Quantitative methods to determine factors affecting profits of lamb fattening enterprises

Y. Cevger

Department of Livestock Economics, Faculty of Veterinary Sciences, Ankara University, Diskapi Ankara, Turkey

ABSTRACT: The purpose of this study was to demonstrate the use of profit function regression model as a possible practical decision support tool in the lamb meat production. It was found that all independents variables except "Fattening Duration", "Capacity Use", "Total Other Expenditures" and "Number of Lambs", had strong statistical associations ($P < 0.01$) with the profit from per kg live-weight. Because marginal impact of each independent variable on the profit was the estimated co-efficient value, they could simply be used to evaluate "what-if scenarios" and the risk of investment under changing circumstances in lamb meat production. It is, therefore, intended that lamb meat producers could use such modelling approach as a practical decision support tool.

Keywords: meat production; profitability; regression function; decision support tool; what-if scenarios

Majority of the meat produced in Turkey is obtained from the beef cattle, lamb, sheep and goat. The lamb fattening enterprises, which have a significant place in meat production, form a component of the mainly small-scaled enterprises that perform activities with traditional production methods in Turkey and that mostly have a poly-cultural structure (that perform vegetal and animal production cooperatively) (Cevger, 1997).

Besides the production's being traditional in lamb fattening enterprises, other enterprise functions such as input provision and marketing are not performed with a conscious enterprise understanding.

The enterprises face a market where usually the animal merchants form a purchasing monopoly in the livestock marketing. Therefore, these enterprises don't have sufficient bargaining power on price formation (Aral, 1988; Sakarya, 1990a).

The success to be achieved in the enterprise significantly depends on control of the costs. It is important to know the individual (marginal) effects of each of the factors affecting the enterprise profit while taking decisions concerning the future in order to increase the profitability.

Usually accounting calculations are used in the studies researching the enterprise profitability in Turkey. The accounting calculations offer valuable information in the assessment of the activity performed from the financial aspect, however, it isn't quite practical in usage as a support medium in the inspection of different scenarios for the future plans.

Econometric modelling techniques are used as a planning and decision-supporting tool in livestock enterprises in the world (Heady and Dillon, 1961). Heady *et al*. (1961) have used quadratic, square root and Cobb-Douglas type production function models with the aim of determining the marginal effects of maize and soybean on the live-weight costs of broilers. In Turkey, Sakarya (1990b) has inspected the return to scale with the productivity analysis of the broiler enterprises by estimating Cobb-Douglas type product function in Ankara-Kazan province broiler enterprises.

Information of situations regarding the profitability conditions of the enterprises in econometric studies, in which Cobb-Douglas type production function estimated for livestock enterprises in Turkey is used, are evaluated within the framework of the results obtained from the profitability ratios, not directly with the profit function estimates (Sakarya, 1990b; Cevger, 1997; Gunlu and Sakarya, 2001). Profit function is used with the aim

of selection in dairy (Andrus and McGillard, 1974; Gill and Allaire, 1976; Stott and Delorenzo, 1988; Van Arendonk, 1991; Dartt *et al*., 1999), commercial layer and breeding layer enterprises (Heady *et al*., 1961; Dekkers *et al*., 1995; Pribylova *et al*., 1996). It seems possible to use this functional approach as a decision support tool in lamb fattening of which production process is rather shorter.

From this point of view, this research is aimed at using profit function model to estimate factors affecting profits in the lamb meat production, and exploring its possible use as a practical decision support tool in the field by producers.

MATERIAL AND METHODS

Material

Data of three years belonging to 41 lamb fattening enterprises that make activities in Karaman province and its districts form the material of the research. The data in question include the production activities performed in 1993, 1994 and 1995 and they have been obtained by interview survey.

Methods

Information has been obtained regarding the production factors, prices and quantities used in the production process in the lamb fattening enterprises and regarding the quality, quantity and prices of the lambs sold and also regarding the socio-economic structures of the enterprises.

The data obtained through interview survey were manuplated using Microsoft Excel 2000 (2000) software to create input data for the regression analysis.

Forming regression equation

Multiple regression method were used with the aim of estimating the direction and magnitudes of the relation between the profit per kg live-weight (Y) and the variables that are considered to have effect on the profit. The initial regression equation was:

$$Y = f(X_1, X_2, X_3, \mathrm{Dev}X_4, \mathrm{Dev}X_4^2, X_5, X_6, X_7, X_8, X_9, X_{10}, X_{11})$$

where: Y = profit (TL/kg LW = Turkish Lira/kg Live-Weight)

X_1 = live lamb purchase price (TL/kg LW)

X_2 = live lamb selling price (TL/kg LW)

X_3 = daily average live-weight gain per lamb (g)

$\mathrm{Dev}X_4$ = deviation form the mean of fattening duration (day)

$(\mathrm{Dev}X_4)^2$ = quadratic form of $\mathrm{Dev}X_4$

X_5 = capacity use (%)

X_6 = labour cost (TL/kg LW)

X_7 = total other expenditures (veterinary service + maintenance and repair + depreciation + other) (TL/kg LW)

X_8 = average live-weight at the beginning of fattening period (kg/head)

X_9 = amount of concentrated feed as dry material per live-weight (kg)

X_{10} = concentrated feed price (TL/kg)

X_{11} = number of lambs at the beginning of fattening period (head)

Procedure followed in regression analysis

The relation between dependent variable (Y) and each independent variable was inspected by examining the scatter graphics. It was observed that Y and X_i relation, except X_4, also seen in the regression equation above was linear or nearly linear, however, the relation between dependent variable and X_4 was not linear. For this reason, the linear form of X_4 was also included in $(X_4)^2$ equation.

It was observed that there was a quite high (between 80–95%) correlation between the independent variables that were expressed in TL (Turkish Lira) due to the effect of inflation. In order to avoid the multi-correlation problem that arise in the regression estimations as a natural result of this, all data were adjusted with the monthly Wholesale Price Index (WPI) and the hypothesis of "non-existence of high correlation between independent variables" of the Least Squares Method was fullfilled (Andrus and McGillard, 1974).

Since quadratic form of X_4 (X_4^2), is obtained from the multiplication of variable with itself, normally a very high correlation has occurred between the two terms. ($\mathrm{Dev}X_4$) term was, therefore, formed by subtracting all values of X_4 from its average value and then this term was squared $(\mathrm{Dev}X_4)^2$ in order to avoid the multiple correlation problem resulting

from the high correlation between the two terms of X_4. By this way, the correlation between these two terms was reduced to 58.6 percent.

Regression equation was estimated by using Stepwise Regression Analysis Procedure in the SPSS for Windows 7.5 statistic software (1996). In the stepwise procedure, independent variables are included in the equation respectively starting from a variable having the highest correlation with a dependent variable and the ones that are deemed to be statistically insignificant at $P < 0.05$ are automatically dropped from the equation. Thus, the best model explaining the dependent variable can be without a need of trial and error of several models.

RESULTS

The model results estimated with stepwise regression method and the relevant statistical tests are presented in Table 1. The R^2 of the model was 93% (column 5) which means that the independent variables included in the model explains 93% of the variation occurring in the profit per kg LW in the lamb fattening enterprises in Karaman province.

The Beta values (β) in the table are the coefficient estimates of the equation and they indicate how much TL change shall realize in the dependent variable (profit per kg LW) against a 1 unit change in each X_i.

As seen from Table 1, DevX_4, (DevX_4)^2, X_5, X_7 and X_{11}, were found to be statistically insignificant at P < 0.05, and discarded from the model. The estimated equation was as follows:

$$Y = 39463.539 - 4966.606X_9 - 925.391X_8 + 69.286X_3 - \\ - 2.726X_{10} - 1.42X_6 + 0.960X_2 - 0.787X_1$$

As can be seen from Table 1, the sign of the relationships between the dependent variable and all independent variables were found as expected.

According to the regression findings, the increase of 1 kg occurring in the amount of concentrated feed as dry material type consumed per live-weight (X_9) causes a decrease of about 4 677 TL in the profit ob-

Table 1. Estimated regression model of the profit from per kg LW[a] (TL)[b] on several factors affecting profitability in the lamb meat production[c]

Column No.	Beta (β)	Standard error	t	Sig. t	Adj. R^2	Durbin-Watson	F	Sig. F
	1	2	3	4	5	6	7	8
(Constant)	39 463.539	10 378.441	3.802	0.000	0.934	2.234	208.475	0.000
Concentrated feed as dry material per Lw(kg) (X_9)	–4 966.606	1 134.378	–4.378	0.000				
Average initial LW (kg/head) (X_8)	–925.391	151.917	–6.091	0.000				
Daily average LW gain per lamb (g) (X_3)	69.286	12.030	5.759	0.000				
Concentrated feed price (TL/kg) (X_{10})	–2.726	0.933	–2.922	0.004				
Labour cost (TL/kg LW) (X_6)	–1.420	0.229	–6.201	0.000				
Live lamb selling price (TL/kg LW) (X_2)	0.960	0.037	25.709	0.000				
Live lamb purchase price (TL/kg LW) (X_1)	–0.787	0.067	–11.723	0.000				

[a] LW = Live Weight, [b]TL = Turkish Lira, [c]$P < 0.01$

tained per kg live-weight. While the increase of 1 kg to be occurred in the initial live-weight (X_8) causes a decrease of 925.4 TL in Y, the increase of 1 unit in the daily average live-weight gain (X_3) makes the profit increase by 69.3 TL. Besides these highly effective variables, the variables such as concentrated feed price (X_{10}), labour cost (X_6) and lamb purchase price (X_1) had a negative (–) correlation and lamb selling price (X_2) had a positive (+) correlation with the dependent variable.

DISCUSSION

Reliability of model estimates

The reliability of the regression estimates may be undermined by a violation of the assumptions when using regression analysis.

An existence of any violation (abnormally distributed independent variable, autocorrelation, heteroscedasticity and multicollinearity) of the assumptions made in the least square estimation were tested by looking at the histogram of the dependent variable (Figure 1), the Durbin-Watson test (column 6 of Table 1), correlation table (Table2) and the standardised residual plot (Figure 2), and no serious violation of the assumptions was encountered.

Evaluations of the model findings

The findings of this study could not be compared with the literature as similar previous studies applied profit equation to lamb meat production was not encountered from our literature survey. However, the model estimates were quite compatible with the field observations.

Similar to that observed in the field, the model estimates indicate that the most important factors effecting profit per kg LW is the amount of feed (X_9). This indicates how important the use of good quality feed is in a profitable production. Besides the natural importance of feed in livestock, the fact that the concentrated feed prices in Turkey increase faster than the lamb prices, and the feed prices are too expensive to earn adequate profit for the farmers, demonstrate the power of the feed on the profit.

It was determined that the factors having the second and third highest effect were the initial live-weight (X_8) and the daily average live-weight gain per lamb (X_3), respectively. The effect of X_8

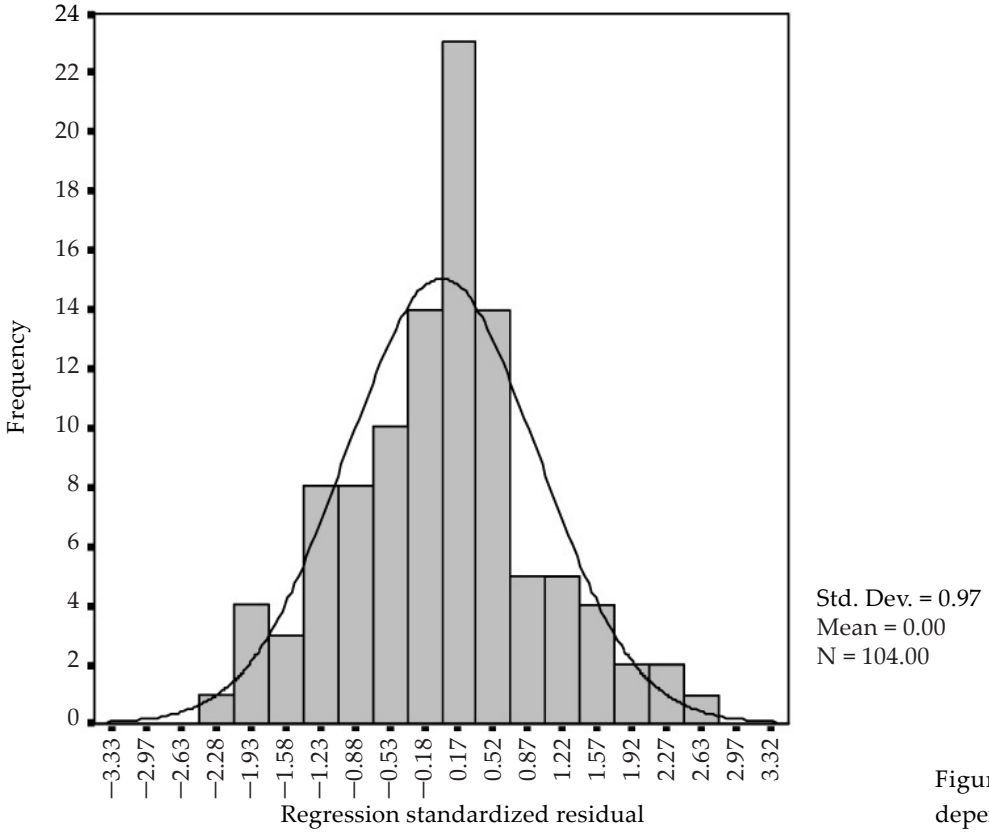

Figure 1. Histogram of the dependent variable (Y)

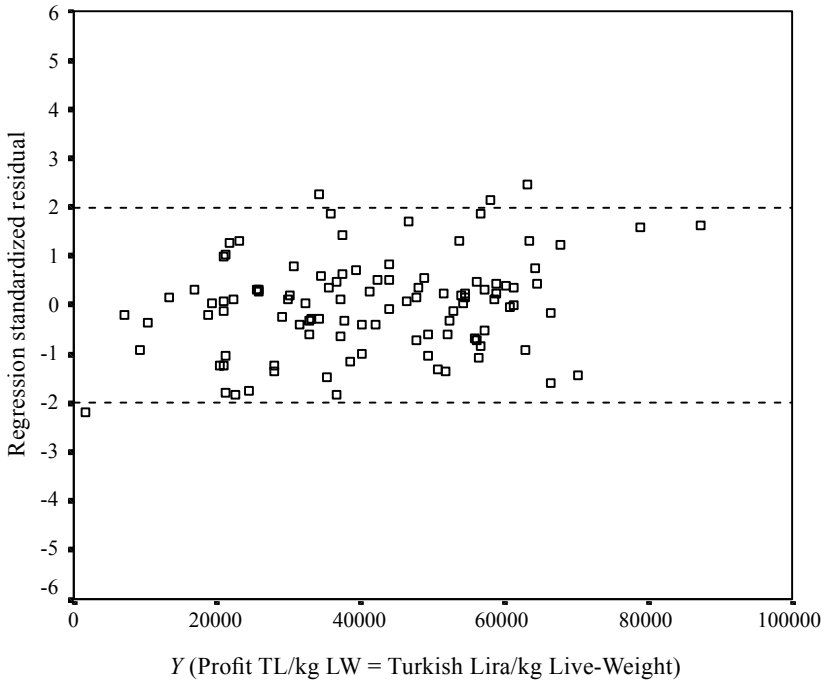

Figure 2. Relation between the dependent variable (*Y*) and the standardized errors

Table 2. Correlation matrix of all variables used in the regression analysis[a]

Variables[b]	Y	X_1	X_2	X_3	DevX_4	(DevX_4)^2	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}
Y	1												
X_1	–0.33	1											
X_2	0.82	–0.03	1										
X_3	0.12	0.28	–0.12	1									
DevX_4	0.23	–0.66	0.17	–0.48	1								
(DevX_4)^2	–0.09	–0.26	–0.03	–0.37	0.59	1							
X_5	0.27	–0.09	0.14	0.05	0.00	–0.46	1						
X_6	–0.51	–0.23	–0.37	–0.35	0.21	0.24	–0.41	1					
X_7	–0.20	–0.14	–0.08	–0.43	0.30	0.01	–0.01	0.31	1				
X_8	–0.21	0.17	0.13	–0.38	–0.13	0.13	–0.11	0.07	0.04	1			
X_9	0.29	–0.39	0.28	–0.11	0.66	0.44	–0.07	0.11	–0.06	–0.30	1		
X_{10}	–0.39	0.54	–0.19	0.20	–0.57	–0.36	–0.01	0.01	0.12	0.23	–0.52	1	
X_{11}	0.25	-0.20	0.09	0.05	0.26	-0.04	0.51	-0.43	-0.16	-0.09	0.07	-0.10	1

[a]$P < 0.01$

[b]Y = profit (TL/kg LW = Turkish Lira/kg Live-Weight); X_1 = live lamb purchase price (TL/kg LW); X_2 = live lamb selling price (TL/kg LW); X_3 = daily average live-weight gain per lamb (g); DevX_4 = deviation form the mean of fattening duration (day); (DevX_4)^2 = quadratic form of DevX_4; X_5 = capacity use (%); X_6 = labour cost (TL/kg LW); X_7 = total other expenditures (veterinary service + maintenance and repair + depreciation + other) (TL/kg LW); X_8 = average live-weight at the beginning of fattening period (kg/head); X_9 = amount of concentrated feed as dry material per live-weight (kg); X_{10} = concentrated feed price (TL/kg); X_{11} = number of lambs at the beginning of fattening period (head)

being negative and the effect of X_3 being positive indicates that it is required to choose younger animals, or not young but healthy animals which were insufficiently fed as the fattening material. As a matter of fact, as it can be seen from the researches (Muftuoglu *et al*., 1980; Yanar *et al*., 1990) the economic performance of the animals taken into fattening in early ages are higher than those taken into fattening in the older ages.

The effect of capacity use (X_5) on Y was found insignificant at $P < 0.05$. In the minimization of the fixed expenses per unit in the enterprises, the capacity use is very important. The more the actual capacity approaches to the theoretical capacity, the lower the share of the fixed cost per unit in the total unit cost shall be. This shall help the enterprise reach its minimum cost target. However, almost whole of the enterprises inspected in this research had traditional type buildings and primitive equipment. Enterprise assets such as building and equipment that have a significant place in the fixed assets have a very low value in the total enterprise assets in these enterprises. Therefore, fixed costs such as depreciation, maintenance, repair and rent had a very low share in the total costs. For this reason, the effect of more efficient usage of the fixed assets in these enterprises does not seem to have a significant impact on the profit. This situation may be considered as the reason for the statistically insignificant effect of capacity use on Y.

However the findings that the effect of "Total Other Expenditures" formed from the total of the expenditure elements including veterinary service, depreciation, maintenance, repair, rent (X_7) and initial fattening lamb number (X_{11}) variables on profit per unit LW (Y) were insignificant at $P < 0.05$ support the above mentioned argument on X_5.

It's noted that the estimates obtained from the research are the average value of all enterprises included in the research. It is, however, possible to establish similar models not only for different production scales (small, medium, large), different production seasons (winter, spring, summer, autumn) and different regions, but also for each individual enterprise using their time series data of several previous years.

Whilst some significant cost and performance parameters can be used to determine the expected results while making the enterprise planning by using the model results, it is also possible to evaluate the effect of the anticipated risk and uncertainty in the production process on the enterprise profitability.

REFERENCES

Andrus D.F., McGillard L.D. (1974): Selection of dairy cattle for overall excellence. J. Dairy Sci., *58*, 1876–1879.

Aral S. (1988): Fattened beasts and meat marketing in our country (in Turkish). J. Turkish Vet. Med. Assoc., *58*, 48–61.

Cevger Y. (1997): Analysis of profitability and productivity of lamb fattening enterprises in Karaman province (in Turkish with English abstract). Vet. J. Ankara Univ., *44*, 277–290.

Dartt B.A., Lloyd J.W., Radke B.R., Black J.R., Kanee J.B. (1999): A comparison of profitability and economic efficiencies between management intensive grazing and conventionally managed dairies in Michigan. J. Dairy Sci., *82*, 2412–2420.

Dekkers J.C.M., Birke P.V., Gibson J.P. (1995): Optimum linear selection indexes for multiple generation objectives with nonlinear profit functions. J. Anim. Sci. *61*, 165–175.

Gill G.S., Allaire F.R. (1976): Relationship of age at first calving, days open, days dry and herdlife to a profit function for dairy cattle. J. Dairy Sci., *59*, 1131–1139.

Gunlu A., Sakarya E. (2001): The analysis of profitability and productivity of dairy cattle enterprises in Konya province and their production and marketing problems (in Turkish with English abstract). J. Vet. Sci., *17*, 97–105.

Heady E.O., Balloun S., McAlexander R. (1961): Production functions, least-cost rations and optimum marketing weight for broilers. In: Heady O.E., Dillon J.L. (eds.): Agricultural Production Functions. Iowa State University Press. Iowa. 330–374.

Heady O.E., Dillon J.L. (1961): Agricultural Production Functions. Iowa State University Press, Iowa.

Microsoft Excel 2000 (2000): Microsoft Corporation.

Muftuoglu S., Escan C., Topak C. (1980): Determining of optimum slaughtering age and weight of Holstein × Southeast Anatolian Red F_1 crossbred male calves (in Turkish). J. Lalahan Livest. Res. Inst., *20*, 100–112.

Pribylova J., Pribyl J., Jakubec V., Soukupova Z., Milerski M., Tyller M. (1996): Comparison of predicted and observed profits for two-, three- and four-way crosses in egg type poultry. Živoč. Výr., *41*, 189–193

Sakarya E. (1990a): Stock-breeding in Turkey's Development (in Turkish). J. Ankara Trade Exchange, *8*, 19–21.

Sakarya E. (1990b): Analysis of profitability and productivity of broiler enterprises in Ankara province (in Turkish with English abstract). Vet. J. Ankara Univ., *37*, 375–398.

SPSS for Windows 7.5 (1996) SPSS Inc.

Stott A.W., Delorenzo M.A. (1988): Factors influencing profitability of Jersey and Holstein lactations. J. Dairy Sci., *71*, 1753–1766.

Van Arendonk J.A.M. (1991): Use of profit equations to determine relative economic value of dairy cattle herd life and production from field data. J. Dairy. Sci., *74*, 1101–1107.

Yanar M., Tuzemen N., Aksoy A., Vanli Y. (1990): A study on the determining of carcass characteristics, optimum fattening period and fattening performance of Swiss Brown calves regarding two different initial live-weights (in Turkish with English abstract). J. Vet. Anim. Sci., *14*, 239–246.

Received: 02–07–24
Accepted after corrections: 03–02–24

Corresponding Autor

Assist. Prof. Dr. Yavuz Cevger, Dept. of Livestock Economics, Faculty of Veterinary Sciences, Ankara University, Diskapi 06110 Ankara, Turkey
Tel. +90 312 317 03 15/324, fax +90 312 316 44 72, e-mail: cevger@veterinary.ankara.edu.tr

THE CENTAUR NETWORK

The CENTAUR network (Food and Agriculture Organization of the United Nations Established Veterinary Biotechnology and Epidemiology Network for Central and Eastern Europe) aims at upgrading the standards of economically significant priority animal diseases control in the region with particular emphasis on transboundary animal diseases, animal health and consumer protection.

The CENTAUR is willing to achieve it through dissemination of scientific information, training, links with the international centres of excellence and cooperation. The important task is also to present the problems, personalities, institutions, and scientific achievement of the region. Efficient utilization of Internet, e-mail and improvement in English language proficiency is followed, too.

Most of the Central and Eastern European Countries have been undergoing intensive socio-economic changes and is willing to join the European Union or to strengthen their trade and other relationships with the EU. Balkan countries were in the last decade the subject of a devastating war and have been intensively recovering and rebuilding a normal economy. The Network has been active since 1996 initially embracing the Czech Republic, Hungary, Poland and the Slovak Republic and since 2001 Albania, Bosnia-Herzegovina (The Federation and Republika Srpska), Bulgaria, Croatia, FYR Macedonia, Moldova, Romania, Slovenia and Turkey.

Initial links have been established with Estonia, Latvia and Lithuania who are willing to join the Network. Also in order to deal with the problems in the region more efficiently as well as for the sake of geographic integrity the CENTAUR invites the cooperation of Finland, Belorussia, Federation of Russia, Ukraine, Yugoslavia and Greece.

The CENTAUR cooperates with the FAO Network EMPRES: Emergency Prevention System for Transboundary Animal and Plant Pest and Diseases (Livestock Diseases Component), the European Commission for Control of Foot and Mouth Disease-EUFMD in Rome and with the Joint FAO/IAEA Division in Vienna. It has a link with the Regional Animal Disease Surveillance and Control Network RADISCON (NearEast/part of Africa).

Under the CENTAUR network the CENTAUR NEWSLETTER FLASH INFORMATION (CNFI), an international electronic bulletin (ISSN 1213-368X), is published, providing subscribers with instant information in the form of e-mail messages relating to fields of interest which subscribers define themselves during the process of registration. CNFI is not limited to Central and Eastern Europe but covers global animal disease-related events and is distributed to the registered readers from all over the world. The number of subscribers has been growing rapidly and new registrations are always welcome. The forms of CNFI are as follows:

E-MAIL MESSAGES are distributed to field specific registered members. Sometimes identical information is distributed to more fields of interest. Therefore second mail with identical subject and time of dispatching should not be opened but immediately deleted.

CNFI BULLETIN: approximately 10 issues per year with general information for the CENTAUR network members are distributed to all registered addresses as an attachment to e-mail. This bulletin is also available for downloading from the CENTAUR web page http://centaur.vri.cz

CENTAUR network members are welcome as authors of original papers or reviews submitted for publication in an international peer reviewed jornal for veterinary medicine and biomedical sciences Veterinarni medicina, indexed is the Web of Science, Current Contents and other databases. Papers published in this journal are free in full text at

http://vetmed.vri.cz

CENTAUR network members can request the Editor for search from the published papers if their intentions are oriented towards to contributions for CNFI or submission the manuscript for publication in the journal Veterinarni medicina.

CNFI subscription is free. Register your "fields of interest" according to the instructions available at http://centaur.vri.cz/default.asp?page=cent_reg.asp and you will receive instant confirmation of your choice by e-mail. To unsubscribe or change the selected fields of interest, send an e-mail to the CNFI editor <hruska@vri.cz>. Contributions, comments and requests of the subscribers are welcome.

CNFI and the CENTAUR network are your tools!