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A Study on the Effect of Zootechnical Parameters on the Achievement of an Optimum Financial Result: A Typological Approach of Greek Pig Farming

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Abstract: Greek pig-farming is presenting a clear shift towards modern business structures. However, the current conditions of the globalized market for agricultural products and meat products specifically, are pointing towards a need for further improvements to be made regarding the competitiveness of pig-farming in Greece. It is therefore considered essential to financially support and strengthen the infrastructure of pig holdings, with the aim of enhancing their level of productivity and economicity. A survey of the financial and zootechnical performance of pig holdings and the creation of clusters of holdings that follow a similar pattern (typology) can assist in taking the appropriate investment decisions, and implementing more rational financing schemes. The objective of this paper is to formulate financing proposals for the restructuring of Greek pig farms, based on the latter's performance in relation to various qualitative, financial and zootechnical parameters. The use of cluster analysis has highlighted five clusters of pig holdings with specific financial operations and a particular zootechnical performance. From an analysis of the typology, the need arises to modernize the pig farms, focusing on improvements to their facilities and mechanological equipment. The installation of automated animal feed supply systems is considered essential, since it will improve the quality of animal feed, lead to a reduction in feed costs, and improve labour efficiency and animal management. Furthermore, the planning and financing of an effective programme for the genetic improvement of pigs in Greece, is expected to lead to a reduction in livestock costs and an increase in the productivity of the animals.

Key words: pig farming; zootechnical characteristics; productivity; economicity; rural policy; financing

INTRODUCTION

Pig farming is a particularly important sector of animal breeding in Greece. This is obvious both from the significant amount of invested capital (over 293 million euros), and from the high overall production of pork 135,837 tons [25].

Pig farming in Greece is a dynamic sector of intensive animal breeding. The major part of domestic pork production is centred in the regions of Central Macedonia, Epirus, Sterea Ellada, Thessaly, Western Greece, and Eastern Macedonia and Thrace. More specifically, the production for 2004 in Central Macedonia was 24,466 tons of pork (18% of the total production) and in Epirus 21,491 tons (15.8% of the total production). Next came Thessaly with 19,586 tons (14.4%) and Sterea Ellada with 16,322 tons (12%). The four regions mentioned above jointly covered 70.1% of the total domestic pork production for 2004 [26]. The pig farms are mainly small to middle-sized, and their productive capacity is significant, covering the needs of the Greek market for pork at a rate of 37-38% [22].

Since 1995, the sector has been presenting a strong orientation towards business structures and a pronounced concentration of livestock. Despite all these tendencies, the pig farming sector is characterized by several structural weaknesses in Greece, compared to the other EU countries [7]. The reasons that have led the sector to shrink and come to a standstill are the following: the high financial costs involved, restrictions regarding the national and community aid investment programmes, the over-indebtedness of pig farms, high production costs due to feeding expenses (high price of cereals, prohibited use of fodder of animal origin, etc) as well as the lack of basic domestic reproductive material [26], which have all resulted in a decreased level of competitiveness. The non-competitive character of the sector was also decisively affected by the subsidies for imported pork at the expense of domestic production (Monetary Compensatory Amounts), and the high interest rates [22].

In order to improve the position of Greek pig farming, it is considered essential to explore the weak points that constitute the basic reasons for the lack of competitiveness and formulate proposals for its restructuring.

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A typological analysis is considered to be particularly useful in the present study, since the changes to the distribution of financial activities in space, the rational distribution and use of the available production coefficients, based on the comparative advantages of each region, the applied development policies and the tools for their implementation, such as regional development incentives, the financing, the taxation and the social policy, can be interpreted through the development of typologies [6].

Many researchers have dealt with the development of typologies for the agricultural areas of Greece, particularly on issues linked to plant and animal production. Indicative examples include: defining homogeneous rural development zones based on the cultivation systems applied, the available production coefficients, the particular soil properties, the characteristics of plant agriculture and common problems of development [27,17,18], development of animal breeding in the Prefecture of Thessaloniki [6], financial activities of pig farms in Greece [2], and agricultural investment activities in central Macedonia [3].

The objective of the present study was to develop a typology on a sample of 71 pig farms in Greece and define similar spatial units-clusters, based on their performance according to significant zootechnical parameters. Through the typological analysis of the pig farms, will attempt to define the effect of the specific zootechnical parameters on the formulation of the optimum financial result and to determine policy and financing measures for pig farms that will improve the competitiveness of pig farming in Greece.

MATERIALS AND METHODS

Cluster analysis is a descriptive method which, in most cases, is not supported by a substantial theoretical framework of Inferential Statistics [16,8]. The formulation of the groups-clusters is based on simple computerized routines [19], which, despite having remarkable mathematical properties, nevertheless constitute nothing more than smart algorithms, the result of which is mainly interpreted through the use of practical rules. Cluster analysis is applied in many scientific fields and is consequently used both for the computerized and the interpretory part of the analysis.

In order to conduct this research, we selected the main pig farming centres of Greece. They are located in four geographical regions, namely Attici-Viotia-Evia, Thessaly, Central Macedonia and Western Greece. The number of pig farms in these regions has been estimated at 360 (representing 36.5% of the total number of pig farms in the country – having over 20 sows each) [24]. The variety of breeding conditions in these regions allows for a generalization of the results of the research for the whole country, without any major deviation from the real picture [14]. The technical-economic data of the research refer to the period 2003-2004 and were collected using specially prepared questionnaires by the method of personal interviews.

The sampling method followed in order to select the sample was proportionate stratified sampling by region and by size of pig farm [5 15]. Thus, the sample included 71 pig farms, a number representing 19.7% of the total number of pig farms in the selected regions, as well as 7.5% of the total number of pig farms in the country.

The classification of the pig farms into similar spatial units-clusters was based on the following zootechnical parameters:

- Mean estrus of the sows. A low return rate is linked to infectious causes, poor stabling and living conditions for the animals, the poor quality of animal feed, which all lead to a reduced breeding productivity [13,33].

- Mean pig slaughter age. The slaughter age of the pigs is linked to the speed of circulation of the livestock, to achieving a high performance with the productive animals, and to the sufficiency and adequacy of the stabling facilities. Generally speaking, the slaughter of pigs with a high live weight (110-120 kg) within a short period, results in an improvement to the economicity of the farms [9,33].

-Sow replacement rate. Maintaining a high performance by the sows depends on whether there is continuous, high-level management of the animals. The performance of the sows can be increased through a rational exploitation of the genetic material and the implementation of an appropriate programme for its genetic improvement and renewal [10].

-Weaning age (in days).

It is a fact that the performance of the pigs is ensured by the reproductive performance of the reproductive animals and the productive performance of the developing pigs [29]. The reproductive performance is mainly related to the productivity of the sow (age at puberty, no of births, litter size at weaning, duration of productive circle, etc.). The productive performance has to do with the fattening capacity of the animals (rate of development, food conversion) and the carcass quality. The selected zootechnical parameters are defining factors both of reproductive performance and productive performance [33].

In order to develop the typology of the pig farms based on the above-mentioned zootechnical parameters, Hierarchical Cluster Analysis was applied. The formulation of the clusters was carried out based on

the Ward criterion, while the square of the Euclidean distance was used to measure the (dis)similarity of the farms[16 30]. The analysis was carried out using the statistical package SPSS ver. 11.5. Before entering the analysis, the variables were transformed into z-scores. The constancy of the results, in relation with the order of entry of the pig farms into the analysis was checked using the software PermuCLUSTER ver.1.0 [32].

Following this, an analysis was carried out of the second level profile of the pig farm clusters, taking into account additional qualitative, financial and technical parameters. In order to examine the second level profile, qualitative, financial and developmental parameters of the pig farms were selected. These parameters constitute contributing factors to the restructuring of the pig farms and the improvement of their competitiveness [28].

These Parameters Are the Following:

a) The geographical location of the farms. More specifically, the farms were grouped according to whether they were installed in the northern or southern geographical part of Greece.

b) The size of the farms. The pig farms were divided according to the size of the farms (M), into three categories [33,12].

- M_1 category. It includes low-capacity farms, with 20 to 199 sows. These are family-run farms that only own the basic equipment required for the farm's operation.

- M_2 category. It includes medium-capacity farms, with 200 to 399 sows. They possess integrated feed mix production systems, with various levels of automation. They present a high rate of modernization and are focused on new trends in pig farming.

- M_3 category. It includes high-capacity farms, with 400 sows or more. These are industrial-type units, with a high rate of verticalization. They also operate integrated systems for the collection, processing and disposal of waste, laboratories, cured meat departments, packaging plants and slaughterhouses.

c) The basic financial results of the pig farms. In order to achieve the aims of the study, we selected gross revenue, agricultural family income, return on capital and annual livestock expenses. These parameters were chosen because they are some of the most widely-used forms of economic output used in modern agricultural economic analysis, and knowledge of these parameters can interpret the "performance" of the farms [11,21].

d) The existence of integrated systems for the automated supply of animal feed.

RESULTS AND DISCUSSION

The Hierarchical Cluster Analysis highlighted five clusters of farms. The first cluster (C_1) consists of 16 pig farms (22.5%), the second (C_2) includes 17 farms (23.9%), the third (C_3) 15 farms (21.1%), the fourth (C_4) 17 farms (23.9%) and the fifth (C_5) 6 farms (8.4%). An analysis of the first level profile of the clusters, based on the defined parameters, is presented in Table 1.

Based on the determination coefficient R^2 (Table 1), the relative importance of the variables used to form the clusters is, in descending order, as follows: sow replacement rate (in %), weaning age (in days), pig slaughter age (in days), estrus of the sows (in %). A study of Table 1 points to the fact that the farms in the first cluster have the highest sow return rate, the longest weaning age for the piglets, and the longest pig slaughter age.

Furthermore, the farms in this cluster present a low replacement and renewal rate of their genetic material. As can be seen, the first cluster is characterized by pig farms that face reproduction and fertility problems, as well as problems related with the management of their genetic material [13].

Furthermore, the long period required for the weaning of the piglets creates major problems with the circulation of the animals, and extends the overall fattening time; these farms are also characterized by livestock of a low value [13,22]. The farms in the second cluster present relatively high values in the above-mentioned zootechnical parameters. They are pig farms that face similar zootechnical management problems with the farms in the first cluster.

The farms in the third cluster have a relatively low sow return rate and slaughter time, and on the other hand have a high replacement rate of their genetic material and a relatively long weaning age for piglets. These farms achieve a good exploitation of their genetic material, with major improvements to the fattening period for the piglets and the circulation of the animals [33].

The farms in the fourth cluster present the lowest return rate, weaning period and slaughter time values, and the highest sow replacement rate. The fifth clusters is characterized by pig farms with a low return rate, short slaughter time and weaning period and achieve the highest replacement rate. It is evident that the farms in the fourth and fifth clusters present the best productivity, based on the selected parameters.

As a next step, a study was carried out of the second-level profile of the five clusters, based on the selected qualitative, financial and technical parameters. In Table 2 is presented the Second Level profile of the

Table 1: Zootechnical characteristics of the pig farms in the clusters

Clusters of pig farms	Mean estrus of the sows (%)	Mean pig slaughter age (in days) (at 100-150 kg)	Sow replacement rate (%)	Weaning age (in days)
1st cluster (C_1):				
Mean	12,1[a]	166,4[a]	26,3[b]	33,4[a]
Standard deviation	2.3	15.2	3.9	2.7
No of farms	16	16	16	16
2nd cluster (C_2):				
Mean	8,5[b]	160.9[b]	25,9[b]	30,1[b]
Standard deviation	2,8	14.6	2.8	3.8
No of farms	17	17	17	17
3rd cluster (C_3):				
Mean	6,8[c]	154,9[c]	32,2[a]	29,1[b]
Standard deviation	2,6	15,7	3,9	2,1
No of farms	15	15	15	15
4th cluster (C_4):				
Mean	4,8[d]	146,7 [d]	33,1[a]	25,9 [c]
Standard deviation	1,7	12,6	4,5	1,8
No of farms	17	17	17	17
5th cluster (C_5)				
Mean	5,2 [c d]	151,6 [c]	33,2 [a]	24,5 [c]
Standard deviation	2,1	13,9	2,1	1,5
No of farms	6	6	6	6
R^2	0,509	0,636	0,775	0,743

*Means that are located in the same column and are followed by different letters, differ significantly, at a significance level α=0.05, according to the results of the Tukey HSD test (Toothacker, 1993).

Table 2: Second Level Profile of Cluster C_1

Socio-economic Factors		No of farms	(%)
Geographical area			
	North	10	62.5
	South	6	37.5
Size of farms			
	M_1: 20-199 sows	15	93.8
	M_2: 200-399 sows	1	6.3
	M_3: ≥ 400 sows	0	0
Financial results			Tests
	Gross revenue	1820.13[e] ± 116.4	Tukey
	Agricultural family income	429.7[ab]±332	Dunnett's
	Annual livestock expenses	62.09 [e] ±33.7	Tukey
	Return on capital	1.52[d]±0.47	Tukey
Automated supply of animal feed			
	Yes	5	31.2
	No	11	68.8

*Means that are located in the same column and are followed by different letters, differ significantly, at a significance level α=0.05, according to the results of the Tukey HSD and Dunnett's test (Toothacker, 1993).

first cluster (C_1). The pig farms in the first cluster (C_1) are mainly located in the northern geographical part of the country, and are small, family businesses, that only have the absolutely necessary equipment for their operation. These farms achieve a low gross revenue and return on capital, and their annual livestock expenses are also low. On the contrary, their agricultural family income is high, a fact that points indicates towards a high efficiency of return rate from the same production coefficients and a low dependency of these farms by other factors[11,21,22]. These farms seem to face problems regarding reproduction and fertility issues, as well as problems with the management of their genetic material. In addition, the long period required for the weaning of the piglets leads to major problems related to the circulation of the animals and extends their total fattening period. Finally, the farms in question are characterized by livestock of a low value.

Table 3 presents the Second Level profile of the second cluster (C_2). This table shows that the farms in the second cluster (C_2) present similar zootechnical management problems with the farms in the first cluster. They are primarily located in the northern geographical part of the country and are mainly small, family-run businesses. The majority of these farms do not have automated feeding systems, and their genetic material is of a low value. Nevertheless, they present a high productivity and return rate from the same production coefficients, while there is a small dependence of these farms on other coefficients (loan capital). We do not observe a satisfactory exploitation of the invested capital in the farms of this cluster.

Table 4 shows that the pig farms in the third cluster (C_3) are mainly located in the northern geographical part of the country. They are small and medium-sized, and they show a tendency to modernize their structures.

These farms achieve a good exploitation of their genetic material, with major improvements to the fattening time for their piglets and the circulation of the animals. Nevertheless, the low-value genetic material (low annual livestock expenses) leads to reduced productivity [11,20,21,22,28]. In addition, the agricultural family income achieved and return on capital are very low, a fact that is related to the high investments they make, with the support of loan capital [1,2].

Table 5 is consisted the profile of the fourth cluster (C_4). A study of this table shows that cluster C_4 consists of pig farms of a medium and large size, with a high degree of verticalization. They present a high rate of modernization, with animals of a high genetic value (high annual livestock expenses), thus resulting in a high level of productivity [23]. The return on capital is high, but there is also extensive use of other production coefficients (low agricultural family income).

Table 6 presents the profile of the fifth cluster (C_5). The pig farms in this cluster are mainly located in the southern geographical part of Greece. The majority of them are large-sized farms, with modern facilities and equipment. The farms in this cluster have livestock with a high genetic value, which leads to increased productivity. These farms achieve the best exploitation of the factor “capital”.

As it appears from the Cluster analysis the farms of a medium and high capacity achieve the best zootechnical management. These farms (clusters C_4 and C_5) also achieve the best values as regards the selected financial parameters. This is due to the development of economies of scale in conjunction with the size of the farms. The improvement of the zootechnical parameters of the farms is directly linked to a high replacement rate of the reproductive material and also high annual livestock expenses, combined with the existence of animals of a high genetic value.

In the high-capacity pig farms, we observe the shortest weaning period for the pigs, a result directly linked to the increased market demand for pork, and to sound zootechnical management. In the large-sized farms, the optimum zootechnical profile assists in the exploitation of the invested capital. These farms (cluster C_5) achieve the highest return on capital and therefore present a high capacity for funding with foreign capital, with a significant safety margin in their management. More specifically, from a comparison of the return on capital at the pig farms in the five clusters, with the current bank loan interest rate (5.5%), [4], it seems that only the large and medium farms (C_3, C_4, C_5) are in a position to negotiate loans in order to improve their structures. On the contrary, the small farms (C_1, C_2), present a weakness in covering their loan obligations. These farms need to improve their zootechnical profile, which means that their inclusion in funding programmes for the improvement of their genetic material is essential.

Conclusions: The results of the present work show that after the application of the Cluster Analysis method on a sample of pig farms, various types of pig farms emerged, with particular technical and financial characteristics, based on which proposals can be formulated for the restructuring of Greek pig-farming and the strengthening of its competitiveness. From a study of the effect of the zootechnical parameters on the formulation of the financial profile of the farms, it is possible to arrive at a typology, based on which relevant Rural Policy measures can be determined.

Table 3: Second Level Profile of Cluster C_2

Socio-economic Factors		No of farms	(%)
Geographical area			
	North	11	64.7
	South	6	35.3
Size of farms			
	M_1: 20-199 sows	13	75.5
	M_2: 200-399 sows	4	23.5
	M_3: ≥ 400 sows	0	0
Financial results			
	Gross revenue	1854.13^{b}±110	Tukey
	Agricultural family income	440.7^{a}±342	Dunnett's T3
	Annual livestock expenses	76.18^{d} ±34.8	Tukey
	Return on capital	2.35^{d} ±1.59	Tukey
Automated supply of animal feed	Yes	8	47
	No	9	53

* Means that are located in the same column and are followed by different letters, differ statistically significantly, at a significance level α=0.05, according to the results of the Tukey HSD and Dunnett's test (Toothacker, 1993).

Table 4: Second Level Profile of Cluster C_3

Socio-economic Factors		No of farms	(%)
Geographical area			
	North	9	60
	South	6	40
Size of farms			
	M_1: 20-199 sows	6	40
	M_2: 200-399 sows	6	40
	M_3: ≥ 400 sows	3	20
Financial results			
	Gross revenue	1920^{c} ±94.7	Tukey
	Agricultural family income	323^{d} ±145	Dunnett's T3
	Annual livestock expenses	96.34^{c} ±30.9	Tukey
	Return on capital	7.32^{c} ±2.1	Tukey
Automated supply of animal feed	Yes	10	66.7
	No	5	33.3

*Means that are located in the same column and are followed by different letters, differ significantly, at a significance level α=0.05, according to the results of the Tukey HSD and Dunnett's test (Toothacker, 1993).

The proposed policy measures that aim at the restructuring of Greek pig farming and the improvement of its competitiveness, based on the results of the typology, are the following:

Financial support for the transfer and modernization of the pig farms, with the aim of improving their facilities and mechanological equipment. The installation of automated supply systems for animal feed is expected to improve the quality of the animal feed, lead to reduced feed costs, and improve labour efficiency and animal management. Concerning the use of the genetic material, it is considered essential for pig farms to use a proper system for the renewal of their existing genetic material, or to commercially cross-breed their material with the appropriate pig breeds, in order to achieve better financial results. The planning and financing of an efficient project in Greece for the genetic improvement of pigs using appropriate genetic material, with the right focus in each case, and in correlation with the local production and trade conditions for this product, will decisively contribute to satisfying the requirements of producers as regards the timely and economical provision of suitable animals for reproduction. It is a fact that in Greece, the relevant organizational structures are lacking and consequently no integrated programmes operate for the genetic improvement of pigs; as a result, producers face serious problems in obtaining the necessary animals for reproduction, particularly gilts, at reasonable prices.

Table 5: Second Level Profile of Cluster C_4

Socio-economic Factors		No of farms	(%)
Geographical area			
	North	8	47
	South	9	53
Size of farms			
	M_1: 20-199 sows	2	11,8
	M_2: 200-399 sows	9	52,9
	M_3: ≥ 400 sows	6	35,3
Financial results			
	Gross revenue	1989 [b] ±97.3	Tukey
	Agricultural family income	410 [c] ±183	Dunnett's T3
	Annual livestock expenses	107.64 [b] ±37.02	Tukey
	Return on capital	10.68 [b] ±2.32	Tukey
Automated supply of animal feed	Yes	17	100
	No	0	0

*Means that are located in the same column and are followed by different letters, differ significantly, at a significance level α=0.05, according to the results of the Tukey HSD and Dunnett's test (Toothacker, 1993).

Table 6: Second Level Profile of Cluster C_5

Socio-economic Factors		No of farms	(%)
Geographical area			
	North	2	33.4
	South	4	66.6
Size of farms			
	M_1: 20-199 sows	0	0
	M_2: 200-399 sows	2	33.3
	M_3: ≥ 400 sows	4	66.7
Financial results			
	Gross revenue	2024 [a] ±95.8	Tukey
	Agricultural family income	424 [b] ±185.8	Dunnett's T3
	Annual livestock expenses	126.48 [a] ±31.4	Tukey
	Return on capital	12.71 [a] ±2.47	Tukey
Automated supply of animal feed	Yes	6	100
	No	0	0

*Means that are located in the same column and are followed by different letters, differ significantly, at a significance level α=0.05, according to the results of the Tukey HSD and Dunnett's test (Toothacker, 1993).

REFERENCES

1. Aggelopoulos, S., 2004. Feeding and Production Systems in Greek Pig-Farming and their relation to economics, competitiveness and the viability of the sector. Ph.D., Aristotle University of Thessaloniki, Faculty of Geotechnical Sciences, Department of Agriculture, (in Greek).
2. Aggelopoulos, S., V. Samathrakis, K. Galanopoulos, A. Pavloudi, 2006. Typology of pig farm activities in Greece. Review of Economic Sciences (in press).
3. Aggelopoulos, S., 2007. Financing agricultural investments: The programme "rural development and restructuring of the countryside 2000-2006. Journal of Greek Business Administration Academy, 4: 49-58.
4. Agricultural Bank of Greece, 2004. Economic report 2002-04, Athens (in Greek).
5. Apostolopoulos, C., H. Theodoropoulou, G. Petrakos, G. Theodoropoulos, 2001. Factors Affecting the Regional Pig Meat Productivity of Commercial Pig Units in Greece. Agricultural Economics Review, 2: 39-46.

6. Arabatzis, G., C. Batzios, V. Samathrakis, T. Koutroumanidis, 2005. Typology of Animal Breeding Activities in the Thessaloniki Prefecture. Geotechnical Scientific, 16: 12-19.
7. Batzios, Chr., 2001. Animal Production Economy. Sychroni Paideia Publications, Thessaloniki.
8. Coakes, S. and L. Steed, 1999. SPSS Analysis without Anguish, Singapore: John Willey and Sons, Inc. Kinnear, T. and Taylor, J., 1996. Marketing Research An Applied Approach, 5th Edition, McGraw-Hill, INC., USA.
9. Close, W.H. and J.E. Pettigrew, 1990. Mathematical models of sow reproduction. Journal of Reproduction and Fertility, 40: 83-88.
10. Close, W.H., 1998. Energy levels to fuel reproduction. Pig international, 28: 4-25.
11. Doll, J. and F. Oragen, 1984. Production Economic. New York: John Wiley and Sons.
12. Dotas, D., 1995. Pig farming. University lectures, School of Agriculture, AUTh.
13. English, P., V. Fowler, S. Baxter, B. Smith, 1988. "The growing and finishing Pig", Farming Press, U.K.
14. Galanopoulos, K., 1998. Financial study of pork production: long-term balamce of production and trade in Greece. Zootechnical Science Review, 25: 19-28
15. Galanopoulos, K., S. Aggelopoulos, I. Kamenidou and K. Mattas, 2006. Assessing the effects of managerial and production practices on the efficiency of commercial pig farming. Agriculture Systems, 88: 125-141 (in Greece).
16. Hair, J., R. Anderson, R. Tatham and W. Black, 1995. Multivariate Data Analysis with Readings. 4th Edition, Prentice-Hall International, INC., USA.
17. Karanikolas, P., 1999. Homogeneity and Heterogeneity in Rural Space. In Critical Approaches to the Development and Protection of the Rural Environment. Edited by L. Louloudis and N. Beopoulos. Stochastis Publications, Agricultural University of Athens, pp: 59-75 (in Greece).
18. Karanikolas, P. and N. Martinos, 1999. Spatial Differentiation of Greek Agriculture Towards 2010. Papazissis Publications, Agricultural University of Athens, pp: 245-307 (in Greece).
19. Kinnear, T. and J. Taylor, 1996. Marketing Research An Applied Approach. 5th Edition, McGraw-Hill, INC., USA.
20. Kitsopanidis, G., 1999. The sustainability and competitiveness of modern pig farms. Animal Breeding Symposium entitled: Greek pig farming-A technical-economic approach. Journal of Zootechnical Science, pp: 33-51.
21. Kitsopanidis, G. and C. Kamenidis, 2003. Rural Economy. Zitis publications, 3rd edition, Thessaloniki.
22. Kitsopanidis, G., 2006. Economics of Animal Production. Principles, Applications, Technical Economic Analysis. Ziti Publications, Thessaloniki (in Greece).
23. Matsoukas, I., 1989. Improvement objective and form for Greek pig farming. Zootechnical Science Review. Special Edition, 60: 178-219.(in Greece).
24. Ministry of Rural development and food, 2003. Evaluation of the technical infrastructure and livestock.
25. Ministry of Rural development and food, 2005. D/ate of Rural Policy, Support Measures for pig farming.
26. Ministry of Rural development and food, 2006. Report on pig farming.
27. Panagiotou, A., 1986. Productive structures and Production Systems: A Methodological Approach on the Creation of Agricultural Development Units. Proceedings of A.T.E. International Conference: Economy and the Rural Sector, (A): 326-339 (in Greece).
28. Ridgeon, R.F., 1992. Pig Management Scheme Results 1991. Agricultural Economics Unit, University of Cambridge, January 1992, England.
29. Schukken, Yh., J. Burman, R. Huirne, Ah. Willemse and J. Vernooy, 1994. Evaluation of optimal age at first conception in gilts from data collected in commercial swine herds. Journal of Animal Science, 72: 1387-1392.
30. Sharma, S., 1996. Applied Multivariate Techniques. New York: John Willey and Sons, Inc.
31. Toothacker, L., 1993. Multiple comparisons procedures. Thousand Oaks, CA: Sage Publications.
32. Van der Kloot, W., S. Bouwmeester and W. Heiser, 2003. Cluster instability as a result of data input order. In H. Yanai, A. Okada, K. Shigemasu, Y. Kano, & J. Meulman (Eds.), New developments in psychometrics: Proceedings of the international meeting of the psychometric society IMPS2001 pp: 569-576. Tokyo: Springer.
33. Whittemore, C., 1993. The science and practice of pig production. Longman Group, UK.