VETERINARSKI ARHIV 86 (4), 499-513, 2016

Estimation of production and reproductive performance losses in dairy cattle due to bovine herpesvirus 1 (BoHV-1) infection

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CAN, M. F., V. S. ATASEVEN, C. YALÇIN: Estimation of production and reproductive performance losses in dairy cattle due to bovine herpesvirus 1 (BoHV-1) infection. Vet. arhiv 86, 499-513, 2016.

ABSTRACT

Infectious bovine rhinotracheitis caused by bovine herpesvirus 1 (BoHV-1), which negatively affects the production performance of infected cattle herds, results in considerable economic losses in dairy farms. The present study aimed to estimate farm-level production and reproductive performance losses in seropositive (SP) dairy cattle infected with BoHV-1. A total of 266 non-vaccinated cows were selected from 31 herds located in different parts of Hatay, Turkey. Data collected from SP and seronegative (SN) cows were compared with each other. Compared to the SN cows, 10% and 9% decreases were found regarding milk production ($P<.01$) and live weight ($P<.01$) in SP cows, respectively. Reproductive and mixed clinical problems in infected cows lead to the highest losses in respect of milk production and live weight, respectively. The financial loss due to the infection was estimated to be $US331 if abortion does not occur, and $US509 if abortion occurs as a result of the infection. Considering the likelihood of abortion, the average cost of infection was estimated to be $US379 per infected cow.

Key words: BoHV-1, cattle, economic, production losses

Introduction

Infectious bovine rhinotracheitis, caused by bovine herpesvirus 1 (BoHV-1), is a disease of domestic and wild cattle (OIE, 2010). BoHV-1 leads to respiratory disease (infectious bovine rhinotracheitis, IBR) in cattle, genital diseases in females or males (infectious pustular vulvovaginitis, IPV and infectious pustular balanoposthitis, IPB), and

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ISSN 0372-5480
Printed in Croatia

other clinical syndromes, such as: conjunctivitis, metritis, mastitis, encephalitis, abortion, and enteritis (STRAUB, 1990). MUYLKENS et al. (2007) and NUOTIO et al. (2007) stated that latently infected animals that shed the virus play a major epidemiological role in the dissemination of BHV-1 infection. The infection has a low mortality rate, and generally follows a subclinical course. Most of the cattle in a herd can become infected in a short time as a result of respiratory transmission (McDERMOTT et al., 1997). In spite of a clear immune response, the virus, which can establish life-long latency, is not eliminated from the infected host (ACKERMANN and ENGELS, 2006).

It is reported that BoHV-1 has been eradicated from only a small number of European countries, including Austria, Denmark, Finland, Sweden, Italy (Province of Bolzano), Switzerland, Norway, and parts of Germany. However, the infection is widely distributed in beef and dairy cattle herds around the world (ACKERMANN and ENGELS, 2006). Serological surveys performed over the past 40 years in different parts of Turkey, which is located in the southeastern part of the European continent, have indicated that the virus is endemic among dairy and beef cattle populations (GÜRTÜRK et al., 1975; BURGU and AKÇA, 1986; ÖZTÜRK et al., 1988; ALKAN et al., 2005; TAN et al., 2006; BISWAS et al., 2013). The disease is notifiable in many countries except Turkey, and some control measures, such as screening, surveillance, vaccinations, precautions at borders, and eradication policies, are currently being implemented against BoHV-1. Although many countries allow vaccinations, they are prohibited in countries that have eradicated the disease (NUOTIO et al., 2007). Vaccination has been considered as an effective method to prevent BoHV-1 and reducing economic losses; however, it contributes to high seroprevalence. If the decision is made to eradicate the infection from cattle populations, the culling of SP animals without vaccination can be a successful method when the prevalence is relatively low (ACKERMANN and ENGELS, 2006). Previous reports indicated that some cattle that have recovered from an acute infection remain latent carriers for the rest of their lives, and the infection can be reactivated by stressful conditions and immunosuppressive treatments (PASTORET et al., 1984; NANDI et al., 2009).

BoHV-1, which negatively affects the production performance of infected cattle herds, results in considerable economic losses in dairy farms due to loss of body weight, decrease in milk production, abortion, embryonic death, still birth, fertility disorders, extra feeding costs, and infection control costs (MILLER, 1991; NOORDEGRAAF et al., 2000; BANDYOPADHYAY et al., 2010; ATA et al., 2012; BISWAS et. al., 2013). The introduction of the virus into a cattle farm can also cause restrictions in international livestock trade (NANDI et al., 2009). In order to reduce economic losses due to BoHV-1, feasible disease control strategies should be implemented in terms not only of a technical perspective, but also an economic aspect (CAN and YALÇIN, 2014). For this, the first step should be to estimate the production losses caused by BoHV-1.

A large number of previous studies have referred to the economic importance of the infection, (MILLER, 1991; NOORDEGRAAF et al., 1998; NANDI, 2009; BANDYOPADHYAY et al., 2010; ATA et al., 2012; BISWAS et al., 2013) but there are only a few studies which analyze the production and/or reproductive performance losses due to BoHV-1 (BIUK-RUDAN et al., 1998; HAGE et al., 1998; DEL FAVA et al., 2006; ATA et al., 2012). To the best knowledge of the researchers, to date, there have been no observational studies undertaken in Turkey to investigate production losses due to BoHV1 infection. The new insights provided by the present study would be to clarify the estimation of the BoHV-1-induced production losses in Turkish dairy herds, where the disease is endemic. The aims of the study were (I) to estimate production and reproductive performance losses in seropositive dairy cattle infected with BoHV-1, (II) to investigate the association between different clinical statuses of infected animals with the production and performance parameters, and (III) to calculate financial losses due to the infection.

Materials and methods

Selection of herds and animals. The study was carried out on a total of 266 randomly selected Holstein-Friesian dairy cows, selected from 31 herds located in different parts of Hatay, Turkey. The city, which is located in the Mediterranean region of south-central Turkey (36°15′N, 36°08′E), has a population of nearly 1,500,000, 142,473 cattle and 5,403 square kilometers' total area. A majority of the dairy herds, both in Turkey and Hatay, are still small-scale, and mixed farming is the dominant production system on these farms (TSI, 2011; CAN and ALTUĞ, 2014).

In order to determine the minimum number of cows for the study, the following formula was used (ISRAEL, 1992):

$$n = \frac{Z^2 \, p\,(1-p)}{e^2}$$

where p = the expected BoHV-1 prevalence rate of 20%, which was obtained from previous studies conducted in Turkey, Z = 1.96 for a 95% confidence interval, e = 0.05 sampling error, or in other words, the desired level of precision. Using the formula, the minimal estimated sample size was found to be 246. Cows were registered in the TURKVET veterinary information system, which is kept by the Ministry of Food, Agriculture and Livestock of the Republic of Turkey. Volunteer farms were selected from those that were willing to work and collaborate with us. In the study, 25% of each herd was sampled until the desired sample size was reached. Cows were selected randomly from a list including their tag numbers. The number of cows in the herds ranged from 16 to 68 (mean ± SD was 34.32 ± 13.77). None of the cows included in this study had ever been vaccinated against BoHV-1. New animals were not introduced into the selected herds during the study.

Serology. Sera were diluted to 1:5 and tested using a commercial anti-gB BoHV-1 antibody competitive ELISA kit (ID Screen, IDvet, France), which had specificity ($CI_{95\%}$: 99.69-100) and sensitivity ($CI_{95\%}$: 96.23-100) of 100%. The test was carried out as described by the manufacturer, and all results were evaluated spectrophotometrically at 450 nm adsorbance. Samples with OD values ≤50% were considered positive for anti-gB BoHV-1 antibodies, as indicated in the kit procedure.

Data collection and evaluation. After diagnostic tests, farms in which BoHV-1 seropositive cows were detected were visited by the researchers for a second time to collect the production (milk production-MP, live weight-LW) and reproductive performance (age at first calving-AFC, calving interval-CAI and numbers of insemination used per pregnancy-NI), and health data (abortion and observed precise clinical signs) as mentioned below. CAI can be defined as the period of time between two calvings. AFC covers puberty, gestation, and delivery of a calf and may be defined as the period of time between the date of birth and the date of the first calving (DAKAY et al., 2006; BORMANN and WILSON, 2010).

In the present study, MP and LW were measured over 3 months after the diagnostic tests. MP data were collected from SP and SN cows over a 90-day period and the performance parameters for milk production were reported in kg milk/day (BARTELS et al., 2006). Since all cows were milked twice a day on these farms, morning and evening yields were added together to obtain the daily MP. Data were checked for missing values and if there was a missing value, it was replaced by the mean of the previous and following MPs for the same time of day, morning or evening, as HAGE et al. (1998) suggested. In data collection process, the researchers did not obtain all the LW data with one measurement due to the large number of problems caused by the weighing platform or process, the hyperactivity of some of the cows, and the lack of time/rushing of the farmers. Therefore, SP and SN cows were weighed three times during the study on the 30^{th}, 60^{th}, and 90^{th} days. To avoid stress to the animals during the data collection process, milk yield and live weight measurements were taken by experienced staff familiar with the cows (HORAN et al., 2005).

Reproduction parameters, including the presence of abortion cases (Yes or No), NI, CAI, and AFC, were based on farm records for the years 2012-2013. Both reproductive and clinical data were followed up for one year before diagnostic tests. Production losses observed between the years of 2012-2013 were also calculated for different clinical problems similar to BoHV-1. In the study, SP animals were classified into four categories: (I) no clinical signs, (II) only respiratory problems, (III) only reproductive problems, (IV) mixed problems (both respiratory and reproductive problems). The clinical problems were defined on the basis of precise clinical signs. For reproductive problems vaginal discharge and/or abortion, and for respiratory problems inflammation of the nose and nasal discharge, were considered in particular (NANDI et al., 2009; OIE, 2010). Clinical signs were recorded by the farmer and subsequently confirmed by a private vet.

Table 1. Parameters considered and calculation methods for financial losses due to BoHV-1

Parameters and calculation methods 1.Technical and financial parameters	Unit values	Values	Source of information
1.a. Estimated MP loss	L/day	1.88	Present study
1.b. Estimated LW loss	kg/cow	42.50	Present study
1.c. Delay in AFC	days	13.88	Present study
1.d. Delay in CI	days	13.20	Present study
1.e. Abortion rate due to infection	%	27.45	Present study
1.f. Feed saved due to infection	%	0.10	Assumption
1.g. Raw milk price	$/l	0.51	Turkish Milk Board (2015)
1.h. Liveweight price	$/kg	3.62	UCCET (2015)
1.i. Value of 1 day delay in CI	L milk equivalent	11.0	Yalçın and Yıldız (2014)
1.j. Value of 1 day delay in AFC	L milk equivalent	16.0	Yalçın and Yıldız (2014)
1.k. Daily feed intake	kg dry mater equivalent	10.0	Interviews with farms
1.l. Price of 1 kg dry mater	($/kg)	0.34	UCCET (2015)
1.m. Lactation length in cows	Days	305	Accepted literature value
2. Calculation methods for losses			
2.a. MP losses $/cow/year	$/cow/year	= [(1a×1g ×1m) - (1f×1k×1l×1m)]	
2.b. LW losses	$/cow/year	= (1b × 1h)	
2.c. Cost of delay in AFC	$/cow/year	= (1c × 1e × 1j)	
2.d. Cost of delay in CI	$/cow/year	= (1d × 1e × 1i)	
3. Final losses due to the BoHV-1			
3.a. The cost of infection if abortion occurs	$/cow	= (2a + 2b + 2c + 2d)	
3.b. The cost of infection if abortion doesn't occurs	$/cow	= (2a + 2b)	
3.c. Average cost of the BoHV-1	$/cow	= [(3a × 1e) + ((3b × (1-1e))]	

Statistical analyses. The statistical association of the differences in production and reproductive performance values between SP and SN cows was obtained using either the paired sample t test (if parametric test assumptions were met) and Wilcoxon signed rank test (if parametric test assumptions were not met). The Mann-Whitney U test was used to compare the differences between the SP and SN dairy cows in terms of abortions. The Shapiro-Wilks test (more suitable for a sample size lower than 50) was used to test for normality. Fisher's exact chi-square test was used to test for possible associations between abortions and the observed clinical signs (CAN, 2014; CAN and ALTUĞ, 2014). All probability values <.05 were considered to be statistically significant.

Financial analysis. The infection-induced losses were calculated by deducting the values of production parameters of the seropositive (SP) cows from those that were seronegative (SN), if the difference was found to be statistically significant. In order to compare the data correctly, SP and SN cows that were of the same age and lactation period were selected from the same herd (raised under the same management and environmental conditions). In other words, SP and SN cows were considered as the experimental and control groups, respectively.

The methodological framework regarding the financial calculation (calculation methods and math formulas) was adapted from previous studies (SENTÜRK and YALÇIN, 2008; SARIÖZKAN and YALÇIN, 2009; CAN and YALÇIN, 2014). The details of the data used in the financial analysis are presented in Table 1.

Results

The present study results reveal that 51 (19%) of the 266 cows were seropositive for BoHV-1 (95% CI: 10.62-29.58). In this study, 31 farms were sampled for BoHV-1 antibody status and, as a result of the sampling process, a total of 18 herds (58.06%) were found to be positive. Seroprevalence rates for BoHV-1 in the individual herds ranged between 0 to 85.7%. The mean, standard deviation, and significance levels of some of the production and reproductive performance parameters are given in Table 2. A statistically significant difference was found regarding milk production and live weight between the SP and SN cows. The results show a 9% decrease in LW and a 10% decrease in MP in SP cows compared to the SN cows. In spite of the fact that the values of production and reproductive performance parameters were lower in SP cows than those in the SN cows, these associations were not found to be statistically significant at the $P<0.05$ level.

The data were further analyzed by separating the groups according to whether abortion occurred as a result of the infection. The findings are presented in Tables 3 and 4. The statistical analyses show that if the infection did not result in abortion, the differences in the performance parameters between SP and SN cows were not significant at $P<0.05$, except for LW (Table 3). In contrast, if the infection resulted in abortion, the differences in all of the performance parameters between SP and SN cows were found to be significant at $P<0.05$ (Table 4). In the present study, significant differences were also found between SP and SN dairy cows in terms of abortions (Mann Whitney U test = 620.500, $P<0.01$).

Table 2. Comparison of the production and performance characteristics of seropositive and seronegative dairy cows

Production and performance characteristics	SP[a] dairy cows		SN[b] dairy cows		Estimated loss	P-value
	N	Mean ± SD	N	Mean ± SD		
Milk production (L/day)	49	17.63 ± 6.64	49	19.51 ± 7.12	1.88 L (10%)	< 0.01
Live weight (kg)	51	420.39 ± 85.17	51	462.94 ± 68.26	42.55 kg (9%)	< 0.01
Calving interval (day)	32	406.63 ± 26.98	32	402.47 ± 20.57	4.16 day	> 0.05
Age at first calving (day)	17	870.29 ± 42.49	17	863.88 ± 39.51	6.41 day	> 0.05
Number of insemination	49	1.72 ± 1.03	49	1.56 ± 0.70	0.16 times	>0.05

[a] SP - seropositive; [b] SN - seronegative

Table 3. Comparison of the production and performance characteristics of seropositive and seronegative non-aborted dairy cows

Production and Performance characteristics	SP[a] non-aborted cows		SN[b] non-aborted cows		Estimated loss	P-Value
	N	Mean ± SD	N	Mean ± SD		
Milk production (L/day)	20	18.00 ± 6.37	20	19.05 ± 6.09	1.05 L (6%)	> 0.05
Live weight (kg)	21	421.63 ± 85.16	21	465.31 ± 68.25	43.68 kg (9%)	< 0.01
Calving interval (day)	11	407.91 ± 29.27	11	404.09 ± 21.72	3.82 day	> 0.05
Age at first calving (day)	9	864.78 ± 28.34	9	855.22 ± 30.70	9.56 day	> 0.05
Number of insemination	20	1.57 ± 0.81	20	1.48 ± 0.68	0.10 times	> 0.05

[a] SP - seropositive; [b] SN - seronegative

Table 4. Comparison of the production and performance characteristics of seropositive and seronegative aborted dairy cows

Production and Performance characteristics	SP[a] aborted cows		SN[b] aborted cows		Estimated loss	P-Value
	N	Mean ± SD	N	Mean ± SD		
Milk production (L/day)	13	16.23 ± 7.23	13	19.15 ± 7.19	2.92 L (15%)	< 0.05
Live weight (kg)	13	410.00 ± 85.16	13	455.77 ± 68.25	45.77 kg (10%)	< 0.01
Calving interval (day)	8	415.13 ± 31.05	8	401.25 ± 11.62	13.88 day	< 0.05
Age at first calving (day)	5	888.00 ± 28.34	5	874.80 ± 30.70	13.20 day	< 0.05
Number of insemination	13	2.23 ± 1.14	13	1.54 ± 0.66	0.69 times	< 0.05

[a] SP - seropositive; [b] SN - seronegative

Table 5. Production and performance parameters according to clinical histories of the seropositive dairy cows infected with BoHV-1

Production and performance characteristics	Clinical categories for SP[a] and SN[b] dairy cows											
	No clinical signs -I (n = 25)			Respiratory problems - II (n = 6)			Reproductive problems -III (n = 14)			Mixed problems -II and III (n = 6)		
	SP[a]	SN[b]	Loss	SP[a]	SN[b]	Loss	SP[a]	SN[b]	Loss	SP[a]	SN[b]	Loss
Milk production	17.91	19.27	1.36*	22.75	17.91	NS	17.64	20.58	2.94*	13.16	14.16	NS
Live weight	435.23	472.50	37.27**	376.0	448.0	NS	415.88	454.11	38.23**	414.16	463.33	49.17*
Calving interval	401.63	399.66	NS	405.25	401.25	NS	412.2	409.2	NS	-	-	-
Age at first calving	866.83	842.0	NS	-	-	-	854.43	880.0	NS	903.25	868.5	34.75*
Number of insemination	1.59	1.40	NS	2.0	1.75	NS	1.53	1.76	NS	2.67	1.50	1.17*

[a] SP - seropositive; [b] SN - seronegative; NS - non-significan; *< 0.05, **< 0.01

The findings regarding some production and performance characteristics according to the different clinical histories of the SP and SN dairy cows are presented in Table 5. Significant production and performance differences were detected between the groups for some clinical categories. On the other hand, no significant losses were observed in infected cows for respiratory problems. A statistically significant association was observed between the presence of abortion and the clinical histories of the SP dairy cows. In the current study, farm records concerning abortion cases indicated that 27% of the infected cows (14 of the 51 animals) aborted during the study period, and the highest rate of abortion occurred in those having reproductive problems (Table 6).

Table 6. Association between the clinical histories of seropositive dairy cows infected with BoHV-1 and the presence of abortion

Presence of abortion	Clinical categories for seropositive dairy cows (n = 51)									
	No clinical signs-I		Only respiratory problems-II		Only reproductive problems-III		Mixed problems -II and III		Total	
	N	%	N	%	N	%	N	%	N	%
No	23	92.0	5	83.3	6	42.8	3	50.0	37	100
Yes	2	8.0	1	16.7	8	57.2	3	50.0	14	100

The Fisher's exact test value = 12.596, P< 0.01

Table 7. Financial losses due to BoHV-1 according to different outcomes of the infection

Production and performance losses	Estimated financial loss per infected cow (US$)	Proportional shares of the losses (%)
a. Losses due to “milk yield” reduction	177	34.8
b. Losses due to “live weight” decrease	154	30.2
c. Losses due to “prolonged age at first calving”	103	20.3
d. Losses due to “prolonged calving interval”	75	14.7
“Outcome I”: If abortion does not occurs (a + b)	331	65.0
“Outcome II”: If abortion occurs (a + b+ c + d)	509	100.0
The estimated average loss[a]	$379 US	

[a] This is the weighted average of the two different financial outcomes of the infection

The results of the financial analysis are presented in Table 7. As may be seen from the Table, MP is the largest loss component. Furthermore, total financial losses increase if abortion occurs as a result of the infection. The financial loss due to the infection was estimated to be $US331 if abortion does not occur and $US509 if abortion occurs. Considering the likelihood of abortion, the average cost of infection was estimated to be $US379 per infected cow.

Discussion

There were a number of potential difficulties in the current study. Firstly, although there were a large number of small-scale farms in the region, we had a limited number of volunteer farmers who kept production records regularly and completely. However, the data used in the study were relatively more reliable due to the fact that all the farmers were members of the dairy cattle breeding organization, and their farms were under the control of a private or official veterinarian. Secondly, the selection of SN animals was an important stage in this study, because they should have had very similar characteristics to SP cows. Therefore, in order to estimate the losses more accurately, the differences between some of the individual characteristics of the paired cows (such as management conditions, breed, age, lactation period etc.) were minimized as much as possible. The main obstacles to obtaining more SP animals were the lack of sufficient budget and volunteer farmers.

The reported seroprevalence rates of the disease cover a wide range in the Turkish cattle population. The results of seroprevalence studies conducted in different parts of Turkey between 1971 and 2012 (GÜRTÜRK et al., 1975; BURGU and AKÇA, 1986; ÖZTÜRK et al., 1988; ALKAN et al., 2005; TAN et al., 2006) demonstrated that the disease is endemic in the cattle population, and the reported seroprevalence of BoHV-1 ranged from 4 to 79%. In this study, about one out of five of the sampled cows was found to be positive for

BoHV-1. This wide range of results in the literature may be explained by many factors, such as the number of animals sampled, the age of the animals, the conditions of care and feeding (ALBAYRAK et al., 2012), different biosecurity measures implemented by farmers (CAN and ALTUG, 2014) and the geographical localization of the herd sampled. It is to be noted that the real prevalence in the study area probably differs from our finding, owing to the use of volunteer farms. However, even so, it may be close to the real value because the total number of animals used in the study was greater than the minimum sample size.

Although many studies have previously mentioned that infected animals are negatively affected by MP and LW losses (MILLER, 1991; NOORDEGRAAF et al., 1998; NANDI, 2009; BANDYOPADHYAY et al., 2010; ATA et al., 2012; BISWAS et. al., 2013), very few studies have analyzed the impact of BoHV-1 and disease induced MP losses. HAGE et al. (1998) reported the statistical association of the differences in MP in SP and SN cows. Moreover, a daily decrease of 0.68 kg MP loss was reported in their study. This finding is similar to the result reported in the present study, but the estimated disease induced loss reported here is much higher. Although DEL FAVA et al. (2006) reported that infection has no significant effect on the LW of the infected cows, in the current study, statistically significant differences were found in respect to LW between the SP and SN cows (Table 2, 3, and 4).

Unlike in this study, the impact of the disease on reproductive performance was investigated in similar studies in the literature without separating cases where abortion occurred from those where it did not occur as a result of the infection. In the present study, the statistical association between differences in the reproductive performance parameters was only found to be significant if abortion occurred as a result of infection. It is more logical to expect the extension of AFC and CAI if abortion occurs. Significant reproductive disorders (BIUK-RUDAN et al., 1998) and a decrease in the pregnancy rate (HAGE et al., 1998) have been reported due to the infection. Also, another study reported that there was a close relationship between BoHV-1 infection and reproduction loss in Repeat Breeding Dairy Cows (RBDC). The average days open period was significantly longer in seropositive RBDC than seronegative RBDC (ATA et al., 2012). However, in contrast to these studies, DEL FAVA et al. (2006) did not detect any reproductive disorders (decrease in calving rate, birth of weak calves or stillbirths) in infected cows. It should be noted that the above mentioned losses cannot be observed in some infected cases because SP animals may not show clinical signs, or losses may have occurred only during the acute phase of the infection.

Previous studies (MILLER, 1991; GIVENS, 2006; ATA et al., 2012) reported that BoHV-1, which is the most frequently diagnosed cause of abortion in cattle, can cause abortion and fertility disorders. In contrast, ALLAN et al. (1975) and HAGE et al. (1998) reported that the impact of the infection on pregnancy and abortion rates was not statistically significant. The results reported in this study are along the same lines as the first group of studies mentioned above. Furthermore, although the current study reported that abortions commonly follow reproductive problems, according to GIVENS (2006), in contrast to these findings, abortions commonly followed the respiratory form of the disease.

Significant production and performance changes may occur in infected cows in cases when no clinical signs, reproductive problems or mixed clinical problems are detected. Additionally, "only reproductive problems" and "mixed problems" lead to the highest losses in MP and LW, respectively (Table 5). There were no production or reproductive performance losses in infected cows if only respiratory problems were observed. The possible reasons for these findings may be overlooked symptoms, simultaneous infection with more than one organism/pathogen, or the limited number of dairy cows sampled.

In this study, the estimated financial loss for an infected case is nearly 15% of the market value ($404/$2600) of Holstein-Friesian dairy cattle on the current market in Turkey. If other direct and indirect losses (culling, medical treatment and infection control costs, work force expenditure, transportation costs, export bans etc.) are added to the present findings, the total cost will significantly increase for both producers and the national economy. It should however be borne in mind that if losses are to be calculated at regional or national levels, a different methodological approach (e.g. the impact of the disease on the supply and demand curve and hence the market equilibrium price) and much more comprehensive data (e.g. data not only for the impact of the disease on production, but also beyond the production system) will be needed. BENNET (2003) reported that the annual economic burden of the infection (output loss and input expenditure, including control measures) for Great Britain ranged between £1 and £4 million according to different scenarios. Another study reported that national losses due to the infection for Netherlands vary from about Dfl. 1000 to Dfl. 300000 (NOORDEGRAAF et al., 2000).

The study concluded that the infection causes losses in the MP and LW of cows. Furthermore, if the infection results in abortion, further losses are occurred due to longer AFC and extended CI. The average financial loss due to infection was estimated to be $US402 per infected cow in this study. This loss may be reduced to an acceptable level on infected farms by correctly applied and economically rational biosecurity practices. Testing for BoHV-1before introducing animals to the herd may be the best way to protect against the infection. Although culling is an important alternative for producers, it does not seem to be economically advantageous or feasible. The authors of the current study suggest that partial budget analyses at the farm level and cost-benefit analyses at a national level should be conducted before determining which infection control strategy should be used. Also, transparent legal regulations concerning the infection must be put into practice, and training programs should be arranged to increase awareness among livestock producers. Even though the results of the present study provide useful information about infection induced losses, further comprehensive studies are needed to determine the effect of BoHV-1 on reproductive performance and production losses, in both dairy cattle and beef cattle.

Acknowledgements

No conflict of interest was declared by the authors of this paper. The current study was supported by the Mustafa Kemal University, Scientific Research Project Department (Project No.291). A preliminary abstract of this study was presented as an oral presentation at the 31st World Veterinary Congress (17-20 September 2013, Prague, Czech Republic)

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Received: 17 June 2015
Accepted: 22 March 2016

CAN, M. F., V. S. ATASEVEN, C. YALÇIN: Procjena proizvodnosti i gubitaka zbog reprodukcijskih poremećaja u mliječnih goveda zaraženih goveđim herpesvirusom 1. Vet. arhiv 86, 499-513, 2016.

SAŽETAK

Zarazni rinotraheitis uzrokovan goveđim herpesvirusom 1 negativno utječe na proizvodne sposobnosti zaraženog stada i dovodi do znatnih gospodarskih šteta. Istraživanje je provedeno radi procjene proizvodnje i gubitaka zbog reprodukcijskih poremećaja mliječnih goveda serološki pozitivnih na goveđi herpesvirus 1. Za istraživanje je bilo odabrano ukupno 266 necijepljenih krava iz 31 stada iz različitih dijelova područja Hatay u Turskoj. Međusobno su uspoređeni rezultati od serološki pozitivnih i serološki negativnih krava. U usporedbi sa serološki negativnim kravama proizvodnja mlijeka u serološki pozitivnih bila je smanjena za 10% ($P<0,01$), a tjelesna masa za 9% ($P<0,01$). Reprodukcijski i drugi klinički poremećaji u zaraženih su krava doveli do većih gubitaka u proizvodnji mlijeka i tjelesne mase. Financijski gubitci zbog infekcije bili su procijenjeni na razini 331 US $ ako se nije javljao pobačaj, a 509 US $ kad se javljao pobačaj kao rezultat infekcije. Razmatrajući vjerojatnost pojave pobačaja, prosječni gubitak od infekcije procijenjen je na 379 US $ po zaraženoj kravi.

Ključne riječi: goveđi herpesvirus 1, govedo, gospodarski gubitci