Socioeconomic structure of animal production systems: methods and results of multivariate data analysis

I. Gidarakou[*] and C. Apostolopoulos[**]

Summary

The present study consists in an examination of the socio-economic structuring of the sheep- and goat-breeding system, utilising the methodological tools of analysis/classification of three methods of multi-variate analysis, factor analysis, canonical correlation analysis and discriminant analysis. The study is based on field research and was carried out in a region of the country which is one of the most representative of the system. Application of the above mentioned methods showed that each of them in its own way yields valuable findings, serving different purposes as regards the relevance of systems approach, such as the investigation of the relations between the characteristics defining the socio-economic structure of the system and the identification of its chief components or the analysis/classification of sheep-and goat-breeding farms in accordance with the type of breeding or whether the farm is situated in a mountain region or in the lowlands. Moreover, common findings emerging from the application of the different methods to the data of the same study reinforce these findings' claims to reliability.

Introduction

Each agricultural system is a coherent whole entity, which is defined by a complex of structural, operational, productive and social factors, which derive from the natural, economic and social conditions of the wider area, within which it operates. The formation of these factors and their relations define the system's operation, its economic efficacy and its evolution. Their systemic exploration allows the extraction of useful findings, relatively to the complexity of these factors, their identification/classification and the meaning of their relations. It allows the understanding of the farmers' decision- making, of the rationality that governs their attitude towards the policy measures and finally facilitates the application of more rational interventions for the improvement of the system.

In the framework of the above preoccupation, the systemic investigation of the branches of animal production, and especially the goat - sheep production, constituted for us, during the last years, a challenge and a motive for research, since such a research has never been attempted until then.

We focused our research interest on stockfarming systems because the development of animal production sector in Greece constitutes one of the most basic matters of agricultural economy. For many decades the value of animal production still remains less important than that of vegetable production keeping a proportion of about 1/2. Goat - sheep production constitutes the most important cattle-breeding branch, since it covers almost 43% of its gross value. It is a branch with important comparative advantages in the country.

[*] Associate Professor of Agricultural University of Athens
[**] Associate Professor of Harokopio University (Athens)

More specifically, the investigation of socioeconomic structures of herds, static and movable goat - sheep production, was attempted in the geographical department of Thessaly, in Central Greece. Given that socioeconomic structures are defined, on the one hand, by a large number of factors, on the other hand, by interrelated factors, their investigation imposed the use of statistic models, which proceed to the reduction of data, while simultaneously they face the variables' multicollinearity problem.

From the methods of the multivariate data analysis, factor analysis and principal component analysis are known to have been used in research for a long time, both as investigation as well as data reduction approaches, in the efforts of classifying agricultural systems (e.g. Haggood 1943, Henshall and King, 1966). Agro-geographers have also very often attempted, recently, to combine Principal Component Analysis with cluster analysis methods, while discriminant analysis combined to principal component analysis were used as analytical models of the agricultural systems (Anderson 1975, Aitchison 1986). The use of factor analytic methods have recently become commonplace, exceptionally the principal component analysis, as both a data search and a data-reduction procedure (Atchison 1972,1986, Gregor 1982, Martinos et al. 1999)

In the present paper, factor analysis, canonical correlation analysis and discriminant analysis were used. Each of these methods, was used for different purpose in the proceeding of the research, while common, up to a point, results strengthen the validity of the results. These models, in the analysis of multi-variate' data of the systems of animal production, are in this case more important as indication of the methodology and less as analytical classifying tools on the structures, since they were used for the first time in the Greek data for the investigation of the matters of agricultural systems and not only for that. Moreover, the methodology and the analysis results are going to be analyzed next.

The research setting

Thessaly was chosen for the purposes of the research as the most representative geographical area of the country in the area goat - sheep production (Iakovidou & Ananikas, 1981, Apostolopoulos, 1986). It combines the mountainous area in the west (Pintos mountain chain) and the vast plain in the East, allowing free grazing of animals all year long. The mountainous area constitutes the resort of the transhumance cattle- breeding and relatively the plain constitutes the main winter pasture.

Data and Methods

A representative sample of 172 mixed agri - goat sheep productive or unmixed goat-sheep productive farms were chosen with a random sample taking per strada. The statistical data was collected with the filling in of a questionnaire and of an one year calendar of the registration of data, that presented eternal evolution. Five sets of variables, which identified the system's structures were defined (as seen in table 1).

a) Structural characteristics of the farms
b) Social characteristics of the stockfarmer
c) Employment characteristics
d) Farm modernization characteristics
e) Production characteristics

The principal axis factoring (P.A.F) with varimax axis rotation was used from the factor analysis methods, for the data analysis. P.A.F. method was used for the identification/

classification of the main coefficients of the goat- sheep production system and for the explanation of the causal relations, that connect the total of the variables, that define the socioeconomic structures of the system. The relationships between the sets of variables, that were defined from the beginning (a,b,c,d,e, see above), were studied with the use of the canonical correlation method. This method offers the redundancy measure of groups of variables and allows the formation of a relatively satisfactory prediction of the differentiation of the variables of one group based on the differentiation of the variables of the other. It presents indications for the proportion of variables' variance of a group, based on the knowledge of the variables' variance of the other. It also allows the identification of sub-dimensions of the variables' groups that present the maximum part of mutual relationship of the initial groups, i.e. that present the structures of the relations between these groups. The investigation of these sub-dimensions structure also verifies findings of the factor analysis. The discriminant analysis was used as a classifying tool for the distinction of goat- sheep productive farms, based on the type of breeding (semi-stabled, herd - static and movable), as well as on the geomorphologic location of the communities (farms in the plain and mountainous areas) and the differences between the farms' categories were studied. Discriminant functions were defined through discriminant analysis and then variables with more discriminatory power between the categories of farms or variables that enable farms' classification in the pre- selected categories. The definition of classification functions, in the expression of which the discriminatory functions are involved, is also allowed through this method. Farms are classified in each category with the transformation of the classification factors for each farm to a probability of membership with the classification categories. The proportion of the farms that is classified constitutes a further criterion of the sufficiency of the model, in the explanation of the differences in the farm categories.

Mathematical presentation of statistical methods- brief presentation

Factor analysis

With this method the basic variables x_j, j=1,2,..n, are reduced to a smaller number of standardized variables F_i, i = 1,2,..m, called factors, which are linear combinations of the basic variables and which react as the most important variables included in them. Factor analysis allows the revelation of the structures and the explanation of the multiplicity of the relations that connect the basic variables, because it is based on interrelationship of the variables.

The linear method of the classic factor analysis is as follows:

$$Z_j = \alpha_{j1} F_1 + \alpha_{j2} F_2 + \ldots\ldots + \alpha_{jm} F_m + d_j v_j,$$

j = 1, 2, … n, n >m

Where: Z_j: variable j in standardized form
a_{ji}: loading of the variable j on the factor i
F_i: factor i, i=1,2,..m
v_j: characteristic factor of j variable (consisting of the

unique factor sj and the error factor ε_j)

d_j: regression coefficient (i.e. the load) of variable j on the characteristic factor v_j

and under the condition that characteristic factor v_j is rectangular to all Fi factors, as well as to the characteristic factors of all other variables.

Principal factoring with iterations was used from the models of factor analysis.

Rotation of the factors' matrix with the varimax rotation method was used for making factors’ identification easier. The load proportions in some variables decrease and in others increase with the method of this rotation, so that grouping of the variables becomes clearer, without interrupting their relevant position within the factor; simultaneously rectangularity of the factors is preserved (Harman 1967, Cooley- Lohne 1971, Kim 1975).

The sequence of the factors defined expresses their role in the explanation of the common and total variation of the sample’s variables (see also Kerlinger, 1981).

The canonical correlation analysis

The canonical correlation method was used for the investigation of interrelationships between the variable groups. Just like as in factor analysis, it is a reduction method of the data, having as main target the investigation of the correlations between two groups of variables (Warwick 1975, Cooley-Jones 1971).

If the values of the two variables’ groups, that have a specific theoretical context (such as, for example, a group of economic variables and a group of social characteristics variables) are available for a sample of N individuals or objects (in the present paper: farms) and their standardized values are calculated; and if the vector with coordinates the variables (in standardized form) of group A is denoted by Z_1 and by Z_2 the vector with coordinates the variables (in standardized form) of group B, then: with the analysis model of the canonical correlation at first a couple of new standardized variables is searched for, factors x_1, y_1, where each factor is a linear combination of the standardized variables of groups A and B respectively, so that x_1, y_1 expose the maximum possible correlation. This means that two vectors c_1 and d_1 are searched for, so that for the standardized variables $x_1=c'_1Z_1$ and $y_1=d'_1Z_2$, the quantity

$$\frac{1}{N}\sum_{i=1}^{N} x_{1i}y_{1i}$$

becomes maximum, where $x_i=c'_1z_{1i}$ and $yi=d'_1z_{2i}$ i= 1,2,…N and z_{1i}, z_{2i} the values of the vectors Z_1 and Z_2 for the i individual or object.

Next a second couple of factors x_2 and y_2 is searched for from groups A and B relatively, so that each factor is rectangular (i.e. non- correlated) towards x_1 and y_1 and further x_2 and y_2 to present the maximum possible correlation. Again two vectors are searched for c_2, d_2, so that for the standardized variables- factors $x_2=c'_2Z_1$ and $y_2=d'_2Z_2$, the quantity

$$\frac{1}{N}\sum_{i=1}^{N} x_{2i}y_{2i}$$

becomes maximum, under the condition that x_2 and y_2 are not correlated to the previously drawn factors x_1, y_1, etc. This procedure is stopped when the correlation between the drawn factors is not statistically significant.

The drawn factors x_i, y_i are called canonical factors or canonical variaties and their relevant correlations, canonical correlation coefficients.

Also, a very important quantity is the redundancy measure. If the coefficient of canonical correlation of the canonical factors x_i y_i is symbolized by R_i then the quantity RDx_i is called redundancy measure of group A, which is expressed by x_i, when B is given. It expresses how the A variables' group is unnecessary, when the B variables' group is given, in relation to the canonical factor x_i.

Presented differently, this measure of redundancy expresses the proportion of variation in group A, which was found through the i canonical correlation as being unnecessary (i.e. not needed) in the interpretation of the variation of variables of group B, if this last group is available.

The sum of RDx_i for all the factors that were drawn from group A, presents the total redundancy measure, i.e. how unnecessary is group A on the whole, when group B is given. The quantities Rdy_i for group B of the variables are relatively defined. (Miller 1969, Cooley-Lohnes 1971).

Discriminant analysis

The study of the differences, between different g groups of individuals or objects, defined on the basis of a definition group variable, is attempted with the discriminant analysis method. N individuals or objects from all the groups are selected for this purpose randomly. The k values of the discriminating variables are defined for each one of them. These measure the characteristics, on which the groups are expected to differ. Moreover, the finding of linear functions of the distinctive variables is aimed to, so as to maximize the distinction between the groups accordingly.

These discriminant functions are rectangular factors of a maximum multitude of n=min(g-1,k) and have the standardized form:

$$D_j = C_{j1} Z_1 + C_{j2} Z_2 + \ldots\ldots C_{jk} Z_k ,$$

$j = 1, 2, \ldots, n.$

where: D_j is the score of disciminant function j

Z_i i=1,2,..k are the k disciminant variables in standardized form, and

C_{ji} is the coefficient of the i standardized discriminant variable on the j function

The score of the C_{ji} coefficient expresses the contribution of the Z_i variable in the discrete ability of the D_j, while D_j acts as the most important of the discriminant variables that exist in its expression, a fact, that is also used for the naming of D_j.

The n discriminant functions define a system of n rectangular axis in the area of n dimensions, while the procedure of finding them is gradual.

The discriminant functions are drawn based on the importance and the number of those that will be characterized sufficient for the explanation of the differences between the groups, is decided according to the use of criterion Λ of Wilks.

Based on the data, g linear classification functions (one for each group) can be found, in the expression of which are involved the discriminatory functions. The classification functions allow the researcher to decide if a person or an object for which the k values of the discriminant variables are known, may be classified in one particular g group from the existing ones.

The scores of the classification functions for each individual or object can be transformed in probabilities of group membership of the individual or the object. The classification of the cases, that were used for the finding of discriminant functions, (with the use of classification functions), constitutes one more criterion of the model validity, in the explanation of the differences between the groups (Klecka 1975 Panel on discriminant analysis and clustering, 1989).

The stepwise procedure is used in the present case for the selection of the discriminant variables with the most discriminant power, that will be used in the analysis.

Results[1]

From the use of factor analysis derives that the variables of the socioeconomic structure of the goat- sheep production define 6 basic factors, which in a declining meaning in the explanation of total and common variance are identified as follows: ***Direction of production,*** defined by the large loads of the following variables *direction of production, size of the herd, form of breeding, geomorphology, own production of animal food, change of direction, change in the type of breeding* (Table 1). ***Economic result of the farm,*** defined by the large loads of the following variables: *cattle-breeding income, herd size.* ***Stockfarmers' social characteristics,*** defined by the large loads of the following variables: *age of farmer, farming experience, agricultural experience, family situation, education level.* ***Product management,*** defined by the large loads of the following variables: *cheese making, way of disposition of milk.* ***Use of private farms,*** defined by the large loads of the following variables: *private animal grazing, technical animal grazing.* ***Expenses per productive animal,*** defined by the large loads of the variables: *monetary expenses per sheep, use of mixtures and production per sheep.*

To sum up, from the investigation of the structure of these dimensions, is noted that in the farms, where animal breeding, compared to agriculture, overcomes income, are observed the largest sizes of herds of static or movable breeding, found mainly in the mountainous areas. The leaders of farming families have little agricultural experience and the private production of animal food is limited. The efficiency of productive animals is less in the pure animal breeding farms and larger in the smaller herds of mixed agricultural - animal breeding farms. The size of the herd defines the economic result of the farm regardless of the productivity of the animal capital, while it is also related to the structure of the family and the employment in the farm. Younger leaders have larger families, a fact that is connected to the presence of members beyond the nuclear family (couple's ancestors), who are employed in animal breeding. There is not any relation between the social characteristics of the farmer (age, education) and the economic characteristics of the farm. Modernization of large sheep production farms is mainly related to the mechanical and

[1] Only the table of the definition and presentation of the variables is including in the text. The results' tables are not included in the presentation text, due to their increased number. However, they are available, from the authors, to anyone interested.

building equipment and not to parameters of modern breeding, such as privately owned pastures, technical pastures and the use of concentrates.

With the use of canonical correlation, the correlations of the following groups of variables were studied: a) the farm's structural variables, to the economic variables, b) the stockfarmer's social characteristics group and characteristics of labour to the production variables and c) the farm's structural variables to the stockfarmer's social characteristics and of labour variables. In the first case, three couples of canonical factors occurred with statistically important canonical correlations 1) ***size of farm - product management*** 2) ***production modernization - animal capital management*** 3) ***production direction- cost of breeding per animal***, with total scores of the redundancy measure of the two groups 0.226 and 0.359 respectively. From the three pairs, the first offers the larger part of interrelated coverage, that means that the size of the herd, directly connected to the breeding system, presents the larger part of correlation with the characteristics that express the economic result and the way of managing the produced product. Basic results of factor analysis are also confirmed from the structure of the first canonical factor of the first couple: i.e. that big animal breeding farms are mainly movable in mountainous areas, where animal breeding overcomes agriculture as an economic activity, as well as that the leaders of these families are younger people and their families are larger.

The canonical correlation of the stockfarmers' social characteristics and labour variables to the production variables, even if it gave three couples of canonical factors with important statistical correlations the redundancy measure of the two groups is limited, 0.167 and 0.173 respectively. In this way it occurs that the social characteristics of the stockfarmer, as well as the conditions of employment do not present an important part of the variation of the production variables, i.e. they are not basically connected to the effectiveness of the farm and the management of the product and vice versa (ascertainments that are certified also by the results of factor analysis).

From the canonical correlation of the third groups of variables occurs that from the individual - social characteristics of the farmer, firstly the variable of education does not intervene in the structure of any of the three canonical factors with large loads, while the age variable is presented in the structure of third factor, which, however, presents a minimum proportion of interrelated coverage of the groups. From the relatively small values of the redundancy measures occurs that, despite the ascertainments of an important correlation between the groups, the structural characteristics of the farm do not allow serious prediction for the social characteristics of the producer and the conditions of employment in the farm. The shortage of important correlation of the individual characteristics of head farmer and the economic parameters of the farm (ascertainments that also occur from factor analysis), lead to the hypothesis that even if the leaders of large animal breeding units are relatively younger, the farm operation is served by the elder members of the family, as it occurs from the ascertainment of membered families in the cases of younger farmers. To the point that this happens, modernization of goat - sheep production systems becomes more difficult.

Based on the discriminant analysis it occurred that some of the structural and economic characteristics are differentiated a lot between the categories of farms, that are defined from the form of breeding (semi-stabled, herd static and movable) or the geomorphology of the area that the farms are located (plain or mountainous zone) and the method operates effectively as a classifying tool of the farms in these groups. At the beginning, 12 variables of structural characteristics were used as discriminating variables and then the group of the economic characteristics' variables was used. Based on the differentiation according to the breeding form two discriminating functions occurred, relevant to each group of discriminating variables that were used. In the case of the structural variables, the functions were recognized based on their structure as: ***herd size*** and as ***geographical location***, while in the case of economic variables as: ***efficiency of productive animals*** and ***treatment of the product.*** The proportions of correct classification were increased to 71.5% and 64.5% respectively.

For the separation in farms of the plenary and mountainous zone, structural variables defined a discriminating function as the economic variables did, based on which, the farms are separated in two different categories. In the first case, the function is characterized mostly by the following variables, ***herd size, private animal grazing*** and ***technical animal grazing,*** while in the second case from the variable, ***production per animal.*** The proportion of correct classification of the farms in both cases were increased to 88,9% and 84,3% of the farms. The results of the discriminant analysis showed, that some of the structural and economic characteristics of the farms are differentiated a lot between farm categories, so that the farms are separated in these categories in the most satisfactory way. The individual - social characteristics of the farmer were not included in the discrimination of the farm categories. Some of the ascertainments of the discriminant analysis are also certified by the results of the two previous methods of data analysis. Finally, from the discriminant analysis occurs that the structural characteristics are differentiated more intensely related to the altitude than to the breeding system, while the economic characteristics are differentiated less than the structural characteristics, both in the altitude, as well as the breeding system dimension.

Discussion

The present study comprises an examination of the structure of a production system of considerable importance to the Greek economy. It makes use of three methodological tools of analysis/classification for studying multi-variable data.

The choice of the production system of sheep- and goat-breeding was made because it is an important one, in the continuing development of which this country enjoys a comparative advantage, notwithstanding the fact that for a number of decades this production has not been able to be sustained to the level which might be considered desirable. The reason that the three separate methods were selected is that it was believed that each one of them could be of assistance in the solution of certain specific problems and serving specific (and different) purposes within the framework of the analysis/classification of systems, while findings to some extent common, emerging from their parallel application to the data of the same study, also reinforced the claims to reliability of the findings corresponding to each of the separate methods.

As for the systemic approach, one basic advantage of the methods is that they are methods of data reduction and also attempt to deal with the problem of the multicolliniarity of the variables. Given that a production system is defined by a host of economic, social, technological and environmental factors and by a greater or lesser degree of mutual dependency (or the absence thereof), data reduction provides the researcher with a capacity to handle them with greater ease. Factor analysis, for example, makes it possible to investigate the relationship between the characteristics defining a production system, at the same time yielding a small number of linear combinations of the initial variables which also constitute the chief components of the system. In the present work the total of 29 variables which determined the structure of the system were reduced to 6 components and investigation of the linear combinations of the initial variables made it possible for the relationships linking them to be investigated. Discriminant analysis is a useful tool for the study of differences between productive systems or units in a productive system. It is also a tool for classifying agricultural systems or elements (e.g. farms) in an agricultural system into their respective units, which are distinguished on the basis of certain of their characteristics. Utilising the method of the present study, characteristics (variables) of the system are further broken down into semi-stabled, herd static and transhumance (itinerant) forms of stockbreeding or into the zones of the mountains and the plains. The method also made it possible to ascertain which of the groups of initial variables among the above mentioned farming units can be differentiated and which not, leading to significant conclusions, particularly in relation to the role of the social characteristics of farm heads but also the differentiation of the variables of the system according to the form of stockbreeding or the geographical distribution from the point of view of altitude. The combination of the two methods, factor analysis as a method of reduction of the initial characteristics of a system or units thereof and discriminant analysis as a classificatory tool utilising derivations from the reduction (e.g. the factors) as discriminating variables, offers a potential for resolving important issues to do with the management of these characteristics and facilitating the solution of problems of geographical distribution of farming systems. Discriminant analysis or a combination of the two methods (factor and discriminant analysis) is a good analytical/classificatory tool for the study of regional development questions, mapping of regions with common characteristics or common problems, within a broader framework. The method of canonical correlation, beyond the increase in the reliability of certain common finds rising out of the parallel application of the previous methods also, particularly those of factor analysis, itself permits an investigation of the interrelationship between groups of variables which in the opinion of the researcher possess theoretical content warranting their being treated as units. As a method of data reduction, in the case of the systemic approach it makes possible the categorisation of the different features of the system and the investigation of interrelationships, not to mention the pinpointing of those features which expose the main part of the correlation between their categories. The size of the redundancy measure is an index which to some extent permits the derivation of predictions in relation to the breakdown of the characteristics of one category on the basis of knowledge relating to the formation of the values for the other. In the present study canonical correlation indicated that the social characteristics and employment conditions are not significantly linked to the efficiency of a farm, confirming basic conclusions of the factor analysis. The structural characteristics of the farm show high levels of correlation with the economic characteristics, while the variables of flock size, fixed capital, employment and family situation in one group and stockbreeding income and self-consumption in the other show up as those manifesting the greatest part of the correlation between the two groups.

Finally, concerning basic ascertainments, from the study of the structures of sheep - goat production, the farming income is found to be defined by the size of the herd. Animal productivity is higher in the small farms, which are agriculturally led and not cattle breeding, however, its differentiation between the herds is not adequate, so as for its presence to be obvious in the structure of the component of the economic result of the farm. However, it consists of the basic variable of economic character, which is differentiated between the breeding categories, both in the dimension of breeding as well as that of geomorphology. Individual and social characteristics of the farmer and employment conditions are not basically connected to effectiveness of the farm and do not differentiate between the units of farms that were defined. These last ascertainments that occurred from the application of the three methods suggest the need for detailed research of the topic, since the fact that the families of young farmers are larger suggests that the operation of the farming units is largely based on their elder ancestors (parents), while younger leaders of the farms present tensions of change from breeding to agriculture (see also Martinos et al., 1999). The differentiation of the farms towards the structural characteristics is more obvious between plenary and mountainous areas than between the different ways of breeding. The differentiation of the farms according to geomorphologic dimension, is mainly expressed by the differentiation of the variables that define the breeding system of the animals.

Bibliography

Aitchison, J.W. (1986), Classification of Agricultural Systems. In M. Pacione (ed), Progress in Agricultural Geography. CROOM HELM, London.

Anderson, K.E. (1975), An agricultural classification of England and Wales. Tijdschrift voor Economische en Sociale Geographie, 66, p.p. 148-157.

Apostolopoulos C. (1986), Contribution in the structural study of production system of sheep breeding in Thessaly, as well as in the investigation of the possibilities of its productivity increase, Ph.D. Thesis, Agricultural University of Athens.

Apostolopoulos C. and Gidarakou I. (1991), Investigation of the structural and economic characteristics of sheep breeding farms through the application of statistical analysis methods of multivariate data, Spoudai, Vol. 41, Issue 3, p.p. 327,368.

Cooley, W.W. – Lohnes, R.P. (1971), Multivariate data analysis. John Wiley and sons, p.p. 129-136, 168-176.

Gregor, H.F. (1982) Large-scale farming as a cultural dilemma in Us rural Development- the role of capital, Geoforum, 13, 1-10

Haggood (1943), cited by Aitchison, J.W. (1986).

Henshall and King (1966), cited by Aitchison, J.W.

Harman, H. (1967), Modern factor analysis. 2d ed. Chicago, Chicago University Press, p.p. 115-117.

Iakovidou, O. & Ananikas, L. (1981), Direction of the Agricultural production of the Greek geographical areas, Thessaloniki University, Agricultural School.

Kim Jae On (1975), Factor Analysis, Statistical package for the social sciences. Mc Graw – Hill, USA, p.p. 469-514.

Klecka, W.R. (1975), Discriminant analysis. Statistical package for the social sciences. Mc Graw – Hill, USA, p.p. 434-467.

Martinos, N., Gidarakou, I., Karanikolas, P. and Maraveyas, N. (1999), Productive Systems and the Decision – Making Process, *MEDIT*, No 1, p.p.37-42.

Miller, J.K. (1969), The development and application of bi-multivariate correlation. A measure of statistical association between multivariate measurement sets. Buffalo, State University of New York.

Warwick, P.V. (1975), Canonical correlation analysis. Statistical package for the social sciences. Mc Graw – Hill, USA, p.p. 515-527.

TABLE 1

Definition and presentation of the variables

1	2	3
Variables' group	**Variable**	**Variable presentation**
A. Farm's variables	1. Flock size 2. System of breading 3. Geomorphology 4. Type of Production 5. Farming Land 6. Cultivation of plants for animal grazing 7.Own production of animal feed for breading 8. Variation in type 9. Variation in the system of breeding	Total number of heads 0: Home breading and semi-stable 1: Flock – Village (static) 2: Flock – Movable 0:Plain 1: Mountainous 0: Farming exceeds (regarding activity and income), 1: Sheep grazing exceeds 2: Pure sheep grazing (possible farming refers only to plants for own consumption) In 1.000m % of the sum of the cultivating areas 0: No 1: Yes 0: No 1: Yes 0: No 1: Yes
B. Stockfarmer's variables	10. Stockfarmer's age 11. Educational level 12. Animal breeding experience 13. Farming experience 14. Family situation	Number of years Number of basic education Years Years Number of family members
C. Labour variables	15. Labour (total: family and non family employment) 16. Non family employment 17. Labour outside agriculture	In man working (8) hours % of total labour 0: No 1: Yes
D. Variables of farm's modernization	18. Buildings 19. Cultivation Machines 20. Equipment of animal farm 21. Use of concetrates 22. Private pasture 23. Technical pasture	Value (in thousand drachmas) Value (in thousand drachmas) Value (in thousand drachmas) 0: No 1: Yes 0: No 1: Yes 0: No 1: Yes
E. Variables of production and income	24.Production/ Sheep-goat 25. Own consumption 26. Cheesemaking (Home handicraft) 27. Way of production allocation 28. Monetary expenses/ sheep 29. Animal Breeding income (milk, meat, etc.)	Gross income in drachmas Value in drachmas % of the total milk production 0: stockfarmers alone with no intermediate, 1: No (i.e. through trade) in drachmas in thousand drachmas