SZENT ISTVÁN UNIVERSITY

GÖDÖLLŐ

ECONOMIC ANALYSIS OF DECISIONS WITH RESPECT TO DAIRY COW HEALTH MANAGEMENT

THESIS OF THE DOCTORAL (PHD) DISSERTATION

LÁSZLÓ ÓZSVÁRI DVM

GÖDÖLLŐ
2004

The doctoral school

Name: Doctoral School of Economics and Organization Science

Branch of science: Agricultural Enterprise Management

Head: Dr. István Szűcs
Professor, Doctor of the HAS
SZIU, Faculty of Economics and Social Sciences,
Institute of Economic Analysis and Methodology

Theme leader: Dr. Csaba Illés B.
Associate professor, Candidate of Agricultural Sciences
SZIU, Faculty of Economics and Social Sciences,
Institute of Business Economics,
Department of Production Economics and Management

…….. ……..
Approved by of Head of School Approved by Theme Leader

1. INTRODUCTION

1.1. Significance of the topic

The number and total production of dairy cows greatly declined in the last decade in Hungary. The competitiveness of the Hungarian dairy cattle sector could be improved materially by using the production-oriented herd health management in practice. In the countries with developed agriculture the management and the veterinary practitioners' service of dairy herds have changed because of the structural changes of dairy industry. The animal disease has become one of the most important risk factors of herd profitability and the animal health management has shifted from curing to prevention. The producers and veterinary practitioners have been making greater demands on implementation of economic analysis of herd health programs in practice.

The agricultural requirements of European Union could cause several economic and social problems in Hungary. In order to have good prospects of the sector, to prevent the disadvantageous effects of EU-joining and to produce competitively in the united European market, there is great importance of dissemination of economic analysis for decisions with respect to dairy cow herd health and production management in Hungary. Because of the continuously increasing milk-production per cow and the strong competition in the EU, the financially viable production-oriented herd health management has become one of the most important conditions of competitive milk-production.

The long-term competitive, profitable milk-production can only be achieved by reducing production costs and by minimizing losses caused by herd level diseases. According to the results of studies, in the dairy industry the largest economic losses have been currently caused by - often subclinical - mastitis, reproductive disorders and diseases of bovine digits, and the largest part of damages is resulted from the returns foregone, it has diminished income due to reduced production. In the dissertation the losses due to diseases in dairies were estimated in monetary values using data of international and national literature and assuming average Hungarian production and economic conditions, or were quantified on the basis of data available of average-level Hungarian dairy farms, in order to attract attention of dairy farm owners and veterinarian practitioners to the importance of prophylaxis of herd level diseases.

Only healthy herd can produce proper quality milk economically. Therefore, the production-oriented herd health management - integrating the other production factors along with the classical veterinary work - can contribute to the profitable milk-production. This essay researches the basic principles and challenges of this approach.

1.2. Targets

The aims of the study are:

- Exposing the role and importance of complex, production-oriented herd health management programs in improving the profitability of intensive dairy herds under Hungarian circumstances.
- Overviewing the economic aspects of herd health management in dairy herds. Researching basic principles, methodology and practical applications.
- Elaborating economic models, accommodating outland modelling techniques to the Hungarian circumstances, to support decision-making process in optimising dairy herd

health management. Contributing to the use of models in practice. By use of economic models:

- Quantifying and assessing the damages due to herd level diseases (mastitis, reproductive disorders, diseases of bovine digits, IBR and BVD-MD);
- Economic analysis of prophylactic interventions against herd level diseases (prevention, medication and eradication).

The target is to research the progressive role of animal health management in improving the profitability of intensive dairy herds under Hungarian circumstances. The expected results could confirm that the animal health management has unemployed economic reserves to achieve a higher profitability in the sector. The purpose is to verify the great importance of production-oriented herd health management in the modernization, development and increase of the Hungarian dairy sector.

1.3. Methods and Sources

The approach of research is interdisciplinary and polyfactorial. The complexity of the research theme requires application of manifold techniques based on wide-ranging theoretical and methodological skills (agricultural economics, business management, epidemiology, veterinary medicine (e.g. reproduction, udder health management)). The main methods and sources of the study are:

- Overviewing the international and national literature;
- Surveying the historical development of production-oriented herd health management in dairy herds of developed countries, and seeking out the ways to accommodate this approach to the Hungarian circumstances;
- Analysing situations on the basis of farm data;
- Evaluating dairy herds economically, revealing interrelations by using decision support models with respect to dairy cow health management;
- Completing critical, comparative studies of dairy herds, drawing interactions and conclusions generally based on the results of the models;
- Analysing the prophylactic methods (medication and eradication) economically.

The relevant literature is largely international, because the national sources focus on the theme from a veterinarian point of view essentially, and far less concentrate on the evaluation of economic effects on animal health problems. The personal interviews with theoretic and practical experts have greatly assisted to expose the less completed fields of research.

2. OWN RESEARCHES

Decreasing the losses caused by diseases is one of the basic aims for having profitable milk-production in the dairies. According to the opinion of the inland theoretical and practical experts, confirming the results of references, the largest economic losses have currently been caused by mastitis, reproductive disorders, metabolic problems, diseases of bovine digits and IBR and BVD-MD of different contagious diseases in the Hungarian dairy industry. Therefore, the losses due to diseases mentioned above - except metabolic diseases - were estimated assuming average Hungarian production and economic conditions, or were quantified on the basis of data available at Hungarian dairy farms of average level. Estimating separately the losses caused by the different diseases can help the producers to invest the resources available with the best return.

2.1. Quantification of economic losses caused by mastitis in a large-scale Holstein-Friesian dairy farm

The aim of the study was to quantify the annual herd level losses resulted from mastitis in the given large-scale dairy herd, which was executed by model calculation. The method of partial budgeting was used in the calculations; the basic logic of it that by changing the value of production indexes it is possible to calculate how many additional returns would be derived from the absence of the disease in the herd. In this model the losses caused by mastitis can be divided into three categories: reduced milk receipts, costs of treatment and costs of premature disposal. The decreased milk-production, the discarded milk and the lowered milk quality cause the reduced milk receipts. The surveys were performed at an average, large-scale Holstein-Friesian dairy farm in Eastern-Hungary between 1st January 1999 and 31st March 2001. During the survey averagely 440 cows were kept on the farm.

According to my hypothesis the cows with higher somatic cell count (SCC) than 250,000/ml had subclinical mastitis, and hence, their milk-production decreased. For the quantification only the average milk-productions of cows with SCC of under and below 250,000/ml were compared to each other, but in the average milk-productions of cows with SCC of under and below 400,000/ml and 1,000,000/ml comparisons were drawn between them, as well (**Table 1**).

Table 1. Average milk test values of cows producing milk of different SCC

Individual SCC (thousand/ml)	Average milk-production (kg/day)	Average milk fat%	Average milk protein%	Average SCC (thousand/ml)	Number of milk tests
<250	24.64	3.33	3.34	87.28	6 563
>250	22.19	3.43	3.40	1 138.10	2 765
<400	24.25	3.34	3.35	113.47	7 428
>400	22.60	3.43	3.41	1 514.30	1 900
<1000	24.07	3.34	3.35	175.27	8 436
>1000	22.48	3.47	3.42	2 514.08	892

On the basis of the average milk test values it can be concluded that as the SCC increases, the milk-production of heifers decreases. The average daily milk-production of cows with subclinical mastitis (more than 250,000 SCC/ml) was 2.45 kg less than that of the healthy ones (less than 250,000 SCC/ml).

Table 2. Annual reduced milk receipts

Sources of losses	Annual reduced milk receipts		
	in herd	per cow	
	HUF	HUF	USD
Decreased milk-production	5 035 972	11 445	44.9
Lowered milk quality	385 655	876	3.4
Discarded milk	3 021 182	6 866	26.9
Total	*8 442 809*	*19 188*	*75.2*

Table 2 shows that the decrease in annual milk receipts was about 8.5 million HUF in herd, and 19 thousand HUF (75 USD) per average cow (1 USD = 255 HUF). The largest part of the damage resulted from the decreased milk-production; on the other hand the losses resulted from discarded milk were responsible for the lowest cost. The monetary results of the earlier surveys were mostly expressed in USD, therefore the values of the calculations in the thesis were given in USD, not in EUR, for comparability.

Table 3. Annual losses due to mastitis

Sources of losses	Annual losses		
	In herd	per cow	
	HUF	HUF	USD
Reduced milk receipts	8 442 809	19 188	75.2
Treatment costs	475 152	1 080	4.2
Premature disposal	2 964 569	6 738	26.4
Total	*11 882 530*	*27 006*	*105.9*

Taking into account the other economic losses due mastitis beside reduced milk receipts, the annual total loss was approximately 12 million HUF in this herd (**Table 3**)! The annual loss per cow equalled to 27 thousand HUF (106 USD).

However, it should be emphasized, that the EU-joining brings strict milk quality requirements: the Hungarian limits of the highest quality class of so-called "Extra" milk in 2003 (less than 400,000 SCC/ml and 100,000 total germs/ml) are the criteria of the eatable milk in EU. From 8th January 2004 this regulation is operative. In Hungary 85% of marketed milk fulfilled these limits in 2003. The largest quantity of substandard milk was assignable to the small-scale herds, but the temporarily high SCC has occurred in numerous large-scale farms, that can lead to marketing problems of milk in 2004. It can cause much more losses due to lowered milk quality, consequently higher losses owing to mastitis could occur. If this phenomenon recurs often, then the herd being can be in danger. It can be concluded that the farms should do the best endeavours to keep the SCC of bulk milk low that is to diminish the incidence of subclinical mastitis.

2.2. Quantification of losses resulted from decrease in milk-production caused by subclinical mastitis on the basis of individual SCC

On the basis of surveillances carried out in countries with developed dairy sector the subclinical mastitis is that form of mastitis, which causes the most part of total losses resulted from mastitis, because of the decrease in milk-production. This achievement was supported by the results showed before. Because of its economic importance, the interrelation between SCC and milk-production was examined in more details. In a Hungarian large-scale (with 1850 cows on an average) Holstein-Friesian dairy herd the losses resulting from decrease in

milk-production based on individual SCC were quantificated on the basis of data representing the year 2000. The results of this survey could be compared with the findings of the preceding study in order to draw more representative conclusions.
Table 4 shows the average milk-production and SCC of individual milk samples of monthly milk tests at periods from 1 to 100 days, 101 to 200 days and beyond 201 days of lactation in heifers, respectively.

Table 4. Average milk test values of heifers producing milk of different SCC

Individual SCC (thousand / ml)	Average SCC (thousand /ml)			Average milk-production (kg/day)			Number of milk tests		
	1-100. days in lactation	101-200. days in lactation	201-305. days in lactation	1-100. days in lactation	101-200. days in lactation	201-305. days in lactation	1-100. days in lactation	101-200. days in lactation	201-305. days in lactation
<250	84	89	106	32.13	31.97	25.10	633	510	852
251-400	310	313	317	31.27	32.74	23.52	46	57	164
401-1000	613	610	604	32.06	32.69	22.78	47	72	183
>1000	2130	2306	2127	29.68	30.24	24.11	35	59	95

Table 5 shows the average milk-production and SCC of individual milk samples of monthly milk tests at periods from 1 to 100 days, 101 to 200 days and beyond 201 days of lactation in cows, respectively.

Table 5. Average milk test values of cows producing milk of different SCC

Individual SCC (thousand / ml)	Average SCC (thousand /ml)			Average milk-production (kg/day)			Number of milk tests		
	1-100. days in lactation	101-200. days in lactation	201-305. days in lactation	1-100. days in lactation	101-200. days in lactation	201-305. days in lactation	1-100. days in lactation	101-200. days in lactation	201-305. days in lactation
<250	91	100	127	39.93	35.91	25.67	513	503	715
251-400	319	315	322	39.53	33.92	20.95	91	101	283
401-1000	624	650	613	37.65	33.37	20.67	121	144	371
>1000	2478	2546	2158	36.34	32.34	20.99	107	133	187

The average differences in milk-production between healthy cows and heifers (SCC less than 250,000/ml) and cows and heifers with subclinical mastitis (SCC more than 250,000/ml) on daily and yearly basis by period of lactation, and the losses caused by the decrease in milk-production are given in **Table 6**.

Table 6. Average decrease in milk-production of cows with subclinical mastitis and the calculated losses

		Heifers	**Cows**
Decrease in milk-production	1-100. days in lactation (kg/cow/day)	1	2.18
	101-200. days in lactation (kg/cow/day)	0.03	2.75
	201-305. days in lactation (kg/cow/day)	1.76	4.83
	Per cow with mastitis (kg/day)	2.92	
	Per cow with mastitis (kg/year)	1 067	
	Per cow (kg/year)	341	
Losses	HUF/herd/year	34 694 050	
	HUF/cow/year	18 754	
	USD/cow/year	73.5	

The daily reduction in milk-production of cows with subclinical mastitis was three times more than of heifers with subclinical mastitis: 3.77 kg/day/cow versus 1.2 kg/day/heifer. The daily milk decrease in milk-production due to subclinical mastitis was 2.92 kg per cow that result is a little bit more than the 2.45 kg milk per cow daily declining in the previous survey. The calculations based on the individual milk samples show that the annual losses owing to reduction of milk-production exceeded 34.5 million HUF in the herd keeping 1850 cow. The cows calved many times were responsible for the most of losses, since the losses per cow and the proportion of them in the herd were higher than of heifers.

2.3. Assessment of losses due to mastitis on the basis of pathogen type

The number of somatic cells in milk is used as a major criterion for estimating the presence and severity of mastitis by most of the experts on udder health management all over the world. The decrease in milk-production can be quantificated by measuring the increase in SCC. However, some experts are arguing, whether this criterion is still appropriate, and treating pathogens in milk as a diagnostic criterion of mastitis, and using pathogen type as a basis for calculating losses due to mastitis. Therefore, this method is presented in the dissertation as well, in which four different types of pathogens are especially important to be considered: coliform, streptococcal, staphylococcal and *Arcanobacterium pyogenes*. Additionally, there may be clinical cases in which no pathogens can be detected, usually defined as bacteriologically negative. Representative data on the incidence of udder pathogens in Hungary and on the effects of these bacteria on the production have not been released in the literature yet, thus the assessment of losses, in this regard, is based on the results of a Dutch survey, using average Hungarian production and economic data. Whereas, the incidence of pathogens and the rate of clinical and subclinical forms of mastitis are admittedly different in these two countries, the results can be treated as a crude calculation. As shown in **Table 7** based on all these assumptions, the calculated annual losses owing to mastitis amounted to about 16 thousand HUF (62 USD) per cow at prices of the year 2001 that comes out in a herd with 1000 cows at 16 million HUF.

Table 7. Calculated annual losses due to mastitis

Pathogen type	Losses due to clinical mastitis per infected cow		Losses due to sub-clinical mastitis per infected cow		Total losses per average cow in herd		
	HUF	USD	HUF	USD	HUF	USD	%
Coliform	43 951	172.4	–	–	3 077	12.1	18
Streptococcal	46 843	183.7	4 735	18.6	5 372	21.1	33
Staphylococcal	59 135	231.9	4 735	18.6	1 982	7.8	13
Arcanobact. pyogenes	165 604	649.4	–	–	2 650	10.4	19
Bacteriologically negative	48 528	190.3	–	–	2 718	10.7	17
Total/Average	54 560	214	4 735	18.6	15 798	62	100

2.4. Quantification of economical losses caused by *Staphylococcus aureus* in a large-scale Holstein-Friesian dairy farm

In Hungary, on the basis of data available, there is a difference in the incidence of udder pathogens comparing with the results of Dutch studies. In a Hungarian dairy farm the *Staph. aureus* is responsible for most of the mastitis cases, accordingly, an additional survey was carried out to quantify the losses resulted from mastitis caused by *Staph. aureus,* which was

executed by model calculation. The method of partial budgeting was used in the calculations. The sources of losses and the calculation method were the same as those in chapter 2.1. The surveys were made at an average-level, Hungarian large-scale (with 930 cows) Holstein-Friesian dairy herd in 2001.

Table 8 shows the average milk test values of lactations closed in 2001 of cows with *Staph. aureus* positive quarter (53 cows) and the control group (194 cows). The *Staph. aureus* infected cows produced less milk than the healthy ones. The average daily production of the diseased cows was 2.2 kg less than in the control group.

Table 8. Average milk test values of healthy and *Staph. aureus* positive cows

Groups	Number of cows examined (n)	Average milk-production (kg/day)	Average SCC (thousand/ml)	Average milk fat%	Average milk protein%
Control	194	24.76	193	3.70	3.29
***Staph. aureus* positive**	53	22.56	435	3.78	3.29
Of which:					
clinical mastitis	16	22.42	428	3.76	3.25
subclinical mastitis	37	22.64	439	3.79	3.31

Table 9 shows that the annual losses caused by *Staph. aureus* mastitis in the examined dairy herd exceeded 5 million HUF. Clinical mastitis was responsible for 36% - nearly 1.9 million HUF - and subclinical mastitis was responsible for 64% - over 3.3 million HUF. So, the subclinical mastitis resulted in much more economic losses on herd level. The annual loss per infected cow was approximately 100 thousand HUF (385 USD)! Clinical *Staph. aureus* mastitis resulted in a 25 thousand HUF higher loss per cow than the subclinical form, exceeding 115 thousand HUF (454 USD) versus 90 thousand HUF (355 USD). The annual loss per average cow amounted to more than 5.5 thousand HUF (22 USD).

Table 9. Annual losses caused by *Staphylococcus aureus* mastitis (HUF)

Losses	Clinical	Subclinical	Total
Losses due to reduced milk receipts	546 795	1 144 409	1 691 205
Losses from discarded milk	550 588	826 866	1 377 453
Treatment costs	37 668	59 910	97 578
Costs of premature disposal	717 290	1 315 031	2 032 320
Total	***1 852 340***	***3 346 216***	***5 198 556***
Losses per infected cow	115 771	90 438	98 086
Losses per average cow	1 996	3 606	5 602
Losses per infected cow (USD)	454	354.7	384.7
Losses per average cow (USD)	7.8	14.1	22

2.5. Quantification of economic losses caused by reproductive disorders in a large-scale Holstein-Friesian dairy farm

Quantification of losses due to reproductive failures can help greatly taking into account the economic aspects in decisions with respect to cow health management, that is why, by using a method worked out on the basis of international model calculations, the damages resulting from reproductive disorders were calculated at an average-level, Hungarian large-scale (with 1150 cows) Holstein-Friesian dairy farm. The method of partial budgeting was used in the calculations, and the data of cows calved in 2001 were processed.

Economically speaking, the reduced reproductive performance eventually leads to either a longer calving interval or premature disposal in the presented model. The calving interval with the highest yearly net return is defined as optimal, while the difference with every other calving interval indicates the loss in income per cow per year. According to the international and Hungarian literature, the length of calving interval influences three factors: net milk receipts (margin between gross milk receipts and feed costs), calf sales and other components. The number of lactations affects the milk-production; hence, the cows were grouped by lactations in calculating the losses due to reduced net milk receipts.

Table 10 shows the losses owing to the decrease in net milk receipts and in calf sales. Considering both net milk receipts and calf sales, a calving interval of 11 months is optimal for each lactation. The annual loss per average cow due to longer calving interval was 38.5 thousand HUF in 2001. For older cows the lengthening calving interval can cause much more loss than for first lactation cows. The average daily loss per cow is the cost of each day of increased calving interval. On this farm the longer calving interval caused a loss of 490 HUF (1.92 USD) per day per average cow in 2001.

Table 10. Optimal length of calving interval and calculated losses due to longer calving interval (HUF/cow/year)

Calving interval (months)	**11**	**12**	**13**	**14**	**15**	**16**	**17-18**
Lactation 1	0	1 753	15 807	36 535	43 675	65 779	85 657
Lactation 2	0	1 661	64 283	55 391	70 438	81 218	102 080
Lactation 3	0	39 317	35 309	74 529	106 607	120 856	137 085
Lactation 4	0	30 116	70 055	85 733	102 106	137 678	101 874
Lactation 5	0	73 329	61 755	64 548	119 133	152 668	132 224
Lactation 6-8	0	46 444	50 938	45 397	118 894	117 826	136 152
Average cow	*0*	*18 255*	*43 332*	*51 582*	*74 713*	*86 562*	*105 265*
Per day longer calving interval (HUF/cow/day)							
Per average day	0	609	722	573	623	577	540
Per marginal day	0	609	836	275	771	395	623

The annual losses of reproductive failure exceeded 56.5 million HUF per year on herd level (**Table 11**). The longer calving interval was responsible for 54.6% (about 31 million HUF) of the total losses and the premature culling could be blamed for 31.3% (17 million HUF) of the total amount. The increased number of inseminations amounted to 7.7%, while the easily demonstrated costs of medical treatment equalled to 6.4% of the losses. The annual losses exceeded 49 thousand HUF (193 USD) per cow. As the reproductive status of the herd examined corresponds to the average indexes in Hungary, so the amount of losses comparatively represents the countrywide average losses.

Table 11. Annual losses due to reproductive failures

Sources of losses	**Annual losses**		
	in herd	**per cow**	
	HUF	**HUF**	**USD**
Longer calving interval	30 912 580	26 881	105.4
Premature disposal	17 720 800	15 409	60.4
Treatment costs	3 622 039	3 150	12.4
Increase in number of inseminations	4 340 174	3 774	14.8
Total	*56 595 593*	*49 214*	*193*

It will not be possible and profitable to avoid all calculated losses, but in this herd decreasing by 10% of losses corresponds to 5 million HUF per year, which can be achieved in short term. On he basis of these results it can be expected, that considerable economic improvement can be achieved - especially by shortening the calving interval -, and significant part of which can be implemented by more effective herd health management.

2.6. Assessment of losses due to diseases of bovine digits

Losses due to diseases of bovine digits have been partly assessed already by Hungarian researchers, but complex calculation including all sources of losses has not completed yet for a Hungarian herd, whereas diseases of bovine digits have caused the third most damages to dairy herds by references. Consequently, one objective of the thesis was to estimate the economic losses caused by digital diseases for an average, Hungarian large-scale Holstein-Friesian dairy farm, which was executed by model calculation. On the basis of data available in the research literature and in own surveys for different dairies, frequency and average effects on production of digital diseases were defined, and the average Hungarian production and economic circumstances were considered for the calculation. The method of calculation was again the partial budgeting.

The sources of losses due to diseases of bovine digits for the economic model based on the international literature are the following:

- reduced milk receipts;
- longer calving interval;
- treatment costs;
- extra labour input by a farmer;
- premature disposal; and
- reduced body weight.

Table 12. Estimated annual losses due to digital diseases in a herd with 1000 cows

Soures of losses	per case		per cow		in herd
	HUF	USD	HUF	USD	HUF
Reduced milk receipts	10 614	41.6	4 246	16.7	4 245 660
Longer calving interval	9 265	36.3	3 706	14.5	3 706 164
Treatment costs	2 073	8.1	829	3.3	829 348
Premature disposal	6 683	26.2	2 673	10.5	2 673 000
Total	*28 635*	*112.3*	*11 454*	*44.9*	*11 454 171*

Table 12 shows that the diseases of bovine digits cause about 11.5 million HUF annual losses in a herd with 1000 cows that is cc. 11.5 thousand HUF loss per average cow (45 USD) at the prices of the year 2002.

2.7. Cost-benefit analysis of IBR eradication programme by marker vaccination

In Hungary two viral diseases - being mainly in subclinical form - infect most of the dairy herds: infectious bovine rhinotracheitis (IBR) and bovine viral diarrhoea and mucosal disease (BVD-MD). The countries with developed agriculture have recognised the economic importance of the prevalence of IBR and have started eradication programmes. In countries with a high proportion of IBR seropositive herds, like Hungary, the eradication is conducted by marker vaccination. In regard to the high prevalence of IBR (80%) and to the serious lack of capital in economics, from the professional and ethic point of view, the possible IBR eradication programme is the eradication by marker vaccination in Hungary. To support making decisions of dairy herd management for veterinarians and cattle owners the cost-

benefit analysis of IBR eradication programme by marker vaccination was carried out, accommodating international experience to the Hungarian circumstances. Using partial budgeting, firstly the annual losses caused by IBR infection at national level, at herd level (with 1000 cows) - separately for clinical and subclinical form -, and at cow level were estimated. As representative data of the effects on production parameters have not been yet released in the Hungarian literature, thus the assessment is based on the average of results of international surveys, using average Hungarian production and economic data.

Table 13 shows that the estimated annual loss due to IBR was 1.8 milliard HUF at national level, about 9 thousand HUF per infected cow and 5 thousand HUF per average cow in 2002.

Table 13. Estimated losses in Hungary caused by IBR (in thousands HUF/year)

Increased feed costs of heifers	124 948
Costs of premature disposal	888 718
Costs of death	342 476
Treatment costs	110 061
Losses due to reduced slaughter weight of beef bulls	151 110
Losses owing to decreased milk-production	193 752
Costs of abortion	4 944
Total losses at national level	*1 816 010*
Total losses per average cow (HUF)	*5 017*

The estimated losses due to subclinical IBR in a herd keeping 1000 cows are given in **Table 14**.

Table 14. Losses caused by subclinical IBR in a herd with 1000 cows (HUF/year)

Increased feed costs of heifers	605 407
Costs of premature disposal	4 287 226
Costs of death	1 651 038
Treatment costs	529 274
Losses due to reduced slaughter weight of beef bulls	720 678
Losses owing to decreased milk-production	936 000
Costs of abortion	23 900
Total losses at herd level	8 753 523
Total losses per average cow	8 754

These losses indicate the return realizable in case of freedom from the disease and can be the starting point of cost-benefit analysis of eradication programme. As against potential income the costs of eradication programme were calculated: the total costs of marker vaccination and blood-test. By applying cost-benefit analysis, the profitableness and payability of long-term animal health programs can be evaluated.

In the model the prevalence of subclinically infected cattle in the herd with 1000 cows was assumed to be 80% that can be reduced by gradual culling of infected cows. Two eradication strategies were evaluated economically: a five-year-long and a ten-year-long programme. In strategy “A”, assuming an optimal eradication, the virus can be eradicated from the herd in 5 years, reducing the prevalence of seropositive cattle by 16% annually. The strategy “B” is pessimistic, assuming a slower eradication process; the herd will be free of IBR virus in 10 years, diminishing the number of infected animals by 8% annually.

The results showed impressive benefits (**Table 15**). In the case of the shorter ("B") strategy the costs return in the third year; in the longer eradication (strategy "A") the cost recovery takes seven years. The net present value (NPV) is 8.315 million HUF in strategy "A", and 13.328 in strategy "B". The cost-benefit ratio (C/B) is very favourable in both strategies: 1.5 (at year 5 of strategy "A") against 1.44 (at year 10 of strategy "B"). The costs (but benefits also) are almost two times higher in the shorter eradication programme than in the longer, that is about twice the sum has to be paid for eradication. The internal rate of return (IRR) is very high for strategy "A" (77%), but 26% of IRR of strategy "B" is much higher than the rate of interest, as well. The results show that the eradication of IBR is rewarding in everyway from an economic point of view. In future, the method of cost- benefit analysis of animal health programs (of eradication in this case) could be a useful tool for supporting the implementation of health programs in a herd.

Table 15. Economic analysis of eradication strategies „A" and „B"

	Eradication strategy „A"					Eradicatin strategy „B"				
Ye-ar	**Total cost***	**Total return***	**NPV****	**C/B*****	**IRR§**	**Total cost***	**Total return***	**NPV****	**C/B*****	**IRR§**
1	3 736	1 688	-2 048	0.45	-	3 736	844	-2 892	0.23	-
2	6 624	5 030	-1 594	0.76	-	6 624	2 515	-4 109	0.38	-
3	9 539	9 995	456	1.05	13%	9 484	4 997	-4 487	0.53	-
4	12 478	16 548	4 070	1.33	59%	12 370	8 274	-4 096	0.67	-
5	16 562	24 876	8 315	1.50	77%	15 227	12 329	-2 898	0.81	-
6	-	-	-	-	-	18 108	17 147	-961	0.95	-5%
7	-	-	-	-	-	20 961	22 713	1 752	1.08	8%
8	-	-	-	-	-	23 837	29 010	5 173	1.22	17%
9	-	-	-	-	-	26 685	36 025	9 340	1.35	22%
10	-	-	-	-	-	30 622	43 949	13 328	1.44	26%

* Cumulative and discounted (in thousands HUF)
** Net Present Value (cumulative, in thousands HUF)
*** Cost-benefit ratio
§ Internal Rate of Return

2.8. Estimation of losses caused by BVD-MD

The BVD virus can cause a wide range of lesions not merely in cattle with clinical signs but also in infected cattle without any signs and in their progeny, as well. The infection of BVD virus has a strong immunosuppressive effect on the host and so potentiates the effect of other infectious diseases, such as IBR. Hence, the eradication of BVD virus is reasonable in those herds, where IBR eradication is in progress for the success of the programme. The prevalence, incidence and symptoms of BVD virus infection were summarized on the basis of the national and international literature in the thesis. By the results of international surveys, the effects of the virus on production and their extent were defined. Using these data, an economic model was elaborated to the Hungarian circumstances to estimate the annual losses at national level and herd level caused by BVD-MD.

The calculation used the average Hungarian price and production data of the year 2002. The losses due to BVD-MD in Hungary are shown in **Table 16**. The annual estimated losses caused by BVD were approximately 574 million HUF on an average at national level, but if the rate of incidence is higher and the disease effects are more serious, the damage can come close to 1 milliard HUF. The loss per cow averaged 1.6 thousand HUF yearly.

Table 16. Estimated losses in Hungary caused by BVD (in thousands HUF/year)

Sources of losses	Low*	High*
Drop in milk-production	9 371	15 618
Abortion	5 292	105 839
Mortality of cows	7 518	250 625
Premature disposal of cows	19 753	181 073
Mortality of calves or cattle up to 1 year	110 700	442 800
Total estimated losses per national herd	152 635	995 955
Total average losses per national herd	574 295	
Total estimated losses per cow (HUF)	422	2 751
Total average losses per cow (HUF)	1 586	

*Depending on annual risk of infection of the BVD negative herds (30 or 50%) and minimum and maximum effects of the disease on production (extreme values), low and high estimation of losses caused by BVD were carried out.

The losses caused by both acute clinical BVD (**Table 17**) and BVD-MD complex were estimated in a herd with 1000 cows.

Table 17. Losses caused by acute clinical BVD in a herd keeping 1000 cows (HUF/year)

Sources of losses	Low	High
Drop in milk-production	1 725 787	
Abortion	13 674	273 488
Mortality of cows	1 376 250	27 525 000
Premature disposal of cows	3 615 684	19 886 262
Mortality of calves or cattle up to 1 year	314 700	1 258 800
Total estimated losses per herd	7 046 095	50 669 337
Total average losses per herd	28 857 716	

2.9. Comparative studies of production data and drug costs of dairy cattle herds

Total variable costs of a dairy include costs of drugs, vaccines, detergents and disinfectants that can considerably influence the profitability of milk-production. Therefore, the production-oriented herd health management should contain the cost-effective use of drugs in a herd. In the dissertation a comparison was made between the production data and drug costs of dairy cattle herds. Data of drug use of three years (1998-2000.) of three large-scale herds (A, B and C) were examined year-by year and herd-by herd, and the average values were calculated, as well. From the production data the marketing of milk, the progeny rate and the rate of the death plus emergency slaughter were evaluated. Eventually, conclusions on effectiveness and return of drug use were drawn.

The drug cost was divided into groups by product groups and indication. Distribution by product groups of drug costs of dairies examined is shown in **Table 18.** The cost of antibiotics ranked first by product groups in all herds.

Table 18. Distribution by product groups of average total (1998-2000) and yearly drug costs of dairies

Product groups	Herd A	Herd B	Herd C	1998	1999	2000
	%			%		
Antibiotics	49.0	44.4	47.2	50.8	48.4	41.3
Disinfectants	4.3	6.7	15.8	9.4	11.3	6.1
Vitamins, minerals, amino-acid supplements	13.3	7.4	14.1	9.2	9.0	16.6
Hormones	11.7	23.6	1.5	13.1	12.2	11.5
Vaccines	11.8	6.7	10.0	6.5	9.1	13.0
Antiparasiticides	0.4	1.3	3.1	1.3	1.9	1.6
Antiphlogistics, analgesics	0.8	0.7	0.7	0.6	0.6	1.1
Other surgical, medical and diagnostic preparations	7.5	6.7	6.7	8.0	5.8	7.2
Medical instruments and fee of magistrals	1.1	2.4	1.2	1.2	1.9	1.6
Total	100.0	100.0	100.0	100.0	100.0	100.0
Annual drug costs per cow (in thousands HUF)	8.3	8.5	12.0	12.7	10.3	7.1

Table 19 shows the distribution by indication of average yearly drug costs per cow (15 560 HUF). The costs of drugs used for treating mastitis had the highest rate. In the thesis the average cost of antibiotics per cow was distributed by indication, as well.

Table 19. Distribution by indication of average yearly drug costs per cow (HUF;%) (1998-2000)

Indication	Drug costs per average cow (HUF)	Distribution (%)
Udder diseases	4 509	42.7
Reproductive failures	2 915	27.6
Digital diseases	433	4.1
Metabolic disorders	718	6.8
Preventive products	1 077	10.2
For surgical and medical problems	314	3.0
Antibiotics and sulphonamides for treating calves	203	1.9
Antiparasiticides	169	1.6
Others	222	2.1
Total	**10 560**	**100.0**

The comparison was made between costs of drugs treating udder diseases (specific udder health drug cost) and the marketing of milk and between costs of drugs treating reproductive failures (specific reproductive drug cost) and progeny rate (**Table 20**).

Table 20. Main production indexes and specific drug costs in the dairies (1998-2000)

	Herd A	Herd B	Herd C	Average
Marketing of milk (litre/cow/year)	7 820	8 475	7 416	7 904
Specific udder health drug costs (HUF/ litre milk/year)	0.50	0.49	0.85	0.61
Progeny (calf/cow/year)	0.92	0.95	1.03	0.97
Specific reproductive drug costs (HUF/calf/year)	2 316	3 163	1 795	2 425
Rate of death and emergency slaughter (%)	6.1	4.0	9.0	6.4
Specific total drug costs (HUF/cow/year)	8 258	8 461	11 985	9 567

For calculating the returns of drug costs, it was quantificated how many litres of milk per cow is as valuable as the specific udder health costs, and how many calves per cow amount to the specific reproductive costs. It was assumed that milk price was 65 HUF/l and price of a calf (up to 200 kg weight) was 60 thousand HUF (**Table 21**).

Table 21. Return indexes in the dairies (1998-2000)

Indexes	Herd A	Herd B	Herd C	Average
Marketing of milk (litre/cow/year)	7 820	8 475	7 416	7 904
Costs of drugs treating udder diseases (HUF/cow/year)	3 828	3 527	6 293	4 549
Return (litre milk/cow)	*58,9*	*54,3*	*96,8*	*70*
Progeny (calve/cow/year)	0.92	0.95	1.03	0.97
Costs of drugs treating reproductive failures (HUF/cow/year)	2 316	3 632	1 795	2 581
Return (calf/cow)	*0.039*	*0.061*	*0.030*	*0.043*

Evaluating the yearly trends, it can be concluded that the production indices increased a bit or remained stable, at the same time the drug use considerably decreased. The preventives are exceptions to this rule: these products, preventing animal's diseases, could contribute to reducing the costs of curative drugs. Therewith, this positive trend could be induced by the former high use of drugs, or a much lower drug use was sufficient to keep the production at the same level.

In the basis of comparison made between indicative costs and production data, and of return indexes the udder health management was the best in herd B and was the worst in herd C; the reproduction management was at the highest level in herd C, and was at the lowest level in herd B from an economic point of view. On the basis of data between 1998 and 2000 of the three herds it can be stated that if the production indexes are low the drug costs are high and vice versa. Consequently, if the animal health status of a production field is low the drug use of it will raise.

3. NEW AND NOVEL RESULTS

The new and novel results based on the previous chapters are the following:

- I demonstrated the effects of animal health and veterinarians' service on productivity and profitability of the dairy farms, and the progressive economic role of herd health management under Hungarian circumstances. I exposed that, by implementing the complex, production-oriented herd health management programs in a herd, rising part of the veterinarians' service will be consultative assistance, solution-seeking of managerial, organizational and control problems, which includes economical analyses.
- I elaborated economic models that can be applied in practice in order to support decisions with respect to dairy cow health management. The model calculations are based on the results of international research literature, accommodating to the Hungarian production and economic conditions. The models can quantify or can estimate the extent of herd level losses caused by mastitis, reproductive disorders, digital diseases, IBR and BVD-MD. The losses due to metabolic diseases were not researched. In the prophylactic interventions against herd level diseases, I presented two model calculations to evaluate economically an eradication programme and drug use of a herd.
- I presented two different approaches to calculate the losses owing to mastitis. In the first method I quantified the losses resulting from decrease in milk-production caused by subclinical mastitis on the basis of individual somatic cell counts (SCC) in two different dairies. In either of them the damage was integrated with cost of treatment and of premature disposal, thereby in this dairy I revealed the total yearly loss due to mastitis that amounted to 27 thousand HUF per average cow in 2001. The daily decrease in milk-production due to subclinical mastitis was 2.45 or 2.92 kg per cow on the two farms. In the alternative approach, on the basis of pathogen type, using international research data, I estimated at 16 thousand HUF per average cow the yearly loss caused by mastitis. Because of primary importance in Hungary, I quantified the yearly loss resulting form mastitis caused by *Staphylococcus aureus* in a large-scale dairy farm that amounted to 98 thousand HUF per infected cow or 5.5 thousand HUF per average cow in 2001.
- I quantified the losses caused by reproductive problems in a dairy farm with average Hungarian reproductive indices. The average daily loss due to the longer calving interval was 490 HUF per average cow and the amount of loss resulting from reproductive disorders exceeded 49 thousand HUF per average cow in 2001.
- I defined that under average Hungarian production and economic circumstances the diseases of bovine digits caused about 11.5 thousand HUF, the IBR-infection 5 thousand HUF and the BVD-infection 1.5 thousand HUF annual losses in 2002.
- I proved by economic analysis, considering the Hungarian farming systems, the size of a herd, the rate of prevalence and the financial aspects, that the most feasible way to eradicate IBR virus is the selection based on marker vaccination. I evaluated two eradication strategies economically. In the five-year-long strategy the costs return in the third year; in the ten-year-long eradication the cost recovery takes seven years. The cost-benefit ratio and the internal rate of return are very favourable in both strategies: 1.5 against 1.44 and 77% against 26% at the prices of the year 2002.
- I evaluated the effectiveness and profitability of animal health management by comparing the production indexes to the drug costs of dairy farms in different ways. This approach assigns in point of numbers the effectiveness of veterinarians' service and the returns of drugs used, thus I could rank the quality of animal health management of different dairies. I showed up, that the average yearly drug cost per cow was 10 560 HUF on the basis of

data (1998-2000) of three herds. I divided the drug cost into groups by product groups and indication: by product groups the cost of antibiotics ranked first, by indication the cost of drugs treating mastitis was the greatest. According to my calculation, the rates of return showed that 54-97 l more milk per cow recovered the specific udder health drug cost, and 0.03-0.06 more calves per cow compensated the specific reproductive drug cost. I could state that if the production indexes are low the drug costs are high and vice versa.

- I revealed that the herd health management can play a progressive role in the development of Hungarian dairy industry in the present situation, because the animal health management has unemployed economic reserves to improve the profitability of the sector.

4. CONCLUSIONS AND SUGGESTIONS

In the countries with developed agriculture the management of dairy cattle keeping has changed considerably because of the concentration of production, and this process of change accelerated in the last years. The Hungarian practical management has fallen behind this process. Falling into line with this development is serious challenge for the Hungarian dairy cattle sector and its members - for the dairy operators, the experts and the administration, as well. In the absence of rapid improvement of this field, the Hungarian sector will fall even more behind the main competitors.

In the last decade the profitability of the Hungarian dairy cattle sector was very low. Anomalies of trade and market regulations, inconsistencies of support system and deficiencies of housing and animal health management have caused the low profit. After joining EU, because of the strong market competition and the continuously increasing specific milk-production - and consequently growing demands of animals on environment (housing, feeding, etc.) -, one of the main criteria of profitable milk-production is the high-level herd health management based on economic analyses, that amounting and diminishing extent of losses, due to different clinical and subclinical diseases being in a dairy herd, has become key factor. According to the results of the surveys made, the mastitis, the reproductive disorders, the metabolic diseases and the diseases of bovine digits are responsible for the highest losses in dairy herds, therefore, it is needful to estimate the losses of diseases mentioned above in order to make the owners and veterinary practitioners believe the importance of prophylaxis of herd level diseases. These losses can often be quantified with difficulties, thus they pass undetected in many instances.

4.1. Losses caused by herd level diseases

Numerous dairy operators can realize the losses due to clinical diseases, but do not perceive the damages owing to their subclinical forms. They do not often recognize that the subclinical diseases affect disadvantageously the production indices, and cause much more losses, than the clinical forms of that. Many times they do not even conceive that the herd health programmes can improve the productivity of their herds, and hence they can achieve profits.

According to the results of quantifications and assessments, in Hungary the reproductive disorders were responsible for the largest part of yearly economic losses per average cow (49 thousand HUF*), following by the damages due to mastitis (27 thousand HUF*) and digital diseases (11.5 thousand HUF**). These losses amounted to 91.5 thousand HUF (359 USD) per cow at prices of the year 2002 even excluding the financial damages due to metabolic disorders (especially ketosis). According to a Hungarian expert estimation, the ketosis, affecting adverse to milk-production, caused 27 thousand HUF losses per average cow in 1997. According to the results of the examinations, it could be concluded that the yearly loss per average cow due to non-contagious diseases (with metabolic disorders) is about 110-140 000 HUF in Hungary at prices of the year 2002. Assuming unfavourable herd health conditions the extent of damage with the estimated losses caused by IBR and BVD (5 thousand HUF + 1.5 thousand HUF**) could come up to the amount of 150 thousand HUF, not including the costs of different individual health problems and other contagious diseases. The extent of the annual losses due to herd health problems average up to 125 thousand HUF per average cow (490 USD), causing 125 million HUF losses per year in a herd with 1000 cows. This corresponds to almost 20% of gross return of a dairy.

*at prices of 2001; ** at prices of 2002

These shocking data confirm my hypothesis that the improvement of herd health management can greatly improve the profitability of dairies, and promotes the competitiveness of the Hungarian dairy industry in the European market.

In practice it will not be possible - and profitable - to avoid all calculated losses. Differences among farms can help to gain insight into what is attainable and which priorities are under current conditions. Unfortunately, farm-specific data suitable for research on animal health economics are sparse. Available data on differences in calving interval suggest big differences of damages among farms, easily exceeding the calculated average loss. By the results of international studies, the best farms prove to realize only half of the calculated losses on the average farm. So, there is reason to expect that considerable economic improvement can be achieved, especially for farms with higher than average losses. Comparison of the data on production and herd health between farms can actuate to take prophylactic interventions, promoting the effectiveness and profitableness of milk-production.

4.2. Economic evaluations of herd health programs

The economic effects of herd health programs can be estimated. Although dairy operators realize that the animal health problems in a herd cause suboptimal performance, they are often unaware of the economic impact of these problems. The model calculations on estimating herd level losses can be an invaluable aid in marketing herd health control programs. Projected herd level loss figures draw attention to the economic magnitude of problems for the dairy operator, and individual areas of loss identify specific areas on which they should focus veterinary recommendations.

The models for evaluating the herd health programs economically can be used to estimate the economic benefits of proposed changes in animal health that forces realistic projections at the outset, and helps the veterinarian become more actively involved in the management of the dairy. The cost-benefit analysis presented earlier could be a useful tool to support economically the marketability of long-term animal health control programs in a herd.

Monitoring the economic impacts of implemented herd health programs on losses due to diseases is rewarding, because the economic return resulting from the implementation of control program can be analysed periodically. It is important not to evaluate a herd health program too soon, because responses will not be measurable until several months after implementation of a program. As the periodical analysis evaluates benefits, it provides positive reinforcement to the dairy operators when the benefits are increasing as time goes on. Demonstration of a positive increasing return also can encourage an operator to agree to additional changes and allows a veterinarian to act. An effective control program may provide constant returns, with no apparent improvement in herd status once the program has achieved the goals of performance. In this case, the program may be serving to prevent deterioration of status, much the same as an insurance policy provides protection against losses from disease or suboptimal performance when the program was initiated. If no changes or economic benefits are seen during periodic analyses in a herd, the veterinarian may reevaluate the program.

In the countries with developed agriculture farmers evaluate the control programs economically before its implementation in a herd, therefore this approach will be better and better required by veterinarians, as well. In future the Hungarian dairy operators' approach will be becoming more economic, too. Hence, it can be predicted that the successful and profitable milk-production will highly depend on the veterinarians' economic skills and production-orientated approach. In the absence of these qualities the veterinarians' consultative assistance will be refused, however the wide-range implementation of herd health

programs in the Hungarian dairies would be a new source of income for the dairy practitioners.

4.3. Suggestions for theoretical and practical applications of the results

The methods presented in the dissertation could be useful tools of consultative assistance in developing alternatives of evaluation, preparing and making economic decisions, taking actions and evaluating the outcome. Application of these procedures in practice gives a capability for enlarging the veterinarians' service.

The spreadsheet models used in the calculations have the advantage that allows field calculations to use the actual data of a herd ("ad hoc" calculations). Sensitivity analyses on losses and profits of the control programs could be made bychang ing the input values, as well. By raising or lowering the projected values, the practitioner can calculate the estimated return to the dairy operator with recalculated values from the spreadsheet. The veterinarian also may want to estimate the economic returns from various levels of veterinary service to determine a program that would provide maximal return to the operator. These spreadsheet models can operate on laptops; hence they would become an everyday tool for the dairy practitioners.

The differences among results of quantifications and estimations are of importance to emphasize that the results of calculations based on the data of given herds or on average figures should be interpreted with care. For a given herd, owning to all farm data as needed allows to make the most accurate calculation, to draw conclusions and to optimise the herd health management economically.

To make the extent of losses due to diseases more representative data of much more herds are required. Therefore, with regard to the considerable economic implications of the research theme, it is necessary in long-run to establish a national data bank of indexes of all herds on production, animal health status and frequency of diseases that would be available for all producers and all researchers any time. On the basis of these data, the changing of the animal health status of the Hungarian dairy cattle keeping would be monitorised, and the right decisions with respect to dairy cow health management could be made in the right place at the right time. The basic purpose of this bank is to provide such information that can help dairy operators and others interested in the dairy sector to make milk-production more profitable. Accordingly, the data gathered should be systematized and digested so that it could be useful in practice for dairy operators and veterinary practitioners. The information should be standardized and integrated so that the different herds could be compared with each other. This process can provide such central bank of the animal health and production data that would be useful for both research and education.

Application of the model calculations in practice can contribute to reveal the strong and weak points of dairy keeping, to expose the costs and returns of each operation, and to improve the profitability by identifying the priorities and critical points of the business.

The calculative methods can be used to estimate the extent of losses due to diseases, to evaluate and monitor economically herd health programmes, e.g. cost-benefit analysis of medicinal treatments and of eradication programmes, eventually to solve the health problems in the most beneficial way.

The new challenges of veterinary practice demand the change of structure and contents of veterinarians' education. The results and interrelations of the thesis can be used for enlarging the curriculum of "Animal health economics".

The findings of the research can contribute to a better use of the Hungarian natural and economic resources that will be able to result in a better position in the European market.

5. PUBLICATIONS

Scientific articles in Hungarian

1. Bíró O. – Illés B. Cs. - **Ózsvári L.** (1999): Betegségek okozta veszteségek számszerűsítése a sertéstartásban. Magyar Állatorvosok Lapja, 121. (11) 643-647. pp. *HU ISSN 0025−004X.*
2. **Ózsvári L.** - Bíró O. - Illés B. Cs. (2001): A szarvasmarhák vírusos hasmenése és nyálkahártya betegsége (BVD és MD) okozta veszteségek nagyságának számszerűsítése. Magyar Állatorvosok Lapja, 123. (9) 555−560. pp. *HU ISSN 0025−004X.*
3. **Ózsvári L.** - Antal L. - Illés B. Cs. - Bartyik J. - Szenci O. (2001): A szubklinikai tőgygyulladás által okozott tejtermelés csökkenésből eredő veszteségek számszerűsítése az egyedi szomatikus sejtszám alapján. Magyar Állatorvosok Lapja, 123. (10) 600-604. pp. *HU ISSN 0025−004X.*
4. **Ózsvári L.** – György K. - Illés B. Cs. – Bíró O. (2003): A tőgygyulladás által okozott gazdasági veszteségek számszerűsítése egy nagyüzemi holstein-fríz tehenészetben. Magyar Állatorvosok Lapja, 125. (5) 273-279. pp. *HU ISSN 0025−004X.*
5. **Ózsvári L.** – Bíró O. (2003): Szarvasmarhák mentesítésének költség-haszon elemzése I. Gazdálkodás. 53. (2) 76-79. pp. *HU ISSN 0046-5518.*
6. **Ózsvári L.** – Bíró O. (2003): Szarvasmarhák mentesítésének költség-haszon elemzése II. Gazdálkodás. 53. (3) 46-53. pp. *HU ISSN 0046-5518.*
7. **Ózsvári L.** – Taradán Sz. - Illés B. Cs. – Bíró O. (2003): Tejtermelő szarvasmarha telepek termelési mutatóinak és gyógyszerköltségének összehasonlító vizsgálata. Magyar Állatorvosok Lapja, 125. (9) 522-531. pp. *HU ISSN 0025−004X.*
8. **Ózsvári L.** – Fux A. - Illés B. Cs. – Bíró O. (2003): A *Staphylococcus aureus* tőgygyulladás által okozott gazdasági veszteségek számszerűsítése egy nagyüzemi holstein-fríz tehenészetben. Magyar Állatorvosok Lapja, 125. (10) 579-584. pp. *HU ISSN 0025−004X.*

Scientific articles in foreign languages

1. **Ózsvári, L.** - Illés B., Cs. – Fux, A. – Bíró, O. (2003): The quantification of the economical losses caused by *Staphylococcus aureus* in a large-scale Holstein-Friesian dairy cattle farm. Acta Agraria Kaposváriensis, 7. (1) 1-8. pp. *ISSN 1418-1789.*
2. Kikkers, B. H. – **Ózsvári, L.** – Van Eerdenburg, F. J. C. M. – Börzsönyi, L. – Szenci, O. (2004): The Incidence of Mastitis Treated with Antibiotics in Large-scale Hungarian Holstein-friesian Dairy Farms. Acta Veterinaria Hungarica. 52. (1) 19-32. pp. *HU ISSN 0236-6290.*

Conference bulletins in Hungarian

1. Bíró O. - Illés B. Cs. - **Ózsvári L.** (2000): Az integrációs kapcsolatok kialakulásának esélyei a hazai sertéságazatban. Vision-2000 III. (A kooperáció, a koordináció és az integráció szerepe és lehetőségei az agrár- és a vidéki gazdaságban.) Gödöllő, 2000. nov. 10. I. kötet, 50-59. pp.
2. **Ózsvári L.** (2000): Modellszámítás a tőgygyulladás által okozott veszteségek nagyságának számszerűsítésére. Vision-2000 III. Gödöllő, 2000. nov. 10. II. kötet, 334-337. pp.

3. Keszthelyi K. - **Ózsvári L.** (2001): A magyar tejipar erőforrásainak alakulása az elmúlt évtizedben az európai uniós csatlakozás tükrében. VII. Ifjúsági Tudományos Fórum. Keszthely, 2001. márc. 29. CD kiadvány.
4. **Ózsvári L.** - Bíró O. - Illés B. Cs. (2001): A tőgygyulladás okozta veszteségek becslése. VII. Ifjúsági Tudományos Fórum. Keszthely, 2001. márc. 29. CD kiadvány.
5. **Ózsvári L.** - Antal L. - Illés B. Cs. - Bartyik J. - Szenci O. (2001): A szubklinikai tőgygyulladás által okozott tejtermelés csökkenésből eredő veszteségek számszerűsítése az egyedi szomatikus sejtszám alapján. 12. Magyar Buiatrikus Kongresszus, 2001. október 12-14. Balatonfüred, 19-23. pp.
6. Bíró O. – **Ózsvári L.** – Illés B. Cs. (2002): A kocák selejtezésének optimalizálása és a különböző selejtezési stratégiák gazdasági értékelése. VI. Magyar Biometriai és Biomatematikai Konferencia, 2002. augusztus 26-27. Budapest, 7-8. pp.
7. **Ózsvári L.** – Bíró O. (2002): A sertéságazat helyzete Magyarországon 1990-2000 között. III. Alföldi Tudományos Tájgazdálkodási Napok, 2002. október 17-18. Mezőtúr, 98-103. pp. *ISBN 963 9483 02 8*
8. **Ózsvári L.** – Bíró O. – Illés B. Cs. (2003): Modellszámítás a tőgygyulladás által okozott gazdasági veszteségekre egy nagyüzemi holstein-fríz tehenészetben. Agrárgazdaság, vidékfejlesztés és agrárinformatika az évezred küszöbén (AVA), 2003.április 1-2., Debrecen, CD-kiadvány. *ISBN 963 472 742 5* (Összefoglaló formában megjelent 1 oldalon. Agrárgazdaság, vidékfejlesztés és agrárinformatika az évezred küszöbén, 310. p. *ISBN 963 472 721 2*)
9. Bíró O. – **Ózsvári L.** – Illés B. Cs. (2003): A hazai sertéságazat versenyképességének SWOT analízise. Agrárgazdaság, vidékfejlesztés és agrárinformatika az évezred küszöbén (AVA), 2003. április 1-2., Debrecen, CD-kiadvány. *ISBN 963 472 742 5* (Összefoglaló formában megjelent 1 oldalon. Agrárgazdaság, vidékfejlesztés és agrárinformatika az évezred küszöbén, 290. p.)
10. Pogány K. - **Ózsvári L.** – Bíró O. (2003): Tejhasznú kecsketelep létesítésének gazdasági értékelése. Agrárgazdaság, vidékfejlesztés és agrárinformatika az évezred küszöbén (AVA), 2003. április 1-2., Debrecen, CD-kiadvány. *ISBN 963 472 742 5* (Összefoglaló formában megjelent 1 oldalon. Agrárgazdaság, vidékfejlesztés és agrárinformatika az évezred küszöbén, 358. p. *ISBN 963 472 721 2*)

Conference bulletins in foreign languages

1. **Ózsvári, L.** - Antal, L. - Illés B. Cs. - Bartyik, J. - Szenci, O. (2001): Calculation of economical losses due to subclinical mastitis in dairy cattle. III. Middle-European Congress for Buiatrics (Health problems in ruminants), Brno, Czech Republic, 24th and 25th May 2001., 227-230. pp. *ISBN − 80 − 902676 − 8 − 8*
2. **Ózsvári, L.** - Antal, L. - Illés B. Cs. - Bartyik, J. - Szenci, O. (2001): Calculation of economical losses owing to subclinical mastitis in dairy cattle on the basis of somatic cell counts of individual milk samples. 3rd International Conference of PhD students. University of Miskolc, Hungary, 13-19 August 2001. Economics, 177-182. pp. *ISBN 963 661 480 6, ISBN 963 481 4*
3. Keszthelyi, K. - **Ózsvári, L.** (2001): Resources of the hungarian milk industry in the last decade, considering the european integration. 3rd International Conference of PhD students. University of Miskolc, Hungary, 13-19 August 2001. Proceedings, 163-169. 163-169. pp. *ISBN 963 661 480 6, ISBN 963 661 448 1*

4. Bíró, O. – **Ózsvári, L.** (2002): Present situation of the global pig production and trade. 2nd International Conference for Young Researchers of Economics, Szent István University, Gödöllő, Hungary. 17-18 October 2002. Volume II. 37-44. pp. *ISBN: 963 9483 05 29, ISBN: 963 9483 06 9*

Book and lecture notes

1. **Ózsvári L.** (2002): Az EU agrárpolitikája. 40-74. pp. In: Visnyei L. (szerk.): *Európai ismeretek.* Egyetemi jegyzet. Budapest: SZIE, ÁOTK, TTK, 81. p.
2. **Ózsvári L.** – Bíró O (2003): Az állat-egészségügyi menedzsment szerepe a haszonállattartás eredményességének javításában. 33-41. pp. In: Takács I. (szerk.): *Korszerű, HACCP elveken alapuló állatorvosi telepellátás az élelmiszerbiztonságért (KÁTÉ)*. Kézikönyv. Budapest: Nyomdaipari és Kiadói Szolgáltató Kft., 216. p.
3. **Ózsvári L.** (2003): A tejelő szarvasmarha-egészségügyi menedzsment főbb gazdasági kérdései. 177-189. pp. In: Takács I. (szerk.): *Korszerű, HACCP elveken alapuló állatorvosi telepellátás az élelmiszerbiztonságért (KÁTÉ)*. Kézikönyv. Budapest: Nyomdaipari és Kiadói Szolgáltató Kft., 216. p.

Professional articles in Hungarian

1. Bíró O. – **Ózsvári L.** (1999): Világszerte válságban a sertéságazat. A Sertés, 4. (3) 29-31. pp. *HU−ISSN 14 16−55−38*
2. Bíró O. - Illés B. Cs. – **Ózsvári L.** (1999): Integrációs kapcsolatok. Magyar Mezőgazdaság, 54. (23) 20-21. pp. *HU ISSN 0025−018X*
3. Bíró O. - Illés B. Cs. – **Ózsvári L.** (1999): Integrációs kapcsolatok II. Magyar Mezőgazdaság, 54. (24) 16-17. pp. *HU ISSN 0025−018X*
4. **Ózsvári L.** (1999): Az integrációs folyamat I. A Sertés, 4. (4). 78-79. pp. *HU−ISSN 14 16−55−38*
5. **Ózsvári L.** (2000): Hazánk EU integrációs folyamata II. A Sertés, 5. (1). 58-61. pp. *HU−ISSN 14 16−55−38*
6. **Ózsvári L.** (2000): Hazánk agrárkereskedelme az Európai Uniós csatlakozás küszöbén. A Sertés, 5. (2) 62-69. pp. *HU−ISSN 14 16−55−38*
7. Bíró O. – **Ózsvári L.** (2000): Válságok ciklusban I. Magyar Mezőgazdaság, 55. (4) 20. p. *HU ISSN 0025−018X*
8. Bíró O. – **Ózsvári L.** (2000): Válságok ciklusban II. Magyar Mezőgazdaság, 55. (5) 10. p. *HU ISSN 0025−018X*
9. **Ózsvári L.** (2000): Külkereskedelmünk tíz éve. Magyar Mezőgazdaság, 55. (43) 10-11. pp. *HU ISSN 0025−018X*
10. **Ózsvári L.** - Bíró O. (2001): A szarvasmarha fertőző rhinotracheitisének gazdasági jelentősége I. A betegség okozta veszteségek becslése. Állatorvosi praxis. 3. (1): 24-27. pp.
11. **Ózsvári L.** - Antal L. - Illés B. Cs. - Bartyik J. - Szenci O. (2001): A szubklinikai tőgygyulladás által okozott tejtermelés kiesésből eredő veszteségek számszerűsítése az egyedi elegytej szomatikus sejtszáma alapján. Partner Tájékoztató Hírlevél. 2001. június.
12. **Ózsvári L.** - Bíró O. (2001): Az IBR veszteségei. Magyar Mezőgazdaság, 56. (29) 20-21. pp. *HU ISSN 0025−018X*
13. **Ózsvári L.** - Bíró O. (2001): Gazdaságos mentesítés. Magyar Mezőgazdaság, 56. (33) 16-17. pp. *HU ISSN 0025−018X*

14. **Ózsvári L.** - Bíró O. (2001): A szarvasmarha fertőző rhinotracheitisének gazdasági jelentősége II. Marker vakcinára alapozott szelekciós mentesítési program költség-haszon elemzése. Állatorvosi praxis. 3. (3) 26-29. pp.
15. Szeidemann Zs. – **Ózsvári L.** (2001): A hazai szarvasmarha állományok IBR-mentesítése I. Miért szükséges nekünk is mentesítenünk? Partner-Tájékoztató Hírlevél, 2001. szeptember.
16. Szeidemann Zs. – **Ózsvári L.** (2001): A hazai szarvasmarha állományok IBR-mentesítése II. Markervakcinázás mellett végzett szelekció. Partner-Tájékoztató Hírlevél, 2001. október.
17. Szeidemann Zs. – **Ózsvári L.**(2001): A hazai szarvasmarha állományok IBR -mentesítése III. A Bayovac IBR-Marker alkalmazhatósága a mentesítési programban. Partner-Tájékoztató Hírlevél, 2001. november.
18. **Ózsvári L.** - Bíró O. - Illés B. Cs. (2001): Tőgyegészségügyi programok gazdasági értékelésének módszertani kérdései. Kutatási jelentés az MTA Állatorvos-tudományi Bizottsága Akadémiai beszámoló ülésein. Budapest, 2001. jan. 22−24. Magyar Állatorvosok Lapja, 123. (8.) 451. p. *HU ISSN 0025−004X.*
19. **Ózsvári L.** - Antal L. - Illés B. Cs. - Bartyik J. - Szenci O. (2002): Tőgygyulladás – (sejt)számokban. Magyar Mezőgazdaság, 57. (3) 18-19. pp. *HU ISSN 0025−018X*
20. **Ózsvári L.** – Bíró O. – Szmodits Zs. (2002): Kisállatrendelő létesítésének üzleti terve I. Kisállatpraxis, 3. (1) 26-33. pp. *ISSN: 1585-9142*
21. **Ózsvári L.** – Bíró O. – Szmodits Zs. (2002): Kisállatrendelő létesítésének üzleti terve II. Kisállatpraxis, 3. (2) 24-32. pp. *ISSN: 1585-9142*
22. **Ózsvári L.** – Bíró O. – Szmodits Zs. (2002): Kisállatrendelő létesítésének üzleti terve III. Kisállatpraxis, 3. (3) 44-51. pp. *ISSN: 1585-9142*
23. **Ózsvári L.** (2002): Modellszámítás a tőgygyulladás által okozott veszteségek nagyságának számszerűsítésére. Ad. us. vet., (2.) 3-6. pp.
24. **Ózsvári L.** - Bíró O. - Illés B. Cs. (2002): Veszteségek számokban. Magyar Mezőgazdaság, 57. (40) 18-19. pp. *HU ISSN 0025−018X*
25. **Ózsvári L.** - Bíró O. - Illés B. Cs. (2002): Veszteségek számokban. II. Magyar Mezőgazdaság, 57. (42) 16-17. pp. *HU ISSN 0025−018X*
26. Henk A. Kuijk (2002): Az IBR-markervakcinára alapozott szelekciós mentesítés tapasztalatai Hollandiában. Magyar Állatorvosok Lapja, 2002. 124. (7) 398-408. pp. *HU ISSN 0025−004X.* H. A. Kuijk, az Intervet Holland állatorvosának Budapesten, 2002. március 6-án az „IBR-mentesítés küszöbén” elhangzott előadása alapján összeállította **Ózsvári László**
27. Pogány K. – **Ózsvári L.** (2003): Modellszámítás tejhasznú kecsketelep létesítésére. Magyar Juhászat, 12. (4) 13-15. pp. *HU ISSN 0025−018X*
28. **Ózsvári L.** (2003): A tőgygyulladásról számokban. Magyar Mezőgazdaság, 58. (38) 22-23. pp. *HU ISSN 0025−018X*
29. **Ózsvári L.** – Bíró O. – Nagy K.. (2003): Gazdasági modellszámítás vegyespraxis indítására I. Kisállatpraxis, 4. (5) 228-237. pp. *ISSN: 1585-9142*
30. **Ózsvári L.** - Bíró O. (2003): Hogyan növeljük jövedelmünket a haszonállatpraxisban? Állatorvosi Kamarai Hírek, 14. (5) 26-27. pp.
31. **Ózsvári L.** (2003): A hazai tejelő szarvasmarhatartás versenyképességének növelése. Partner-Tájékoztató Hírlevél, 2003. november 9-16. pp.