a region in the Prefecture of Thessaly located at the centre-east of the country. Animal production in Thessaly represents 1/4 of its gross value of the agricultural production and has a significant impact in the national economy by providing income in many families that lives in disadvantage regions. In regional unit of Larisa there are 1.329 goat holdings with 175.096 animals, which represents the 2,1% of the holdings and the 5% of the goats in Greece (Elstat, 2020). In regional unit of Larisa, it is produced 26.400 tons of goat milk and 10.000 tons of meat, which represents 10.6% of the country milk production and 37.7% of meat production respectively (FAO, 2020).

2.2 Data Collection

The analysis relied on data collected with questionnaire survey. The survey took place during 2020 in regional unit of Larisa. In regional unit of Larisa about 1/3 of these holdings belong to the transhumance goat farming. The average size of transhumant flocks is larger than that of non-transhumance flocks in Larissa (Papanastassis, 2009). Transhumant goat farm belongs to traditional farming systems and for this reason was excluded from the sampling. The final sample consisted of 129 farms. A simple random sampling technique was used in the sampling. In the questionnaire there were questions about the economic, social and waste management characteristics of the farms. Moreover, from the obtained questionnaire, it was made a simulation of balance sheet, in order to calculate the basic financial ratios, because in Greece it is not institutionalized a farm accountancy data network. Descriptive statistics and frequencies were used to present these data.

2.3 Selection of Indicators

The knowledge of the financial performance and the financial structure of the farm is very important for the farmers in order to ensure success (Boehlje, Dobbins, Miller, Miller & Barnard, 1999).

Financial performance usually is analyzed with financial ratio analysis (Ozcan & McCue, 1996). There are a number of useful financial measurements that when used together provide significant information about a farm's financial

condition (Ferris & Malcolm, 1999). The Invest Capital Turnover Ratio, the Total Liabilities to Equity Ratio, the Current ratio, the Total Liabilities to Total Assets Ratio, the Return on Assets Ratio and the Total Asset Turnover Ratio are the most commonly used ratios for measure (Haden & Johnson, 1989; Mishra & Morehart, 2001; Purdy, Langemeier & Featherstone, 1997).

The parameters that refer to the manure management is selected because manure is a source of significant agricultural greenhouse gas emissions. Although the goat industry is not considered a major producer of CO_2, it is considered as the source of other greenhouse gases, such as methane and nitrous oxide and phosphorus (Chianese, Rotz &. Richard, 2009). In the region of Thessaly and especially in Larisa smaller operators with fewer animals do not follow the proper livestock waste management protocol (Laspidou & Samantzi, 2014). In Larisa, nitrogen and phosphorus pollutant loads are high due to intensive crop fertilization and inadequate livestock waste management. These factors combine to contribute to the large amount of nitrogen and phosphorus pollutant loads (Laspidou & Samantzi, 2014). The Prefecture of Larisa that is studied is an environmentally burdened area. Appropriate manure management practices are not typically practiced by many farmers, leading to major environmental problems (Ndambi, Pelster, Owino, de Buisonjé & Vellinga, 2019). Concern exists at local level regarding the concentration of goat farm units around the Pinions River basin, which from an environmental point of view, is the second most polluted river in EU (Ioannou, Chatzinikolaou & Lazaridou, 2009). Moreover, according to research a goat that has an average body weight 40 kg produces 157 kg/year/ton nitrogen of animal waste and 24 kg/year/ton phosphorus of animal waste (Laspidou & Samantzi, 2014). Additionally, the prefecture of Thessaly is a region where there is an extra subsidy to the farmers that implement a nitrogen pollution program (Opekepe, 2021). Finally, farming profits can be enhanced by effective manure management (Burney, Lo & Carson, 1980).

The education level represents the sustainability of the farms. The higher the education level is the more sustainable the farm is considered to be (Tzouramani et al., 2020). The age of farmers despite their experience is a crucial factor for sustainability in order to take risks and innovate (Adesina & Baidu-Forson, 1995).

Moreover, the knowledge of grazing is an important factor of intensity. Spain, Italy, and Greece have recognized the need for objective characterization of goat farming systems (Castel et al., 2003; Gelasakis et al., 2012; Usai et al., 2006). The Regional Unit of Larisa has some particularities, as it concerns the structure characteristics. As it has been mentioned, last years the traditional goat breeds have been replaced with high yield goats that produce 440.3 kg/goat/year and 12.9 kg/ goat/year meat, according to our research data. Moreover, the grazing is almost not existed (the daily grazing time in winter is 0.79 hours and in summer 1.5 hours. The days of grazing per year are 55.4).

2.4 Methodology

For the statistical analysis, PCA (Principal Component Analysis) and hierarchical cluster analysis (HCA) were implemented. In order to study the association trends of the different goat farms, and to examine the endogenous structure, PCA was performed. Furthermore, for the confirmation of the groupings of goat farms, resulted from PCA, hierarchical cluster analysis (HCA) was applied on the corresponding *z* scores of the variables used in PCA (Hair, Anderson, Tatham & Black, 1995; Mojena, 1977; Sharma, 1996). Cluster analysis was performed using Ward's criterion (Ward, 1963) and the squared Euclidean distance as dissimilarity between the goat farms (Sharma, 1996).

PCA and HCA were performed using SPSS v26.0. The significance level of all statistical analysis was predetermined at $p<0.05$.

2.5 Principal Component Analysis

In the literature, groupings and typologies are usually based on Principal Component Analysis (PCA). Using the correlation among independent variables, Principal Component Analysis (PCA) identifies common factors that contribute most to the variation in data. (Adesina & Baidu-Forson, 1995). Kaiser-Meyer-Olkin (KMO) was used to test sampling adequacy. Also, Barlett's sphericity test was used to generate the correlation matrix as well as the identity matrix. PCA was limited to indicators with a variation coefficient (VC) over 50% (Nahed, Castel, Mena & Caravaca, 2006; Ruiz et al., 2009). Principal components (PC) with eigenvalues greater than 1 (Kaiser, 1974) were used in the successive cluster analysis (CA).

2.6 Cluster Analysis

To explain the structure of each cluster that PCA yielded, four profiles were created. The first level profile relates to the three principal component scores and the 13 economic variables used in PCA. The second level profile identifies the relationship between the three clusters with the demographic and social characteristics of the farmers. The third level profile explains the relationship between the three clusters with the number of animals and seven economic indicators of the sample. Finally, the fourth profile explains the relationship between the three clusters with the three environmental variables.

3. RESULTS

3.1 Results of PCA

Table 1 presents the descriptive statistics of economic variables that used in the PCA method. The results are calculated in Euro/mean farm/year. As we can see the factors that contribute most to the total production cost are the feed cost, the family labour cost and the depreciations of buildings, machineries and animals.

This section may include subheadings, since the results need to be presented concisely and precisely, in addition to their interpretation, so that conclusions can be drawn.

Table 1. Descriptive statistics of the economic variables used in PCA method.

Variable Names	Mean	Std. Deviation
Imputed rent	180.83	204.19
Hired land expenses	62.36	106.42
Family labour expenses	1889.76	1,019.62
Hired labour expenses	582.53	436.14
Foreign engineering labour expenses	161.69	96.70
Feed cost	2642.12	1,255.25
Fuels/water/electricity	185.39	128.58
Drugs/antibiotics	164.92	103.31
Fixed assets interest	463.32	250.75
Circulating capital interest	544.49	920.35
Depreciation	1,180.32	757.98
Maintenance	102.93	60.94
Insurance premiums	54.81	37.41

The matrix of explained total variance and eigenvalues are presented in Table 2. Principal Component Analysis (PCA) extracted after VARIMAX rotation of the axes, three components that account for 73.46% of total variance.

Table 2. Matrix of the explained total variance and eigenvalues.

Component	Initial Eigenvalues			Extraction SS Loadings			Rotation SS Loadings		
	Total	% of Variance	Cum. %	Total	% of Variance	Cum. %	Total	% of Variance	Cum. %
1	7.14	54.89	54.89	7.14	54.89	54.89	6.88	52.89	52.89
2	1.31	10.08	64.97	1.31	10.08	64.97	1.57	12.06	64.96
3	1.11	8.50	73.47	1.11	8.50	73.46	1.11	8.51	73.46

Based on the practical relevance of the data, only "loadings" at an absolute value of *0.500 are presented in Table 3. (Hair et al., 1995). In Bartlett's test for sphericity, the correlation matrix differed statistically significantly from the identity matrix with respect to the suitability of the Principal Component Analysis model (X^2=1424.501, degrees of freedom=78, p<0.001) and the Kaiser, Meyer, and Olkin sample adequacy index (Kaiser-Meyer-Olkin measure of sampling adequacy-KMO), relative to the appropriateness of the data for application of the Principal Component

Analysis was found to be equal to 0.931, much above the threshold of 0.50 according to Hair et al. (1995).

The first factor that explains (after VARIMAX rotation) the 52.89% of the total variance is mainly related to fixed assets interest, fuels / water / electricity, maintenance, foreign engineering labour expenses, drugs / antibiotics, depreciations, feed cost, and insurance premiums and can be characterized as total expenditure.

The second factor that explains (after VARIMAX rotation) the 12.06% of the total variance is mainly related to circulating capital interest and hired labour expenses and can be characterized as variable capital expenditures.

The third factor that explains (after VARIMAX rotation) the 8.51% of the total variance is mainly related to imputed rent, hired land expenses and negatively to family labour expenses and can be characterized as land expenditures.

Table 3. Rotation loadings of the Principal Components and the Communities for the economic variables**.**

Variable Names	PC1	PC2	PC3	Communalities
Fixed assets interest	0.96			0.93
Fuels/water/electricity	0.94			0.90
Maintenance	0.93			0.87
Foreign engineering labour expenses	0.92			0.86
Drugs/antibiotics	0.89			0.79
Depreciation	0.88			0.79
Feed cost	0.87			0.76
Insurance premiums	0.84			0.71
Circulating capital interest		0.77		0.66
Hired labour expenses		0.64		0.66
Imputed rent			0.66	0.56
Hired land expenses			0.63	0.60
Family labour expenses			-0.50	0.47

3.2 Results of Cluster Analysis and Cluster Profiles

Three clusters were formed. Frequencies and percentages of goat farms per cluster are presented in Table 4.

According to Table 4, the first cluster (C1) consists of 64 goat farms (49.6%), the second cluster (C2) consist of 45 goat farms (34.9%) and the third cluster (C3) consists of 20 goat farms (15.5%).

Table 4. Frequencies and percentages of goat farms per cluster.

Cluster	Frequency	Percent
C1	64	49.60
C2	45	34.90
C3	20	15.50
Total	129	100

3.2.1 First Level Profile

Table 5 shows the mean values of the three principal components in each cluster.

Table 5. Means of components in each cluster.

Clusters	PC1	PC2	PC3
C1	-0.71[a]	-0.14[a]	0.12[a]
C2	0.87[b]	-0.64[b]	-0.12[a]
C3	0.30[c]	1.87[c]	-0.11[a]
η^2	0.53	0.70	0.01
p-value	0.001	0.001	0.41

For each component, in each column, mean values followed by different exponential letters indicate statistically significant difference between the clusters according to Tukey's test (for equal variances) and Games-Howell's test (for not equal variances). In PC1, the Games-Howell's test was applied. In PC2 and PC3, the Tukey's test was applied.

In the first cluster the means of the 1st and 2nd components are lower than the general mean, while the 3rd component is higher than the general mean. In the second cluster the mean of the 1st component is higher than the general mean, the 2nd component is lower than the general mean, while the 3rd component is a little lower than the general mean. In the third cluster the means of the 1st and 2nd components are higher than the general mean, while the mean of the 3rd component is a little lower than the general mean.

In addition, the highest mean value for the first component appeared in the second cluster, the highest mean value for the second component appeared in the third cluster and the highest mean value for the third component appeared in the first cluster. Additionally, both the 1st and 2nd components have high contribution to clustering, but the second component seems to have the highest ($\eta^2=R^2=70\%$). On the other side, the 3rd component has a very low impact on clustering.

Table 6 shows the mean values of 13 standardized economic variables that were used in PCA.

Table 6. Means of the economic variables in each cluster.

Variable Names	C1	C2	C3	η^2	*p*-value
Imputed rent	203.05[a]	104.52[b]	281.40[a]	0.09	0.001
Hired land expenses	44.92[a]	96.00[b]	42.50[c]	0.05	0.001
Family labour expenses	1,506.31[a]	2,213.24[b]	2,388.98[b]	0.14	0.001
Hired labour expenses	434.60[a]	543.11[a]	1,144.61[b]	0.32	0.001
Foreign engineering labour expenses	99.57[a]	234.30[b]	197.11[b]	0.43	0.001
Feed cost	1,765.28[a]	3,607.36[b]	3,276.21[b]	0.49	0.001
Fuels/water/electricity	101.85[a]	275.09[b]	250.92[b]	0.42	0.001
Drugs/antibiotics	97.75[a]	234.13[b]	224.16[b]	0.42	0.001
Fixed assets interest	290.73[a]	648.58[b]	598.80[b]	0.47	0.001
Circulating capital interest	351.93[a]	69.13[b]	2,230.23[c]	0.64	0.001
Depreciation	709.23[a]	1,728.96[b]	1,453.39[b]	0.40	0.001
Maintenance	61.06[a]	142.61[b]	147.64[b]	0.47	0.001
Insurance premiums	34.13[a]	77.48[b]	70.02[b]	0.31	0.001

For each variable, in each column, mean values followed by different exponential letters indicate statistically significant difference between the clusters to Tukey's test (for equal variances) and Games-Howell's test (for not equal variances). For the variables of Imputed rent, Hired land expenses, Foreign engineering labour expenses, Fuels/water/electricity, Fixed assets interest, Circulating capital interest, Depreciation, Maintenance and Insurance premiums the Games-Howell's test was applied. For all the other variables, the Tukey's test was applied.

The highest mean values of Imputed rent, Family labour expenses, hired labour expenses, circulating capital interest and maintenance appears in the third cluster, while for all the other economic variables, the highest mean values are found in the second cluster. The feed cost differs significant in the first cluster, which include a small number of goats, the farms are less extend and the animal diet is based on grazing. In the other clusters the feeding costs are high because feed is based on purchased feed and the grazing almost not exist. Also, the Imputed rent, the Hired land

expenses, the Family labour expenses, the Hired labour expenses and the Insurance premiums have very low contribution in clustering. All the other economic variables have high contribution in clustering, but the Circulating capital interest seems to have the highest one (η^2 =64%).

3.2.2 Second Level Profile

Table 7 presents mean values, standard deviations, minimum and maximum age ranges at which farmers were found in each cluster.

Table 7. Descriptive statistics of the farmer's age for each cluster.

Cluster	Minimum	Maximum	Mean	Std. Deviation
C1	18	82	45.31[a]	19.18
C2	18	82	45.73[a]	16.73
C3	18	82	43.75[a]	16.76
η^2			0.00	
p-value			0.92	

Mean values of age followed by different exponential letters indicate statistically significant difference between the clusters according to Tukey's test (for equal variances) and Games-Howell's test (for not equal variances). In this case, the Tukey's test was applied.

In the first cluster the average age of farmers is 45.31 years old. In cluster two, the average age of farmers is 45.73 years old and in cluster three, the average age of farmers is 43.75 years old. Also, the mean values of the farmers' age in all clusters are not statistically significant different. In addition, the farmer's age has not any contribution in clustering (η^2 =0%).

In Table 8, mean values, standard deviations, minimum and maximum values of the farmer's educational level in years, are presented for each cluster.

Table 8. Descriptive statistics of farmer's educational level in years for each cluster.

Cluster	Minimum	Maximum	Mean	Std. Deviation
C1	1	16	10.23[a]	3.21
C2	2	18	10.02[a]	3.72
C3	4	18	11.10[a]	3.31
η^2			0.01	
p-value			0.49	

Mean values of educational level in years followed by different exponential letters indicate statistically significant difference between the clusters according to Tukey's test (for equal variances) and Games-Howell's test (for not equal variances). In this case, the Tukey's test was applied.

The farmers in the first cluster have an average education of 10.23 years. In the second cluster, the average farmers education is 10.02 years and in the third cluster, the average farmers education is 11.10 years. Also, the mean values of the farmers' education in all clusters are not statistically significant different. In addition, the farmer's educational level has no contribution in clustering (η^2 =0%).

3.2.3 Third Level Profile

In Table 9, mean values, standard deviations, minimum and maximum values of animals' number are presented for each cluster.

Table 9. Descriptive statistics of animals' number for each cluster.

Cluster	Minimum	Maximum	Mean	Std. Deviation
C1	10	90	33.02[a]	16.23
C2	35	135	76.24[b]	25.43
C3	25	100	70.20[b]	19.72
η^2			0.52	
p-value			0.001	

Mean values of animals' number followed by different exponential letters indicate statistically significant difference between the clusters according to Tukey's test (for equal variances) and Games-Howell's test (for not equal variances). In this case, the Games-Howell's test was applied.

According to cluster 1, the number of animals is 33.02 on average, in the second cluster, the number of animals is 76.24 on average and in the third cluster, is 70.20. Also, the mean value of animals' number in the first cluster is statistically significant different from the mean values in the second and in the third cluster. On the other side, all the other mean values are not statistically significant different. In addition, the number of animals has high contribution in clustering (η^2 =52%).

In Table 10, mean values of economic indicators are appeared for each cluster.

Table 10. Means and R^2 of economic indicators for each cluster.

Economic Indicators	C1	C2	C3	η^2	p-value
Invest Capital Turnover Ratio	0.43[a]	0.50[a]	0.47[a]	0.03	0.14
Total Liabilities to Equity Ratio	0.01[a]	0.15[b]	0.31[a, b]	0.09	0.00
Current ratio	0.73[a]	3.15[a]	1.95[a]	0.04	0.08
Total Liabilities to Total Assets Ratio	0.08[a]	0.19[a]	0.37[a]	0.06	0.02
Return on Assets Ratio	-0.06[a]	0.04[b]	-0.00[a, b]	0.08	0.01
Total Asset Turnover Ratio	2.45[a]	2.54[a]	2.57[a]	0.01	0.72
Fixed assets to average employees' ratio	8308.66[a]	8521.50[a, b]	11169.22[b]	0.08	0.01

For each indicator, in each column, mean values followed by different exponential letters indicate statistically significant difference between the clusters according to Tukey's test (for equal variances) and Games-Howell's test (for not equal variances). For the indicator of Total Liabilities to Equity Ratio, Current ratio, Total Liabilities to Total Assets Ratio and Fixed assets to average employees' ratio, the Games-Howell's test was applied. For the indicator of Invest Capital Turnover Ratio, Return on Assets Ratio and Total Asset Turnover Ratio, the Tukey's test was applied.

The highest mean value of Invest Capital Turnover Ratio, of Current ratio and of Return on Assets Ratio, is presented in the second cluster, while the highest mean value of all the other indicators is shown in the third cluster. Also, all the economic indicators have very low contribution in clustering.

In addition, there is not statistically significant difference between the mean indicators of Invest Capital Turnover Ratio, Current ratio, Total Liabilities to Total Assets Ratio and Total Asset Turnover Ratio, in all clusters. The indicators of Total Liabilities to Equity Ratio and Return on Assets Ratio have statistically significant different mean values between the first and the second cluster. On the other side, all the other mean values are not statistically significant different. The indicator of Fixed assets to average employees' ratio has statistically significant different mean values between the first and the third cluster. On the other side, all the other mean values are not statistically significant different.

3.2.4 Fourth Level Profile

A chi-square (X^2) test of independence was performed to examine the relation between the clusters and the three environmental variables.

According to Table 11, there was a significant association between the frequency of waste disposal among the clusters (X^2=38.232, degrees of freedom=4, p-value<0.001). More specifically, a great part of the farmers (50% and 40.6%) from cluster one (C1) dispose their waste whenever there is a need. Also, the majority of the farmers (88.9%) from cluster two (C2) dispose their waste every month. Finally, the majority of the farmers (80%) from clusters three (C3) dispose their waste every month.

Table 11. Crosstabulation of the percentages (%) of the frequency of waste disposal for each cluster.

Statement	C1	C2	C3	Total
Every week	9.4[a]	11.1[a]	10.0[a]	10.1
Every month	40.6[a]	88.9[b]	80.0[b]	63.6
Whenever there is a need	50.0[a]	0.0[b]	10.0[c]	26.4
Total	100	100	100	100

X^2=38.232, degrees of freedom=4, p-value<0.001
For each statement, in each row, percentages followed by different exponential letters indicate statistically significant difference between the clusters based on several Z-score tests.

According to Table 12, there was a significant association between the place of waste disposal among the clusters (X^2=9.427, degrees of freedom=2, p-value=0.009). More specifically, the farmers do not dispose their waste at a biogas unit, while the majority of the farmers from all clusters dispose their waste at a farm.

Table 12. Crosstabulation of the percentages (%) of waste disposal places for each cluster.

Statement	C1	C2	C3	Total
Nowhere	20.3[a]	2.2[b]	5.0[a, b]	11.6
Farm	79.7[a]	97.8[b]	95.0[a, b]	88.4
Biogas unit	0.0	0.0	0.0	0.0
Total	100	100	100	100

X^2=9.427, degrees of freedom=2, p-value=0.009
For each statement, in each row, percentages followed by different exponential letters indicate statistically significant difference between the clusters based on several Z-score tests.

According to Table 13, there was a significant association between the willing to pay for the waste disposal among the clusters (X^2=37.291, degrees of freedom=4, p-value<0.001). More specifically, the majority of the farmers (73.4%) from cluster one (C1) are not disposed to pay for their waste disposal. Finally, the willingness to pay or not for a great part of the farmers (55.6% and 60%) from clusters two (C2) and three (C3) is dependable.

Table 13. Crosstabulation of the percentages (%) of farmers disposed to pay for their waste disposal for each cluster.

	C1	C2	C3	Total
No	73.4[a]	20.0[b]	25.0[b]	47.3
Yes	3.1[a]	24.4[b]	15.0[a, b]	12.4
It depends	23.4[a]	55.6[b]	60.0[b]	40.3
Total	100	100	100	100

X^2=37.291, degrees of freedom=4, p-value<0.001
For each statement, in each row, percentages followed by different exponential letters indicate statistically significant difference between the clusters based on several Z-score tests.

According to the results, three clusters were obtained. The first cluster (C1) can be characterized as family farms with good economic performance but with no environmental performance. Specifically, the first cluster includes 64 farms representing 49.6% of the entire sample of goat farms. Land expenditures become the major part of the costs. The mean age of the head of the farmers is 45.31 years old and their education level is about 10 years. The farms that belong to the first cluster are small size farms and have 33 goats. According to financial ratio results the farms in the first cluster they do not show an effective use of the invested funds in relation to the sales they made, they show a negative return on capital, stating that all their assets are not used effectively, and the financial position of these holdings depends mainly on own funds. Finally, they don't use environmentally friendly practices, such us waste

disposal and they only remove waste whenever it is needed, and the disposal place of the manure is in the farm. Finally, they don't have the willingness to pay for their waste disposal.

The second cluster can be characterized as medium size business ranking farm with environmental performance. Specifically, the second cluster includes 45 farms representing 34.9% of the entire sample of goat farms. The main costs become from the fixed assets interest, fuels/water/electricity, maintenance, foreign engineering labour expenses, drugs and antibiotics, depreciation, feed costs and insurance premiums. Farmers' average age is 45.73 years old and their education level is about 10 years. The farms that belong to the second cluster are medium size farms and have 76 goats. According to financial ratios and taking into account the Total Liabilities to Equity ratio, that captures the ratio of equity to foreign capital and is an indication of the "debt" of the goat farms, its value is low which shows that the level of the foreign capital is small and the farms are reliable. The Total Liabilities to total assets ratio is also small, and that relies that the financial risk of their investment is small. The goat farms are considered to be in a favorable position, because the foreign capital that participates in the structure of the total capital is minimal. The Fixed assets to average employees' ratio is quite small and that shows that there is an appropriate use of the labor factor. The current ratio is the index that is used in practice to determine the financial condition of a production unit in short-term and according to it the debt of the farms in the next year is under control. The second cluster farms based on loans, but they meet their obligations. According on return on assets ratio the second cluster farms operate efficiency. As it concerns the environmental issues, the majority of the farms dispose their wastes every month in the farm and under particular circumstances they have the willingness to pay for their waste disposal.

The third cluster can be characterized as medium size business ranking farm but with surplus staff and with environmental performance. The third cluster includes 20 farms that represent 15.5% of the sample of goat farms. The main costs become from the hired labour expenses and from the circulating capital interest. Farmers' average age is 43.75 years old and their education level is about 11 years. The farms that belong to the third cluster are medium size farms and have 70 goats. According to financial ratio analysis, the Total Liabilities to Equity ratio shows that the level of the foreign capital is quite high, and the farms are unreliable. That means that these farms base their survival on loans that many times cannot repay. Moreover, the Total Liabilities to total assets ratio is also quite high, and that relies that the financial risk of their investment is high. Finally, the fixed assets to average employees' ratio is quite high showing that they occupy surplus staff. The farms in the third cluster take into consideration environmental issues and they dispose their wastes every month in the farm and under particular circumstances they have the willingness to pay for their waste disposal.

4. DISCUSSION

The goal of this study is to profile and categorize goat farms according to their performance by using economic, social, and environmental data from farm-level sources. The sustainability assessment of Greek goat farming is crucial, as goat farming is practiced in disadvantaged regions that cannot be otherwise valorized and produce high quality products. Sustainable development assessments can provide useful data for the formulation of a strategy that will support its improvement. The classification of the farms showed the existence of the differentiation between the analyzed farms. At farm level, it is crucial to take into consideration the whole set of productive inputs (Poczta, Średzińska & Chenczke, 2020). In light of the conducted research, in the goat farming sector the financial status is weak, and the efficiency of its management is extremely heterogeneous. By examining the indicators, we can conclude that the industry does not effectively utilize resources because most farms overinvest capital in fixed assets when compared with sales.

From a study of the cost components, we can conclude that the greatest effect on cost determination is linked to the fixed asset interest, expenditures in fuels, water and electricity, maintenance, foreign engineering labour cost, drugs, depreciation, feed cost and insurance premiums. The reduction of production cost is a crucial factor in order to success ensure (Aggelopoulos, Soutsas, Pavloudi, Sinapis & Petkou, 2009). Construction contractors with the purpose of reducing the cost of foreign engineers and the use of seasonal workers when labor is most intensive are recommended. Moreover, the reduction in feed costs is likely to be achieved by optimizing the grass for goats as a food source. To reduce the cost of drugs and antibiotics the cooperation with veterinarians is vital. The use of renewable energy sources could reduce the cost of energy. The modernization of building facilities and machineries should help farmers to reduce the fixed assets interest.

The demographic variables which classifies goat farms were farmer's age and education level. Both of these factors don't seem to change the management decisions which influences the sustainability of the farm. The majority of the farmers are middle aged without a high education level. This fact stems from the devaluation of the goat occupation both by the farmers and by the state. It is essential the governance to support the dissemination of innovation, in order the farms to become efficiency and the environmental performance to be enhanced and improved (Herrera, Gerster-Bentaya, Tzouramani & Knierim, 2019). Moreover, according to literature, the farmers that have access to advisory services usually support innovative actions. The farms are considered to be more socially sustainable when the education level is high and the farmers are young (Tzouramani et al., 2020). Higher education has been linked to an increase in farmers' skill sets, and as such those farmers are more likely to adopt new techniques that contribute to the sustainability of the farms (Monte & Teixeria, 2006). In our research in terms of age, there is no difference between farmers who have applied environmental programs. This comes in line with the research of Siebert, Berger, Lorenz and Pfeffer (2010), Finger and Lehmann (2012). Age and education are connected only when the environmental issues are understandable (Yiridoe, Atari, Gordon & Smale, 2010).

Farms with more intensive operations apply some environmental measures, but not to a satisfactory level. A number of factors play a role in manure management including the size of the herd, available labour, and climate (Smith & Williams, 2016). According to our study, manure storage is generally located outdoors and the standard method for managing waste on goat farms is spreading the manure on the soil. The production of biogas from manure would be a good solution, but none of the farms in the specific area follow this method. The use of biogas has many advantages, such us the reduction of odor from manure and the additional income. For these reasons, the government and the policy makers should give motivations to the farmers in order to reclaim the manure with appropriate way. One example can be the government to give direct subsidies or reduce the taxes to the farmers who are disposed to pay for the disposal of the wastes (Zemo & Termansen, 2018). Increasing collective action could also be a solution to environmental problems. Lybæk, Christensen and Kjær (2013) refers to the development of new biogas corporate with the participation of farmers and other stakeholders could reduce the difficulties and accelerate the development of biogas.

Sustainable development is a complicated affair, which has many dimensions, some of which are influenced by geography, time, and socio-economic factors. Farmers, limit sustainability only in economic growth (Ripoll-Bosch et al., 2012). Sustainability assessment of agri-ecosystems need to examine not only economic, social, and environmental pillars, but also the relationships between indicators and farmer needs (Ripoll-Bosch et al., 2012).

Greece achieves a low performance in almost all pillars of sustainability. The negative economic sustainability relates to the country's economic and pandemic crisis, that burdens the farms with more expenditures and lower margins. Moreover, there is no disposal from young people to occupy with livestock farms (Gelasakis et al., 2017).

Due to the small size of farms in Greece and insufficient legislation, the sustainability performance of these farms is negatively impacted. The goat sector is essential to adopt sustainable practices in order to become more elastic and competitive (Paraskevopoulou et al., 2020).

5. CONCLUSIONS

This study contributes to filling a gap in the overall assessment of farm-level sustainability. The valuation of sustainability is not so easy, especially when it refers to all pillars and through composite indicators. The first step in improving the sustainability of a goat farm is to identify the key indicators that distinguish different types of goat farms.

Structural and management characteristics such as economic variables that contract the variable and fixed capital in combination with financial ratios can provide significant information about the financial performance of a farm (Ferris & Malcolm, 1999). Moreover, the years of farmers education, the age of the farmers and the environmentally friendly practices that associated with animal waste management and the availability of infrastructures for the waste treatment are critical for the differentiation of farming systems.

Typologies of the goat industry show the structure of this sector and the critical factors that must be considered when finding sustainable solutions.

The combination of principal component and Cluster analysis is a powerful tool for the profiling of farming systems and should be advantageously used in similar studies, because these methods enable the policy formulators to give different ways in the three pillars of sustainability. Future research efforts could focus on the evaluation of the long-term farm sustainability.

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