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Viability and competitiveness of goat farms under the influence of socio-economic environment

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ABSTRACT

Goat farming in Greece is an important sector, since Greece is one of the largest European producer of goat milk among European Union countries and the first country in goat head. Greece is among the leading European Union countries in milk market, because of the high demand for feta cheese, but also because of a large variety of other cheeses made from goat milk. The goat sector in Greece is not so competitive compared to other countries, due to the high operational costs and that makes the sector unprofitable with a high risk for further marginalization. The objective of the current study was to identify the socio-economic structures of the farms in order to identify some improvement strategies and policies. Another objective of the study was to provide target information to the farmers in order to improve goat farm management. For this purpose, in the paper it was analyzed the technical, economic and social aspects of goat farms with the use of multivariate statistical techniques. The variables responsible for the difference were identified using principal component analysis (PCA). The application of PCA highlighted two components that explain 79.87% of the total variance. The first component, explaining 63.26%, is associated with all parameters related to the cost and can be described as component of the general cost. The amount of loans and labour cost had the greatest influence in determining this general cost. The second component, explaining 16.61% of the total variance, can be described as a component of social characteristics of the farmers that contribute to the production cost (PC). In the second PC, the highest contribution is attributed to the farmers' age and their education level.

INTRODUCTION

The livestock sector and particular the goat sector represents a key growth factor for the Greek economy, since it contributes significantly to the country's gross agricultural production value. The importance of the goat sector is indispensable, since Greece is one of the largest European producer of goat milk (holds the fourth position among EU countries and the first country in goat head (around 3.6 million heads) (FAO, 2019). Goat farming in Greece is very adaptable to the natural conditions, because the majority of the farms are situated in disadvantaged areas providing employment to a large number of families. Moreover, Greece is known for her high quality of products, due to her richness in spices flora.

Analyzing the goat milk production in the European Union, it can be noticed that Greece is among the leading EU countries in this market, thus there is a huge market of products which are obtained from milk (Ruiz et al., 2019). Goat farming has received further attention because of the high demand for feta cheese, which consists mainly of sheep and goat milk, but also from a large variety of cheeses made from goat milk.

In Greece, the main farming systems are the sedentary extensive and the semi-intensive (Hatziminaoglou et al., 1992). In the past there were also the transhumant and the

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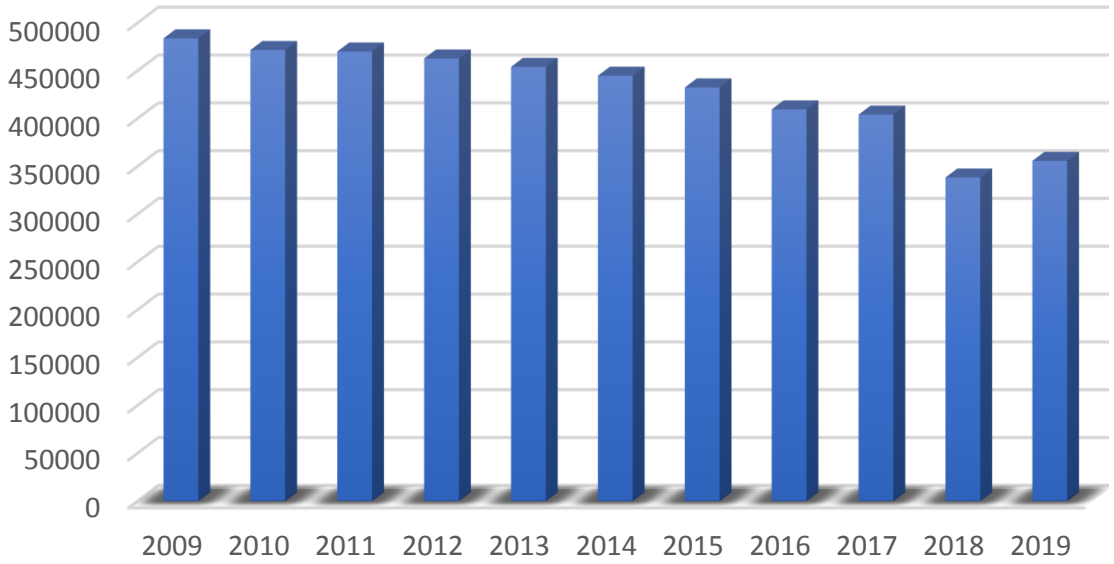

Figure 1. Evolution of number of goats.

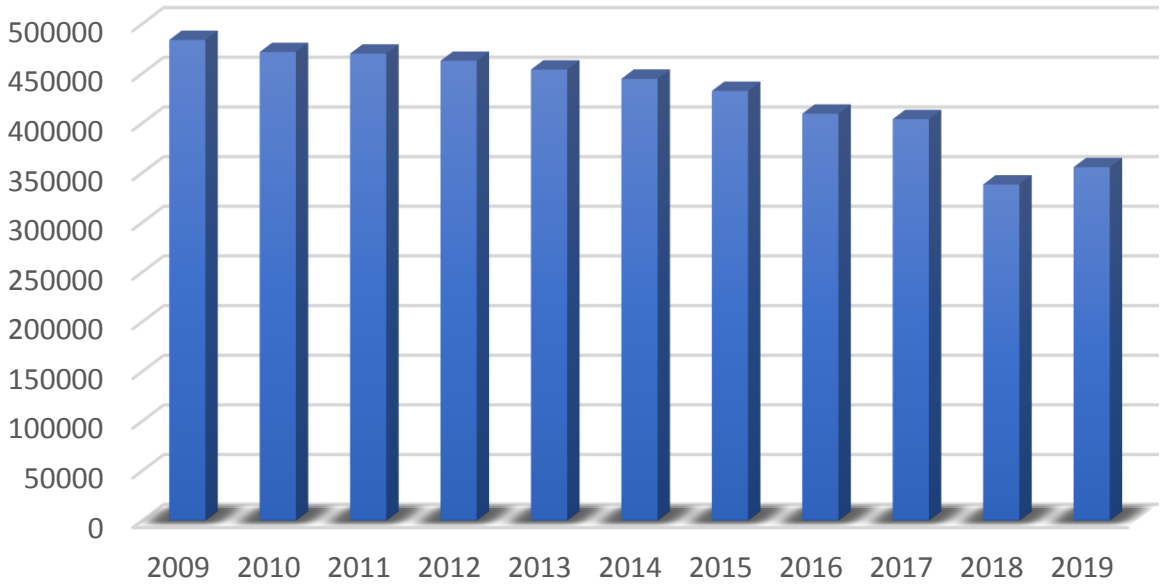

Figure 2. Evolution of milk production.

small intensive systems, but the last years they are replaced from intensive farming systems (Zygoyiannis, 2006). Moreover, the number of animals and production has decrease and the farms are concentrated into fewer and bigger operations (Figures 1 and 2) (Elgo, 2021), that are characterized by considerable capital investment. The production systems that exist have different technical and economic characteristics and achieve different levels of productivity (de Rancourt et al., 2006).

The goat breeding sector in Greece compared to other EU countries is not so competitive and efficient and this become due to the high production costs (PCs). The PC in goat farms is formed from the feed expenses, the fixed capital expenses and labour expenses (Kitsopanidis, 2006). Despite the efforts to improve and promote the sector, the business growth rate still remains low and the majority of the farms operate under increasing scale.

Also, the profitability of the farms is influenced by the

management perceptions for the economic environment, the competition that exists, the markets and by decisions that are related to the structure of the assets and liabilities of the farm. Many farms invest in fixed capital and this requires funding from equity capital or debt capital, generating the financial costs (Bonazzi and Iotti, 2014). There is a need of improvement of the sector. A reduction of the costs can lead to the increase of competitiveness (Napolitano et al., 2005). The level of the PC is very important, since it is linked to the profit and the degree of competitiveness (Kitsopanidis, 1999). There are studies that correlate the feeding system with production and efficiency (Papanastasis et al., 2008) and studies that correlate economic parameters with production (Benoit and Laignel, 2006). The relationships between economic factors and production efficiency in dairy farms have been analyzed in many studies. According to Bijttebier et al. (2017), the cost performance of farmers is affected by large differences in input use across countries. Moreover, there are studies that explore the relationship between technico-economic results in production (Bossis et al., 2006; Castel et al., 2003). The indicators that used to carry out technico-economic analysis vary. Maseda et al. (2004) with the use of Multivariate statistical methods classify farms according their structure characteristics, while other researchers classify farms according techno-economic variables (Milán et al., 2003; Rodriguez and Alfageme, 1996; Serrano et al., 2004a,b). Other studies have also used sociological variables (Castel et al., 2003; Solano et al., 2000).

In another study it is mentioned that the farm operating capital like livestock and machinery is very low in correlation to the non-operating capital like land and infrastructure and as a result the management decisions do not make a serious effect on the overall capital structure (Gaspar et al., 2008). According to Boehlje (1992), there are five groups of factors that influence the change in the structure. The factors include technology, human capital, finances, institutions, and sociology.

The socio-economic uncertain environment of farmers is increasing, creating insecurity in which way farms will face changes in the future (Ripoll-Bosch et al., 2012). The level of intensification, technical aspects of management of animals, labour characteristics and economic performances are factors that contribute to the sustainability of farms (Bernués et al., 2011).

Taking into consideration not only the globalization but also the economic recession that the farms are forced to operate, the study of competitiveness is considered to be necessary. Moreover, it is important to analyze the management strategies that can reduce the operation cost in order to survive the farms (Karelakis et al., 2013).

The objective of the current study is to identify the socio-economic structures of the farms in order to identify some improvement strategies and policies and alongside to provide target information to the farmers in order to improve goat farm management.

There are many methods used that are based on performance indicators and describe the outcomes of farmers' economic and social management practices. These methods include principal component analysis (PCA) (Ripoll-Bosch et al., 2014; Gómez-Limón et al., 2012; Aggelopoulos et al., 2009), analysis of variance (Toro-Mujica et al., 2012; Carpani et al., 2012), multicriteria analysis (Ruiz et al., 2009; Morgan-Davies et al., 2012; Castoldi and Bechini, 2010), regression coefficients (Zaibet et al., 2004) or data envelopment analysis (DEA) (Gaspar et al., 2008; Tsiouni et al., 2017).

For this purpose, the paper analyzes the technical, economic and social aspects of goat farms using multivariate statistical techniques. The variables responsible for the difference are identified using PCA. The novelty of this study lies that the used variables have formerly been normalized and weighted according to importance (Nardo et al., 2008).

MATERIALS AND METHODS

Area of the study

The study area was the Prefecture of Etoloakarnania, in Western Greece. Goat farming in this area is a pillar that supports the local economy, since both meat and mainly goat milk are one of the main sources of agricultural income. It is worth mentioned that in Etoloakarnania, the extensive breeding system is dominated and the majority of the breeds are domestic. In Prefecture of Etoloakarnania it is established the 8% of the total goat farming of the country and holds the 3% of the hole Hellenic milk production, while more than 9% of the farms consists of more than 200 heads.

Data collection

The data were obtained from a questionnaire survey of the farm's heads, during 2019. The sample consisted of 94 farms. Simple random sampling was employed as a sampling method. A pre-test survey took place, in order to ensure readability, and questions were adjusted when necessary. The pre-sampling procedure was conducted in a small sample of fifteen goat farmers.

The field interview is used because the majority of the interviewers were unfamiliar with this kind of research and the older participants had poor literacy. Through the field interview there is the opportunity for explanation of the subject and aims of the research and the questions are more objective.

In the questioner there were questions about the farm characteristics and the overall management practices. Particularly, there were included information about the

farm size and structure, facilities and equipment, feeding management, labour cost, fixed and variable capital and various expenses, production and socioeconomic aspects (Appendix I).

Statistical analysis

First, the data that obtained from the questionnaire were transferred into an Excel 16.21, and all the original variables have been checked in terms of missing or abnormal values. For the statistical analysis R mathematic program was used.

Principal component analysis is a statistical process that converts a set of values (observations) of potentially correlated variables into a group of new values of nonlinearly correlated variables called principal components. The goal of PCA is to extract the most important information from the used variables, keep the important information by compressing the data size, make the description of the data simple and finally, analyze the structure of the observations and the variables.

By applying PCA, the structural coherence of the variables that make up the total PC as well as their importance in its final configuration was investigated (Hair et al., 1995; Sharma, 1996; Cattell, 1978; Dunteman, 1989; Tabakis, 2001). The representation of these variables with unobserved variables-factors, is done according to the mathematical relation:

$$F_i = \sum_{j=1}^{p} w_{ij} Z_j = w_{i1} Z_1 + w_{i2} Z_2 + \ldots + w_{ip} Z_p,$$
$$(i = 1, \ldots, m \leq p \text{ and } j = 1, \ldots, p)$$

Where, w_{ij} are the coefficients (or charges) for the factor or element, i (F_i) multiplied by the measurable value for the variable j (Z_j).

In this study, PCA is performed on the dataset of weighted indicators. Again, the number of components to be retained follows the Kaiser Criterion (Eigenvalue > 1) and only the component loadings with a value higher than 0.60 are accounted for in the analysis (Field, 2009). Eigenvalues can be used to determine the number of principal components to retain after PCA (Kaiser, 1974): An Eigenvalue > 1 indicates that PCs account for more variance than accounted by one of the original variables in standardized data. This is commonly used as a cutoff point for which PCs are retained. This holds true only when the data are standardized. Moreover, PCA can limit the number of components to that number that accounts for a certain fraction of the total variance.

An alternative method to determine the number of principal components is to look at a Scree Plot, which is the plot of eigenvalues ordered from largest to the smallest. The number of components is determined at the point, beyond which the remaining eigenvalues are all relatively small and of comparable size (Jolliffe, 2002; Peres-Neto et al., 2005).

Thus, each principal axis is a linear combination of the original measurable variables. Then for each goat farm was calculated, through multivariate statistical analysis, a score per cost component using the method of Regression (Hair et al., 1995). The Kaiser-Meyer-Olkin measure of sampling adequacy was calculated to test the sampling adequacy. Only 8 PC had eigenvalues greater than 1 (Kaiser, 1974) and were, therefore, retained for the successive CA.

RESULTS

PCA was used to identify the variables that accounted for the maximum amount of variance within the data in terms of the smallest number of uncorrelated variables (components). In this study, PCA was applied to twenty key attitude variables (Hired land expenses, Imputed rent, land cost, Family labour expenses, hired labour expenses, labour cost, feed costs, cost of drugs, cost of foreign engineering labour, current assets interest, depreciations, maintenance, insurance premiums, fixed assets interest, variable cost (without the cost of feed), fixed cost, loans, age and education level of the head of farms, and labour cost), which relate to various aspects of marketing strategic activity, to a smaller set of eight strategic dimensions. The sum of all the eigenvalues give a total variance of eight (Table 1 and Figure 3). The final variables include feed expenses, variable capital without the feed expenses, fixed capital expenses, loans, age of the heads of the farms, educational level of the heads of the farms, land expenses and labour expenses.

The proportion of variation explained by each eigenvalue is given in the second column. For example, 5.061 divided by 8 equals 0.6326, or, about 63.26% of the variation is explained by this first eigenvalue. The cumulative percentage explained is obtained by adding the successive proportions of variation explained to obtain the running total. For instance, 63.26% plus 16.61% equals 79.87%, and so forth. Therefore, about 79.88% of the variation is explained by the first two eigenvalues together. The third axes explain the 11.97% of the variables. As is often the case, we use the first two dimensions of the PCA to summarize the data (Husson and Pagès, 2007).

The factor loading scores of the eight variables onto the eight factors are presented in Table 2. The factor loading scores that were acceptable was 0.6, higher than the 0.35 required according to Hair et al. (1995) in order to achieve 0.05 significance level and 80% level of power.

Eigenvector weights for each variable and each indicator on axes are given in Table 2. In Figure 4 makes

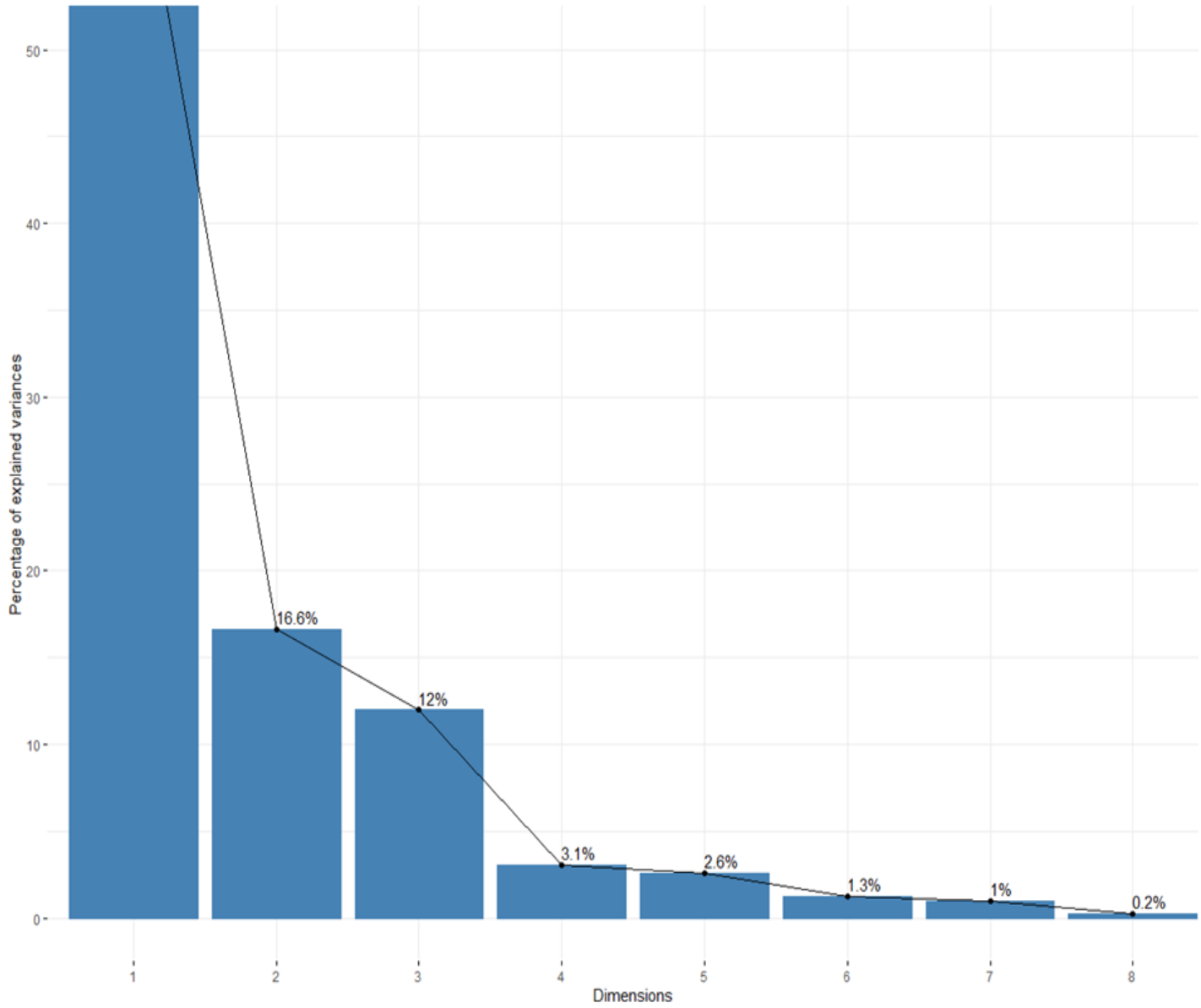

Figure 3. Scree plot for the first eight principal components.

Table 1. Results of principal components analysis of strategy variables.

Components	Eigenvalues	Percentage of variance	Cumulative variance (%)
PC 1	5.061	63.263	63.263
PC 2	1.329	16.616	79.879
PC 3	0.958	11.977	91.857
PC 4	0.245	3.074	94.931
PC 5	0.208	2.603	97.535
PC 6	0.100	1.255	98.791
PC 7	0.773	0.966	99.758
PC 8	0.193	0.241	100.000

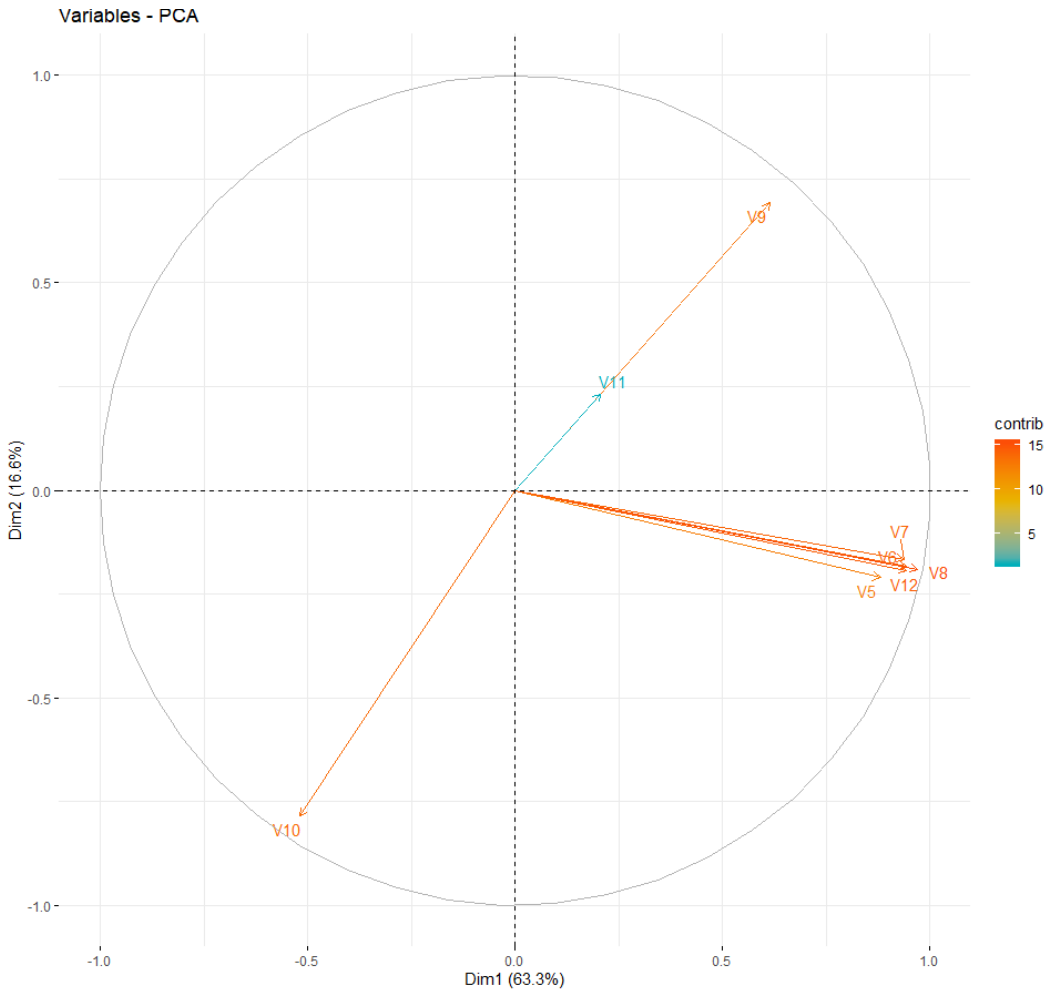

Figure 4. Socio-economic and technical indicators of dairy farms on axes F1 and F2 defined by PCA.

Table 2. Eigenvector weights for each of variables according to principal components. Eigenvectors weights>0.60 have been typed bold.

	PC 1	PC 2	PC 3	PC 4	PC 5	PC 6	PC 7	PC 8
Feed expenses	**0.880**	-0.210	-0.060	0.400	-0.120	0.022	-0.006	0.040
Variable capital without the feed expenses	**0.942**	-0.183	0.046	-0.091	-0.004	-0.195	-0.171	-0.007
Fixed capital expenses	**0.937**	-0.165	0.032	-0.168	0.100	0.215	-0.079	0.043
Loans	**0.970**	-0.189	-0.036	0.026	0.019	0.059	0.055	-0.116
Age of the heads of the farms	0.598	**0.693**	0.173	-0.105	-0.315	0.027	0.009	-0.000
Educational level of the heads of the farms	-0.517	**-0.785**	-0.129	-0.130	-0.285	0.026	0.004	-0.000
Land expenses	0.206	0.231	**-0.949**	-0.043	-0.006	-0.008	-0.003	0.004
Labour expenses	**0.943**	-0.193	0.039	-0.134	0.048	-0.101	0.196	0.045

it possible to characterize the dimensions and to visualize the correlations between descriptors (graph of the variables). Moreover, Figure 4 shows the links that exist between the different descriptors and we can tell that the descriptions in the first axis are strongly correlated. In Figure 4, the positively correlated variables are grouped together, while the negatively correlated variables are positioned on opposite sides of the plot origin. The

distance between variables and the origin measures the quality of the variables on the factor map. Variables that are away from the origin are well represented on the factor map.

The highest eigenvector weights for PC1 includes the cost of feed, the variable cost (without the cost of feed), fixed cost, loans, age of the head of farms and labour cost. The highest weights for PC2 were the age and the education level of the head of the farms. For PC3 the highest weights were the land cost.

To summarize, the variables that used can be described in the following way: The high contribution of feed expenses in the first PC shows the dependence on purchased feed and explains the importance for the farmers to produce self-production animal feed and attach the animal needs on their farms with the development of well-balance and economic diet.

The variable capital expenses play also an important role in the cost formation. The variable capital expenses include the cost of drugs, the fuels, water, electricity, foreign engineering labour cost and current assets interest. The high variable expenses indicate that the farms are unable to meet their needs by covering all regular variable costs for a period of time.

Fixed capital expenses show that the farmers have spent a large amount for the modernization of the buildings and machineries, without necessary improve profitability. Thus, a productive use and rational utilization of the fixed capital is essential.

The high contribution of loans shows that the farms depend on short and long run loans in order to be viable. The high contribution of labour expenses shows that the farms have surplus staff. However, it is recommended the most labour-intensive times of year to use seasonal workforce. The age of the head of farms has a high contribution in the second PC, showing that the age of the farmers contributes to the management practices of the farms. The education level of the heads of the farmers has a negative contribution in the second PC, showing that the education level is a key factor for the proper use of production factors.

To summarize, the PC groups could be described in the following way: Group 1: This group named general cost factors explains 62.26% of the original variance. This group is a combination of five indicators: feed expenses, variable capital without the feed expenses, fixed capital expenses, loans and labour expenses. Group 2: This group named social characteristics of farmers explains 16.61% of the original variance. This group is a combination of two indicators: Age of the heads of the farms and the educational level of the heads of the farms. The education level of the heads of farmers contributed negatively to this group.

Figure 4, provides a visualization of the matrix of the correlation coefficients. According to Figure 4, it can be seen that the variables V8 (amount of loans) and V12 (labour cost) contribute the most to the dimensions 1. The high contribution of loans shows that the farms do not dependent on their equity financing, but thay are dependent of loans. They take loans in order to improve their facilities long lasting or in order to cover the variable expenses in short term, but when they take the loans they do not take into consideration that there are guarantees for bank loans and there is a high possibility most of them not to be able to repaid. On the other hand, the labour cost is the second factor that has a high contribution to the overall cost. The high labour cost shows that the farmers use surplus staff because they are not so specialized and productive.

Additionally, and according Figure 5, we can see that there is a high contribution and that indicates a good representation of the variable on the principal component. In this case the variable is positioned close to the circumference of the correlation circle. Otherwise, when there is a low contribution the variables are not perfectly represented by the PCs. In this case the variable is close to the center of the circle.

For a given variable, the sum of the contribution on all the principal components is equal to one and that means if a variable is perfectly represented by only two principal components [Figure 4, (dimensions 1 and 2)], the sum of the contribution on these two PCs is equal to one. In this case the variables will be positioned on the circle of correlations.

For some of the variables, more than two components might be required to perfectly represent the data. In this case the variables are positioned inside the circle of correlations. Summarizing we can tell that the contribution values are used to estimate the quality of the representation, the closer a variable is to the circle of correlations, the better its representation on the factor map and finally, the variables that are closed to the center of the plot are less important for the first components. In order to highlight some key parameters, we use the individual data.

According to Figure 6, there are indications that the farmers that are less than forty years old are affected more from the examined variables. This can draw useful conclusions for the modernization and the business orientation of goat farming. This high concentration of farmers in the group of under forty years old may indicate that there is interest of young people for this livestock activity. Many researchers focus that the age is effective on the adoption of innovations and development (Yener and Oğuz, 2017; Madhukar and Ram, 1996). The younger farms are more educated, which can explain the tendency to invest more on technology and equipment purchase reducing the feeding and labour cost (Gelasakis et al., 2017). Moreover, young farmers make a better distribution of labour rate and due this to, there is an increase in the share of output sold, hence incomes (Tolno et al., 2015). Otherwise, the determination of farmers' age with the

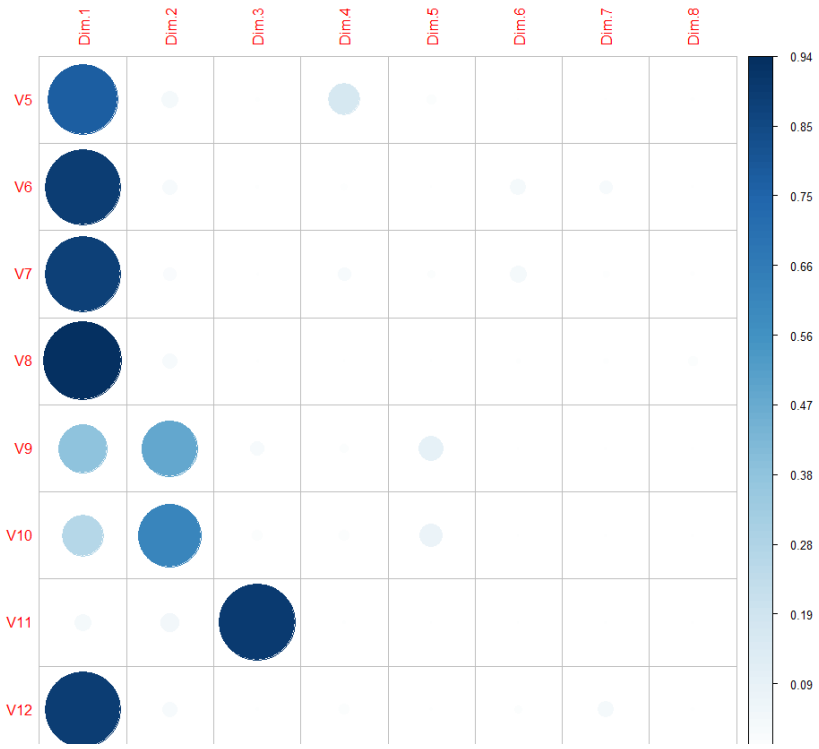

Figure 5. Quality representation for PCA variables.

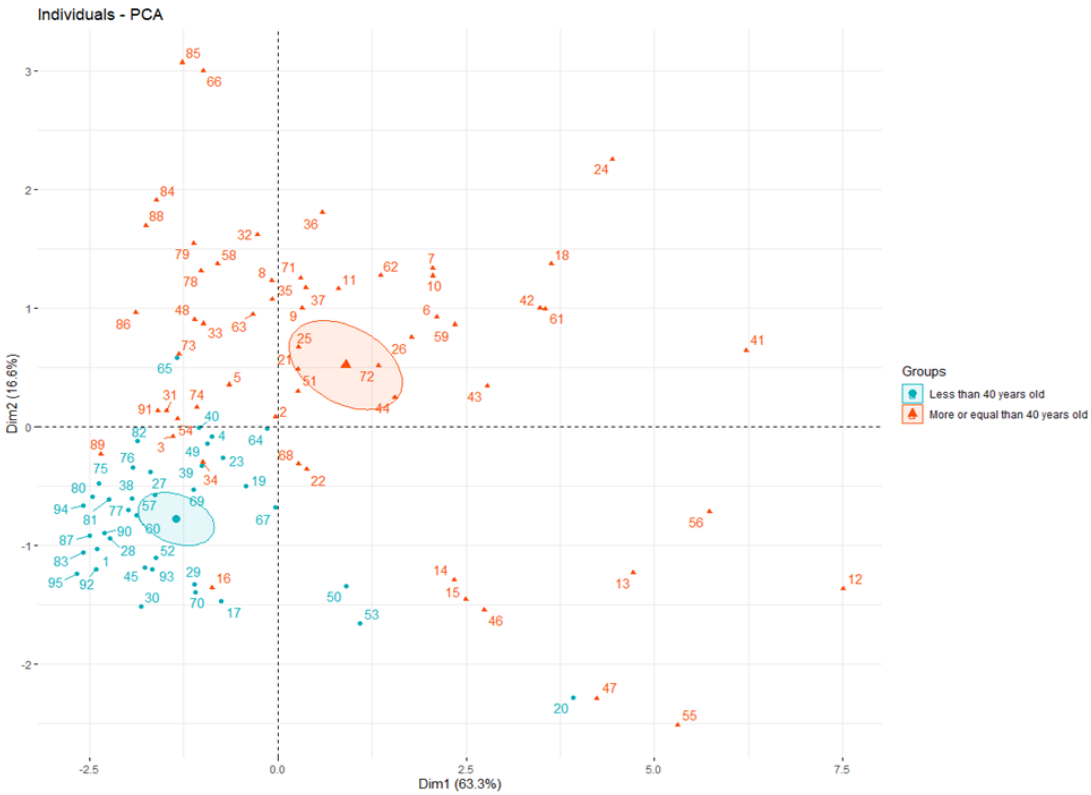

Figure 6. Quality of PCA variables for individual's goat farmers.

economic factors that influence the viability of the farms should be studied detailed in the future.

DISCUSSION

In Greece goat farming is an irreplaceable activity because is adaptable to the nature, it provides high quality products and contribute significantly to the country's gross agricultural production value. The majority of the farms are not viable and the future is uncertain due to the risk of further marginalization. The study of the socio-economic structures of the farms is an important attribute in order to understand the way that farms will face the future changes. The goat breeding sector in Greece is not so competitive and efficient compared to other European Union countries, because of the high operation cost and especially the cost that becomes from feed, fixed capital and labour. Many farms depend on debt capital, generating the financial costs. There is a need of improvement of the sector. A reduction of the costs can lead to the increase of competitiveness. Moreover, the social structure can contribute to the strategies and policies that can improve the performance and the sustainability of the sector.

In this study, PCA was applied to twenty key attitude variables, which relate to various aspects of marketing strategic activity, to a smaller set of eight strategic dimensions. The sum of all the eigenvalues give a total variance of eight. The final variables include feed expenses, variable capital without the feed expenses, fixed capital expenses, loans, age of the heads of the farms, educational level of the heads of the farms, land expenses and labour expenses.

The application of PCA highlighted two axes (components) that explain the 79.87% of the total variance: the first axis explains 63.26% of the total variance, while the second 16.61% of the total variance.

According to results, the first component is associated with all parameters of the cost, except from the land costs. Due to the fact that the first component explains a very high percentage of the total variance (63.26%), it can be described as component of the general cost.

As it can be observed, the amount of loans and labour cost have the greatest influence in determining the general cost, following by cost of variable capital without the feed cost, cost of fixed capital, and feed cost. The second axis can be described as a component of social characteristics of the farmers that contribute to the PC. In the second PC the highest contribution has the farmers age and their education level.

Finally, it is worth mentioned that there are indications that the farmers that are less than forty years old are affected more from the examined variables. This can draw useful conclusions for the modernization and the business orientation of goat farming but further research is needed.

Conclusion

Based on the above analysis and taking into account the current economic and pandemic crisis within the farms operate, the following strategies to improve the sector could be implemented: According to OSCE (2013), governance worldwide, in order to support the agriculture and livestock sector, have create financial institutions for agriculture, providing direct subsidies, loan guarantees and other financial supports to farmers (Lin and He, 2020). The farmers in order to be viable or in order to modernize their farms take loans but they do not take into consideration the volatility of agricultural product prices or other uncertain risks such us pests and diseases. Moreover, the subsidized loans sometimes send wrong signals to farmers about the costs of financing. Farmers should consult experts such as agronomists in order to make the right investments mainly in mechanical and building equipment that will help them reducing the operating costs and increase productivity.

The labour cost is another factor that should be reduced. The creation of contractors in order to reduce mainly the foreign engineering labour cost and the use of seasonal workforce in the most labour-intensive times of year is recommended. The recruitment of specialized workers in the field of milking, feeding or rearing is expected to be more productive.

Last years there is a high increasing in price of purchased feeds, so the optimization of the use of grass as food source for goats will lead to the feed cost reduction. Moreover, the rational use and quality improvement of the feed, the use of a well-balanced and economic ration will lead to a better valorization of this component, and reduce the feed cost.

The variable cost is another factor that should be reduced. The variable cost mainly consists of the cost of drugs and antibiotics. Multifactorial diseases can be efficiently avoided if the farmers participate in animal health programs. The cooperation with experts on herd health management issues is essential. Moreover, another factor that participate in the variable cost is the cost of electricity. For the reduction of this cost parameter it is recommended the farmers to focus on renewable energy sources such as photovoltaics or the management of animal waste such us the manure.

Inappropriately structured fixed assets payment plans usually have long-term negative consequences. For this reason, it is recommended the renegotiation of the programs and the change of the payment method. Moreover, the modernization of building facilities and machineries is not done according to a plan based on existing needs, so there is a capital overinvestment. Thus, a productive use and rational utilization of the fixed capital is recommended.

According to the age of the heads of farms it is crucial the governance and the policy makers to encourage and

motivate farmers to find new ways of developing multifunctional farms, to give them financial incentives and provide consulting services when it is necessary.

The education level is another crucial factor for the competitiveness and viability of the farms. It is essential the farmers to be motivated to participate in seminars which are related to farm management. Moreover, the access to new technology will lead to the adoption of innovations and thus the improvement of the economy. The establishment and enabling of a platform for providing mobile advisory services will help the farmers to improve their management abilities.

In conclusion, the PCA has proved to be a useful tool in order to understand the strong points and the weak points of the goat sector, while the results of the study will be useful in assisting farmers with adjusting their farming practices sustainably and assist policy makers with the design of efficient farm policies.

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Appendix I:

Questionnaire

1.Questionnaire number:

2. Breeder's name:

3. Regional Unit:

4. Characterization of Regional Unit: Mountainous….. Semi-mountainous….. Plain…..

General / Individual data

1) Year of farmers birth:

3) Education level in years:

Characteristics of agricultural / livestock exploitation

Crop production

Crop production	Total land (acre)	Owned land (acres)	Rented land (acres)	Rent of land (€/acre)	Production (Kg)	Sale price (€/acre)
Cultivations						

Buildings - Agricultural constructions

Buildings - Agricultural constructions	Size	Year of construction	Reconstruction value	Materials

Mechanical equipment

Mechanical equipment	Year of purchase	Purchase or construction value	Years of economic life

Land improvements

Land improvements	Year of purchase	Purchase or construction value	Years of economic life

Feed (purchased)

Kind of feed	Quantity in kg	Value in €

Self-produced feed

Kind of feed	Quantity in kg	Value in €

Labour

	Number of people	Months of employment per year	Hours/day	Hours/month	€/month
Farmer					
Wife of farmer					
Other family members					
Foreign labour					
Foreign engineering labour					

Other expenses

Categories	€

Livestock inventory

	Number	Value (€/animal)
Bucks		
Goats		

Productivity and prices

Livestock production	Kg/ animal	Price (€/kg)
Milk		
Meat		

Loans

Initial loan (€)	Type of loan	Year of taking the loan	Duration of loan	Loan installment