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Research Article

Production Losses Due to Endemic Foot-and-Mouth Disease in Cattle in Turkey

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Abstract: This research paper is aimed at estimating foot-and-mouth disease (FMD)-induced production losses in individual dairy and fattening cattle in Turkey. The data used were obtained from a Delphi Expert Opinion Survey.

The weighted average FMD-induced financial losses for all breeds were estimated to be $294/head for a milking cow, $152/head for a dairy heifer and $197/head for beef cattle. However, the amount of financial loss varied across different breeds, ages, and sexes. The study findings suggest that culling Holstein breed cows, beef cattle, and Holstein and cross breed female calves, as soon as they have an FMD infection, would be economically viable for Turkish cattle producers.

Key Words: Foot-and-mouth-disease, Delphi expert opinion survey, financial losses, cattle

Türkiye'de Sığırlardaki Şap Hastalığından Kaynaklanan Verim Kayıpları

Özet: Bu çalışmada Türkiye'de süt ve besi sığırlarında endemik olarak seyreden şap hastalığından kaynaklanan üretim ve verim kayıpları tahmin edilmiştir. Analiz için ihtiyaç duyulan veriler Delphi Uzman Görüşleri Anketi'den elde edilmiştir.

Hastalık kaynaklı kayıplar ağırlıklı ortalama olarak her enfekte inek için 294$, düve için 152$ ve besi sığırı için ise 197$ olarak tahmin edilmiş olup; bu rakamların farklı ırk, yaş ve cinsiyet için önemli ölçüde farklılık gösterdiği görülmüştür. Araştırma sonuçları, Holstein ırkı inek ve besi sığırı ile Holstein ve tüm melez ırk buzağıların şap hastalığına yakalandığında sürüden çıkarılmasının ekonomik açıdan daha uygun olacağını ortaya koymuştur.

Anahtar Sözcükler: Şap hastalığı, Delphi uzman görüşleri anketi, finansal kayıplar, sığır

Introduction

Animal disease control decisions involve optimisation of resource allocation decisions at both farm level and national scale because the inputs it uses are scarce and have alternative uses (opportunity cost). In order to carry out an economic analysis to optimize resource allocation decisions for animal disease control, first of all disease induced financial/economic losses should be estimated. However, most of the required data for estimating the disease-induced production losses were not available in the currently maintained databases in Turkey. Nevertheless, when data are unreliable or unavailable, eliciting information from expert opinions can be used, which is an approach that has recently been popular in studies related to technical and economic aspects of livestock diseases (1-4).

From this point of view, a Delphi Expert Opinion Survey (DEOS) was conducted in order to obtain missing information required for assessing FMD-induced production losses in Turkish field conditions. Research findings from the first part of this study series were published elsewhere (5).

As the second part of this study series, this paper is aimed at estimating the endemic[1] foot-and-mouth disease (FMD)-induced production losses in individual dairy and fattening cattle in Turkey, using the data obtained from DEOS.

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[1] Endemic in Turkey, not in individual livestock farms.

Materials and Methods

The materials of the study were mainly the data obtained from the DEOS from 25 Turkish state veterinarians working at the Department of Animal Health of the Turkish Ministry of Agriculture, all having good field experience of FMD outbreaks. Beside this, secondary statistics from the General Directorate of Protection and Control of the Ministry of Agriculture, TURKSTAT, the State Planning Organisation, Turkish Cattle Breeding Associations, Livestock Boards, and the related literature were utilised for the financial analyses.

FMD-induced losses were estimated separately for cattle by sex (female and male), age (e.g. calf, heifer, and mature cattle) and breed (Holstein, cross, and local). The estimations were not made for buffalos as their population in Turkey is negligible.

In order to calculate FMD-induced financial losses, firstly FMD related loss components for each cattle breed were determined. Secondly, availability of data was explored in the currently maintained databases in Turkey. The required data, either unavailable or available but considered to be unreliable, were collected via DEOS.

All possible loss components under 3 possible disease events (keep, cull, or die) in the infected cattle were taken into account.

The details of loss componets considered and the technical and financial data used are presented in Table 1 to Table 3.

Procedures followed during calculations of FMD induced losses:

Calculation of milk yield losses in infected animals: The probabilities of cows being in lactation and of irreversible udder damage after the infection, were taken into account when estimating milk yield loss in infected cows.

Calculation of fertility losses in infected animals: Oestrus is not seasonal in cattle. Therefore, 'extended calving interval due to FMD' rather than 'increase in abortion rate' was used as a loss component, as the former represents all components of the fertility losses. Extended calving interval (CI) took account of probabilities of being pregnant at the time of infection and the occurrence of abortion during and after infection. Number of days increase in the CI, as a result of infection, was obtained from the DEOS. These figures were then multiplied by the cost of 1 day's increase in the CI. The latter was obtained from the study by Yalçın (6).

Similarly, 'loss from delay in age at first calving (AFC) due to FMD' was estimated by multiplying average number of days delay in age at first calving obtained from the DEOS by the cost of 1 day's delay in AFC obtained from the study of Yalçın (6).

Calculation of losses due to premature culling: The financial cost of an increased culling rate due to the infection was calculated as the difference between the market price of healthy and culled cows.

Calculation of live-weight losses: FMD related live-weight loss in beef cattle was obtained from DEOS survey shown in Table 3.

Calculation of loss in expected profit: It was assumed that when infected fattening cattle and male calves were culled or died, new animals for fattening were not purchased. In order to consider financial losses due to idle capacity of productive resources, 'losses in expected profit' (opportunity costs) were calculated. For this

Table 1. The loss components considered in a FMD infected cattle in the study.*

Age	If remaining in herd after the infection	If culled/slaughtered due to the infection	If died after the infection
Cow	-Milk yield loss -Loss due to extended calving interval	-Losses due to premature culling -Losses due to abortion	-Losses due to mortality -Losses due to abortion
Heifer and Female calf	-Loss due to extended age at first calving	-Losses due to premature culling -Losses due to abortion#	-Losses due to mortality -Losses due to abortion
Fattening cattle and male calf	-Decrease in live-weight gain	-Losses due to premature culling -Losses in expected profit	-Losses due to mortality -Losses in expected profit&

*Separate calculations were carried out in different breeds (local, cross, and Holstein) #considered for heifer, &considered for fattening cattle.

Table 2. The technical and financial data used in calculating FMD induced losses in female cattle.

1.Technical parameters	Holstein	Cross	Local	Source of information
Average milk yield(kg/year)	3108	2042	978	TURKSTAT
Probability of a cows' being in lactation	0.85	0.91	0.95	Calculation
Probability of a cow culled after the infection (%)	10 (5-15)	7 (4-12)	4 (1-5)	DEOS* (5)
Probability of a cow died after the infection (%)	5 (2-5)	2(1-3)	1(1-2)	DEOS (5)
Probability of irreversible udder demage due to the FMD (%)	35 (30-40)	30 (20-35)	20 (10-20)	DEOS (5)
Average delay in CI due to the infection (days)	63.1	52	31.2	Calculation
If abortion does not ocur (days)	60 (60-75)	50 (40-60)	30 (20-60)	DEOS (5)
If abortion occurs (days)	91 (80-150)	90 (60-120)	60 (45-90)	DEOS (5)
Increase in abortion rate due to the infection (%)	10	5	4	DEOS (5)
Saving in feed consumption due to the infection(kg/lt milk)	0.3	0.2	0.1	(6)
2. Financial parameters				
Price of cow milk ($/kg)	0.29	0.29	0.29	Producer price
Price of a replacement heifer ($/head)	1.106	935	545	Producer price
Price of a culled cow ($/head)	719	608	355	Pers.com with butcers
Price of calf (7 days old) ($/head)	232	197	137	TIGEM
Price of concentrated feed ($/kg)	0.21	0.21	0.21	Market price,
Cos of a 1 day delay in calving interval ($/day)	3.20	2.39	0.96	(6)

* The central tendency measures in DEOS are "median". Interquartile ranges are presented in paranthesis.

Table 3. The technical and financial data used in calculating FMD induced losses in male cattle.

1.Technical parameters	Holstein	Cross	Local	Source of information
Probability of being slaugtered after the infection (%)	15 (10-25)	10 (5-20)	5 (2-5)	DEOS* (5)
Probability of a death as a result of the infection (%)	3 (2-5)	2 (1-5)	1 (1-2)	DEOS (5)
Average body weight at time of infection (kg/head)	355	355	175	(10)
Decrease in the liveweight due to the infection (%)	25 (15-30)	20 (13-25)	15 (10-20)	DEOS (5)
Average liveweigh gain (kg/day/head)	1.177	1.04	0.75	
Average concentrated feed intake (kg/day/head)	12.7	9.6	7.4	
Loss in the fattening period due to the infection (day)**	90	90	90	
2. Finansal Parametreler***				
Price of 1 kg liveweigh ($)	2.72	2.72	2.72	Producer price in March 2003
Daily feed cost ($/day/head)	1.91	2.03	1.54	Calculation
Other variable costs****	0.28	0.21	0.14	Calculation
Daily profit margin (TL/day)	0.28	0.63	0.35	Calculation

* The central tendency measures in DEOS are "median". Interquartile ranges are presented in paranthesis.

**Tradationaly fattenning period generaly takes 6 months in Turkey. The infection is assumed to be at the middle of the fattening period.

***Current prices in 2003 in Turkish markets ****The feed cost assumed to be the 90% of the variable costs.

purpose, a daily profit margin was calculated. Infection was assumed to occur in the middle of the fattening period.

In all calculations, current prices in 2003 in Turkish markets and their $ equivalents (1$ = 1.43 YTL) were used.

Results

The estimated FMD-related financial losses in the infected dairy cow varied between $86 and $493 according to the breed (Table 4). Compared to the losses in local breeds, those in cross and exotic breed cows were estimated to be 3 and 5 times higher, respectively. As the details of the loss estimates were examined, it was noticed that the most important loss component was the loss due to mortality (56% to 67% of the total losses depending on breeds). In Holstein cows, the losses were lowest if the infected cow was culled (20%), whereas, in local and cross breeds, the lowest loss was estimated for the animals that stayed in herd after infection (9%-18%). Another notable finding in the table is that 'delay in calving intervals', which accounted for losses due to abortion, had a considerable contribution in the total losses (39-43%) in cows remaining in herds after the FMD Infection.

The weighted average total losses in infected heifers were estimated to be about half of those in infected cows (Table 5). As in cows, the FMD-related financial losses in cross and exotic breed heifers were estimated to be approximately 3 and 5 times higher, respectively, than those of local breed heifers. The losses resulting from death of a heifer accounted for most of the total loss (between 65%-71% of the total loss depending on the breeds). Another notable finding in the table is that, if infected heifers stayed in herd, the FMD-induced losses in a Holstein heifer would be much higher compared to those of local and cross breeds.

The weighted average FMD-related financial losses and contributions of different states of animals, after infection in female calves, were estimated to be similar to those in heifers (Table 6).

The estimated FMD related financial losses in beef cattle and male calves of different breeds in Turkey are presented in Tables 7 and 8.

As can be seen from Table 7, the estimated weighted average FMD induced losses in cross and exotic breed cattle were about 3 times higher than that in local cattle. As in the cases of cows and heifers, losses from death of infected cattle were a major contributor to the weighted average losses (between 68%-72% of weighted average loss depending on breeds). Another finding is that losses in expected profit were negligible, particularly in the Holstein breed, compared to other loss components.

The relationships among cost components for male calf were similar to those estimated for fattening cattle.

Table 4. The estimated FMD related financial losses in a dairy cow ($/infected cow).

The loss components	Holstein		Cross		Local	
	$	%	$	%	$	%
I- If remining in herd after FMD infection	468	23.6	290	18.6	76	9.4
1.1. Milk yield losses	266		166		47	
1.2. Losses due to extended calving interval	201		125		30	
II- If culled\slaughtered due to FMD infection	396	20.0	331	21.2	193	23.6
2.1. Losses due to premature culling	387		327		191	
2.2. Losses due to abortion	9		4		2	
III-If died after FMD infection	1115	56.4	939	60.2	547	67
3.1. Losses due to mortality	1107		935		546	
3.2. Losses due to abortion	9		4		2	
Weighted average total financial losses*	493	100.0	306	100.0	86	100.0

*Weighted by probability of occurrence of each of 3 states of animals after the infection.

Table 5. The estimated FMD related financial losses in dairy heifer ($/infected heifer).

The loss components	Holstein		Cross		Local	
	$	%	$	%	$	%
I- If remaining in herd after FMD infection	207	12.0	96	7	30	3.9
Losses due to delay in age at first calving	207		96		30	
II- If culled\slaughtered due to FMD infection	393	23.0	330	24,2	192	25
2.1. Losses due to premature culling	387		327		191	
2.2. Losses due to abortion	6		3		1	
III-If died after FMD infection	1112	65.0	938	68.8	547	71.1
3.1. losses due to mortality	1107		935		546	
3.2. Losses due to abortion	6		3		1	
Weighted average total financial losses	271		138		48	

Table 6. The estimated FMD related financial losses in female calves ($/infected calf).

The loss components	Holstein		Cross		Local	
	$	%	$	%	$	%
I- If remaining in herd after FMD infection	224	31.3	120	23.7	38	13.1
Losses due to delay in age at first calving	224		120		38	
II- If culled\slaughtered due to FMD infection	113	15.9	89	17.6	59	20.1
Losses due to premature culling	113		89		59	
III-If died after FMD infection	378	52.9	296	58.7	196	66.9
Weighted average total financial losses	243		143		55	

Table 7. The estimated FMD related financial losses in beef cattle ($/infected beef cattle).

The loss components	Holstein		Cross		Local	
	$	%	$	%	$	%
I- If remaining in herd after FMD infection	242	16.7	194	13.2	72	10.2
Decrease in live-weight gain	242		194		72	
II- If culled/slaughtered due to FMD infection	216	14.9	249	17.0	126	17.8
2.1. Losses due to premature culling	194		194		95	
2.2. Losses in expected profit	23		55		30	
III-If died after FMD infection	991	68.4	1023	69.8	507	72.0
3.1. Losses due to mortality	968		968		477	
3.2. Losses in expected profit	23	2.4	55	5.4	30	6.3
Weighted average total financial losses	261		216		79	

Table 8. The Estimated FMD related financial losses in male calves ($/infected male calf).

The loss components	Holstein		Cross		Local	
	$	%	$	%	$	%
I- If remaining in herd after FMD infection	16	5.2	10	2.9	10	3.2
Decrease in live-weigh gain	16		10		10	
II- If culled/slaughtered due to FMD infection	62	19.6	93	25.7	66	22.3
2.1. Losses due to premature culling	44		42		39	
2.2. Losses in expected profit	18		51		28	
III-If died after FMD infection	236	75.2	259	71.5	221	74.5
3.1. Losses due to mortality	218		207		194	
3.2. Losses in expected profit	18		51		28	
Weighted average total financial losses	63		42		23	

However, compared to the latter, the estimated FMD related losses in male calves were 4 to 6 times lower than those in fattening cattle (Table 8).

The weighted average financial losses for all breeds (weighted according to the proportion of each breed in Turkey) were estimated to be $294/head for a milking cow, $152/head for a dairy heifer, and $197/head for beef cattle.

Considering the number of the outbreaks and succeptible cattle population in the outbreak zones in 1999, the FMD related production losses at the national scale was estimated to be $11.5 millions in Turkey.

Discussion

This analysis has shown that the estimated financial cost of FMD-induced losses in Holstein cattle is higher than those of local and cross breeds, as the Holstein breed is more susceptible to FMD. In all breeds, the highest losses occurred when animals died after the infection.

The study findings suggest that culling Holstein breed cows, beef cattle, and Holstein and cross breed female calves after they are infected with FMD would be economically viable for Turkish cattle producers.

The literature related to the impacts of FMD on production and productivity of livestock is limited. This is because the majority of studies on the economics of FMD have been carried out in developed nations where all susceptible animals, in outbreak zones, are slaughtered. Therefore, it is impossible to observe the disease effects on production and productivity of infected animals in the field conditions of these countries. In countries where the disease is endemic, research efforts have mainly been focussed on the aetiology and epidemiology of FMD and technical aspects of FMD control. So far, apart from this research, there have been 3 other studies aimed at estimating FM-induced production losses in Turkish field situations.

Nazlioglu (7) and Nazlioglu and Orun (8) estimated FMD-induced production losses during FMD infection (duration of infection assumed to be 20 days both in cows and sheep) by comparing past yield records of few number of livestock before and after FMD infection in several state livestock farms. They estimated the annual cost of FMD to be $43 million in 1965. However, the estimated costs of FMD-induced production losses were not reported on a per animal basis.

Zog (9) developed a simulation model to estimate the FMD-induced financial losses in Turkey, and costs and benefits of several alternative FMD control/eradication strategies. However, most of the information, particularly that related to production losses due to infection, was based on his guestimates (optimistic and pessimistic expectations), as his main objective was to develop a computerised decision support model to estimate costs and benefits of alternative FMD control/eradication decisions.

Adıbeş et al. (10) estimated the FMD-induced production losses in Turkish field situations by obtaining data from 28 producers' observations of FMD-infected livestock in 10 provinces of Turkey. They reported the average losses in infected dairy cows as $200/head and $250/head in fattening cattle. In spite of the fact that the reported FMD induced losses in cow and fattening cattle are close to those reported in this study, the findings of Adıbeş et al. (10) should not be compared with the findings of the present study as they omitted some important loss componets in their estimations. Such methodology problems exist in the majority of studies related to the economics of animal disease (11), and a well defined methodology is needed in this area.

The economic impact of FMD at national level could not be calculated in the present study since measurements at the national level require more complex economic analyses. Estimates are required of the cost of disease not only to farmers and/or the public purse, but to the whole society. Social impacts include the entire food chain (producers, wholesalers, processing industry, retailers, and consumers), disease implications for consumer demand, markets, trade (loss of export markets and/or export potential), human health, the health and well-being of pets/livestock, wildlife and other externalities (12). Economic analysis at the national level also requires social values and costs that are not captured by market prices since prices in the market may be distorted by government intervention, monopolistic/monopsonistic market structure or for other reasons (4,13).

Moreover, the model used in the economic analyses was static-deterministic in nature that does not take account the knock-on effects of the disease (dynamics of the system) and uncertainties over time. Therefore, incorporation of the economic parameters to a "dynamic stochastic epidemiologic model" would offer a better decision support.

Furthermore, estimation of disease induced losses is important, but should not be the sole information used in the management of contagious disease. For use as a decision support tool, such information should be linked to details of available control eradication strategies, and the estimated reduction in disease-induced losses under each control strategy. This type of economic analysis requires the development of simulation based computerised disease control decision support models which necessitate collaboration by researchers from diverse disciplines such as veterinary science, epidemiology, statistics, and mathematical and computer sciences. Such disease management decision support models have been developed in many countries and successfully used in the management of contagious disease outbreaks. Development of such disease control models for contagious animal disease in Turkey can be possible providing that the required research team and supporting infrastructure are established.

The main conclusions of this study are:

1. FMD is endemic in Turkey, and therefore, results in substantial and continuous production losses in livestock species. The weighted average financial losses of all breeds (weighted according to the proportion of each breed in Turkey) were estimated to be $294/head for a milking cow, $152/head for a dairy heifer, and $197/head for beef cattle. However, the amount of the financial loss varied across different breeds, ages, and sexes.
2. The study findings suggest that culling Holstein breed cows, beef cattle, and Holstein and cross breed female calves when infected with FMD would be economically viable for Turkish cattle producers.
3. The loss components considered in the research are quite elaborative. All possible loss components under 3 alternative disease outcomes (keep, cull, and die) in the infected cattle were taken into account and the missing data were obtained from DEOS survey. This framework of disease costing can be used to estimate financial/economic losses from other contagious diseases. However, the economic analyses presented obtained from a static determisnistic model. As stated in the Discussion section, there are a lot of scopes for improving the model for a better decision support in reseourse allocation decisions related to contagious livestock diseases.

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