Financial impact of foot-and-mouth disease in Turkey: acquisition of required data via Delphi expert opinion survey

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ABSTRACT: The main obstacle in assessing the financial impact of foot-and-mouth disease in Turkey is unavailability of reliable data. Considering this issue, this study aimed at using a Delphi Expert Opinion Survey (DEOS) method to obtain data required for economic analysis of FMD in Turkey. This study concluded that although there were problems in obtaining some information from the experts, in general the Delphi technique is a promising way of obtaining animal health data, which is otherwise missing and/or not regularly recorded in developing countries.

Keywords: foot-and-mouth disease; Delphi; economic analysis; Turkey

Foot and mouth disease is endemic in the majority of developing countries. It not only results in severe production losses of infected animals, but also loss of export potential of livestock and livestock products which could be instrumental in the development of the livestock sector in the developing countries. Moreover, a substantial amount of money and man power must be invested to control the disease and limit its impact, eradication often being impractical or too expensive.

In recent years, computerised disease control decision support systems have frequently been used to estimate direct and indirect losses from contagious animal diseases and costs and benefits of alternative disease control/eradication strategies in many countries.

In spite of the fact that the needs for analysis of disease induced financial/economic losses due to contagious animal disease, and cost and benefits of alternative disease control/eradication strategies have frequently been emphasized in Turkey (Sakarya, 1991), studies in this field are limited. Zog (1992) developed a simulation model to estimate the FMD induced financial losses in Turkey, and costs-benefits of several alternative FMD control/eradication strategies. However, the majority of the required data, particularly those related to production losses due to infection were not available in the currently maintained database in Turkey. He, therefore, obtained most of the required data from published literature and/or made estimates, which reduced credibility of the model estimates for use as a decision support tool.

Availability of reliable data/information is the pre-requisite of reliable estimates of disease induced losses and cost benefit analysis of alternative control/eradication strategies, which is the main handicap in developing countries.

The most reliable way of assessing FMD induced production losses is via appropriately controlled experiments where animals are experimentally infected and effects on economically important yield parameters are observed. However, this is not permissible for FMD, since the disease is too infectious and highly transmissible. Alternatively, the FMD induced production losses could be estimated by obtaining data/information from producer surveys of FMD infected herds or by seeking expert opinion.

Abibes et al. (1998) estimated FMD induced production losses in Turkish field situations by obtaining data on 28 producers' observations of FMD infected livestock in 10 provinces of Turkey. This study produced some useful information related to FMD induced production losses. However, the majority of livestock herds in Turkey are small-scale whose owners are not well educated, and do not have good record keeping habits. Furthermore, many producers are reluctant to provide information on such a sensitive contagious disease.

From this point of view, this study aimed to obtaining information required for financial analysis of FMD (induced losses and cost of control activities), which were otherwise either unavailable or unreliable, by conducting a Delphi Expert Opinion Survey (DEOS).

The Delphi technique, originally developed by the RAND Corporation to forecast future development in technological progress, is a structured process, which utilises a series of questionnaires or rounds to gather and to provide information (Sariaslan, 1994). More generally, the technique is seen as a procedure to "obtain the most reliable consensus of opinion of a group of experts" (Rowe and Wright, 1999; Keeney et al., 2001).

It is growing in popularity especially with health researchers. Gupta and Clarke (1996) reviewed 27 health related studies that used the Delphi Technique. In livestock science, Asseldonk et al. (1999) used the technique to investigate information technology and information needs of dairy enterprises in the Netherlands; Fels-Klerx et al. (2000) used it to determine risk factors of bovine respiratory disease in calves and Bennett and IJpelaar (2003) obtained the missing information from veterinary experts on parameters required to estimate the costs of 35 endemic disease in Great Britain. In order to obtain information required for risk assessment for six different contagious diseases including FMD for the Netherlands, Horst et al. (1998) used 3 different elicitation techniques all of which were based on subjective judgements of experienced people from generally a one-round-meeting (e.g. round-table or workshop). These techniques were: (1) "three-point estimation" (minimum, mostly likely and maximum expected estimates of an event) used to estimate the length of high risk periods, (2) "conjoint analysis (CA)"[1] used to estimate the relative importance of several risk factors of each of 6 disease conditions, and (3) "ELI" techniques (elicitation of uncertain knowledge)[2] used to estimate the number of outbreaks expected for each of the 6 disease conditions. More recently, Stott et al. (2005a) have used the CA to estimate the outcome of different management strategies, including disease control on the profitability of extensive sheep farms in Great Britain under the EU's recent animal welfare policies. Stott et al. (2005b) used the same technique to obtain information from experts (vets) about risk factors for bovine paratuberculosis (Johne's disease).

The novelty of this research is the application of DEOS to obtain information required to estimate the financial impact of FMD (the disease induced production losses at farm level plus government expenditures for disease control) in Turkish field conditions, a country where FMD is endemic.

MATERIAL AND METHOD

The materials of the study were the data obtained from the DEOS contributed to by 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.

In this study, first of all, the data required to calculate FMD induced financial losses in each livestock species affected were specified. Secondly, availability of the required data in Turkey was explored. The data classified as either unavailable or available, but unreliable were determined. Thirdly, a questionnaire form designed to obtain data so classified from the experts was prepared. The questionnaire form included FMD related questions in two categories:

1. Information related to impact of FMD of infected animals (probabilities of death and culling after FMD infection, milk yield and body weight losses, increase in abortion rate and delay in age at first calving and calving interval).

[1]This technique is generally used in marketing research to investigate consumer perceptions of novel products and to help understand purchasing behaviour. For more information about the technique, see Horst et al. (1998) and Stott et al. (2005a).

[2]This technique originates from mathematical psychology. It facilitates the quantification of subjective knowledge about uncertain quantities and provides a best guess. The dispertion corresponds with the uncertainity about this best guess. For more information about the technique, see Horst et al. (1998).

2. Technical and financial information related to activities for combating FMD in outbreak regions and to annual disease vaccination programmes (number of FMD outbreaks, morbidity rates and cost of vaccination and other overhead costs relative to cost of vaccine alone).

Before use in the field, the questionnaire form was sent to 4 veterinary experts to test its suitability and clarity. According to their response, it was corrected and re-organised, and then sent (together with a letter attached stating the purpose of the survey and explanations about confidentiality of the information they would provide to us) to 81 state vets working at the Department of Animal Health of the Ministry of Agriculture in each of 81 provinces of Turkey.

The survey was conducted in 2 rounds. In the first round 25 vets responded. For each question, the median and inter quartile range (IQR) values were determined. When the response to a question was outside the IQR, it was re-asked of the experts concerned to allow them to re-consider their answers, given the median and IQR values of all experts. The experts not changing their outlier answers were asked to state the reason(s) for insisting on their outlier answers.

All 25 experts participated in the second round of the Delphi survey. After analysing the responses from the second round, no further round was considered necessary.

For statistical analyses, firstly, the Friedman Variance Analysis technique was used to test the overall statistical significance of the results. Pairwise comparisons of those found significant at $P < 0.05$ in the Friedman test were carried out with the Wilcoxon test (Conover, 1999).

RESULTS

The results of the DEOS related to information required to estimate FMD induced production losses in infected livestock

States of animals after FMD infection. The median and IQR values of expert opinions on probabilities of dairy cow, heifer and female calf being in different states (cull or death) after FMD infection are shown in Tables 1 to 3.

Table 1. The median and Inter Quartile Range values of expert opinions on probabilities of dairy cow, heifer and female calf being in different states (cull or death) after FMD infection

State of animal*	Probabilities (%)								
	dairy cow			dairy heifer			female calf		
	Holstein	cross	local	Holstein	cross	local	Holstein	cross	local
Culled	10 (5–15)**	7 (4–12)	4 (1–5)	10 (5–20)	7 (4–13)	5 (1–5)	10 (1–15)	10 (3–15)	5 (2–10)
Death	5 (2–5)	2 (1–3)	1 (1–2)	5 (2–7)	3 (1–5)	2 (1–3)	20 (10–50)	15 (10–40)	10 (5–15)

The differences between the culling and death rates amonst the breeds were statistically significant at $P < 0.01$

The death rates for calves under each breed group were significantly higher than those of dairy cow and heifer ($P < 0.01$)

*probabilities of staying in a herd = 1 – probability of cull + probability of death

**the data in parenthesis state Inter Quartile Ranges

Table 2. The median and Inter Quartile Range values of expert opinions on probabilities of beef cattle and male calf being in different states (cull or death) after FMD infection

State of animal	Probabilities (%)					
	beef cattle			male calf		
	Holstein	cross	local	Holstein	cross	local
Culled	15 (10–25)*	10 (5–20)	5 (2–5)	5 (1–10)	5 (0,5–10)	5 (0,5–5)
Death	3 (2–5)	2 (1.5–5)	1 (1–2)	20 (7–45)	11 (5–40)	5 (4–15)

The differences between the culling and death rates amonst the breeds were statistically significant at $P < 0.01$

The death rates for male calves under each breed group were significantly higher than those for beef cattle ($P < 0.01$)

*the data in parenthesis state Inter Quartile Ranges

Table 3. The median and Inter Quartile Range values of expert opinions on probabilities of small ruminants being in different states (cull or death) after FMD infection

State of animal	Probabilities (%)				
	sheep	hog (12–18 month old)	lamb**	goat	kid**
Culled	5 (2–10)	7 (3–10)	5 (1–10)	4 (2–5)	5 (5–10)
Death	2 (1–3)	3 (2–5)	15 (5–40)	2 (1–4)	10 (5–40)

The differences between the culling rates between mature and young animals were not statistically significant at $P \geq 0.05$
The differences between the death rates of mature and young animals were statistically significant at $P < 0.01$
**animals not weaned

As can be seen from Tables 1 and 2, both the median value of the expert opinions on probability of culling and death due to FMD was lowest in local breeds, and highest in the exotic breeds as expected ($P < 0.01$). Another important finding seen in these tables is that mortality rate due to FMD in young cattle was estimated to be much higher than those of mature animals ($P < 0.01$).

Table 3 shows that, there was no notable statistical difference ($P \geq 0.05$) in the estimated rate of culling due to FMD between mature and young small ruminants. However, the FMD related mortality rates in young small ruminants were estimated to be 5 to 7.5 times higher than those of mature small animals ($P < 0.01$).

Effects of FMD on milk yield. The median and IQR values of expert opinions on milk yield losses of infected dairy cows are presented in Table 4.

When the table is examined, it is seen that the risk of irreversible damage to the udder, hence milk yield losses due to FMD in cross and exotic breeds was greater (30 and 35%, respectively) than those of local breeds (20%) ($P < 0.01$). If the infection does result in irreversible damage to the udder, milk yield losses were estimated to be 1.5 to 2.5 times higher (depending on breed) than if udder damage was irreversible.

Effects of FMD on fertility parameters. The median and IQR values of expert opinions on the increase in risk of abortions in FMD infected adult livestock are presented in Table 5.

General trends in expert opinions in Table 5 reveal that the impact of FMD on abortion rate in exotic cattle and sheep were almost 2 times higher than other breeds and goats respectively. The above reported differences were found to be statistically significant at ($P < 0.01$).

The median and IQR values of expert opinions on the FMD related increase in age at first calving (AFC) of dairy heifer and calf are presented in Table 6.

The median values of the expert opinions on the effect of FMD on the delay in AFC of dairy cattle differed significantly amongst the breeds ($P < 0.05$). In general, it varied between 40 and 120 days, highest in exotic breeds and lowest in local breeds. On the other hand, if the infection results in abortion, the delay would almost be doubled.

The median and IQR values of expert opinions on the FMD related increase in calving intervals (CA) of dairy cows are revealed in Table 7.

Table 4. The median and Inter Quartile Range values of expert opinions on FMD related milk yield losses of dairy cows

Breed	Probabilities of maintaining previous milk yield level after the infection (%)	Milk yield losses in current lactation if an infected cow returns to her previous yield (%)	Milk yield losses in future lactations if an infected cow does not return to her previous yield (%)
Holstein	65 (60–70)*	22 (15–40)	40 (30–50)
Cross	70 (65–80)	20 (10–30)	30 (25–40)
Local	80 (80–90)	10 (8–20)	25 (20–30)

The rates for irreversible udder damage and milk yield losses in local bred cattle were significantly lower at ($P < 0.01$) than those of exotic and cross bred cattle
*the data in parenthesis state Inter Quartile Ranges

Table 5. The median and Inter Quartile Range values of expert opinions on the increase in risk of abortions in FMD infected adult livestock

	Dairy cow			Dairy heifer			Small ruminants	
	Holstein	cross	local	Holstein	cross	local	sheep	goat
Expected abortion rate for healthy animals (%) (A)	5 (4–10)*	5 (3–5)	3 (1–5)	7 (5–10)	5 (3–5)	(2–4)	5 (3–10)	5 (1–10)
Expected abortion rate in FMD infected animals (%) (B)	15 (10–20)	10 (7–15)	7 (4–10)	15 (10–20)	10 (6–15)	7 (5–10)	15 (6–25)	10 (5–15)
Net effect of FMD (A–B)	10	5	4	8	5	4	10	5

The differences of abortion rates between cattle breeds and that between sheep and goats were statistically significant at $P < 0.01$
*the data in parenthesis state Inter Quartile Ranges

Table 6. The median and Inter Quartile Range values of expert opinions on the FMD related increase in age at first calving of dairy heifer and calf

	Dairy heifer			Dairy calf (0–6 month)		
	Holstein	cross	local	Holstein	cross	local
If abortion occurs (days)	120 (70–150)*	90 (50–100)	70 (40–90)	70 (30–90)	50 (30–60)	40 (20–60)
If aborts does not occurs (days)	60 (45–60)	50 (40–60)	40 (25–50)			

The differences between the values amongst the breeds were statistically significant at $P < 0.05$
*the data in parenthesis state Inter Quartile Ranges

Table 7. The median and Inter Quartile Range values of expert opinions on the FMD related increase in calving intervals (CA) of dairy cow

	Holstein	Cross	Local
If aborts occurs (days)	91 (80–150)*	90 (60–120)	60 (45–90)
If aborts does not occurs (days)	60 (60–75)	50 (40–60)	30 (20–60)

FMD related increase in CA in the local bred were statistically lower ($P < 0.01$) than those of the exotic and cross bred
*the data in parenthesis state Inter Quartile Ranges

Table 7 shows that delay in calving interval due to FMD varied between 30 and 91 days depending on breeds and occurrence of abortion after infection. Compared to that of local breeds, delay in CA in exotic and cross breeds are 50% and 100% higher respectively ($P < 0.01$). Similarly, occurrence of abortions after infection increases the delay by 1.5 to 2 folds depending on breeds.

Effect of FMD on live-weight gain. The median and IQR values of expert opinions on FMD related reductions in live-weight gain (LWG) are presented in Table 8.

General opinion of the experts shows that infected animals would lose 10% to 25% of their body weight depending on the species and breeds of livestock, highest in the exotic cattle and lowest in the local cattle and small ruminants. The values amongst the small ruminants were not statistically important ($P > 0.05$) whereas, the differences amongst cattle breeds were found to be statistically significant at $P < 0.05$.

The results of DEOS related to information required to estimate FMD related expenditure for disease control at national scale

Morbidity of FMD in Turkey. The results of DEOS on the morbidity rate of FMD at the infected herds are presented in Table 9.

Table 8. The median and Inter Quartile Range values of expert opinions on the FMD related reduction in live-weight gain (%)

	Dairy cow	Dairy heifer	Beef cattle	Calf	Sheep and hog	Lamb	Goat	Kid
Holstein	20 (15–30)	20 (12–25)	25 (15–30)	15 (10–20)				
Cross	15 (12–25)	15 (13–20)	20 (13–25)	10 (8–20)	10 (10–20)	10 (6–20)	10 (10–20)	10 (5–15)
Local	10 (7–17)	10 (7–15)	15 (10–20)	10 (5–15)				

The differences amongst the cattle breeds were statistically significant at $P < 0.05$
No statistical differences amongst the FMD related decrease in LWG amongst the small ruminants at $P < 0.05$
*the data in parenthesis state Inter Quartile Ranges

Table 9. The median and Inter Quartile Range values of expert opinions on the morbidity rate of FMD at the infected herds

Regions	Dairy cattle (%)			Beef cattle (%)			Sheep (%)	Goat (%)
	Holstein	cross	local	Holstein	cross	local		
High livestock density	70 (25–85)*	70 (20–80)	50 (15–70)	70 (25–80)	60 (25–80)	50 (15–70)	50 (15–75)	30 (10–55)
Low livestock density	40 (15–60)	30 (10–60)	25 (5–40)	50 (20–70)	40 (20–60)	30 (10–40)	20 (10–50)	15 (5–40)

The differences of morbidity rates amongst cattle breeds and that between sheep and goat in both regions were statistically significant at $P < 0.05$
The differences of morbidity rates between the regions for each species and breed were statistically significant at $P < 0.05$
*the data in parenthesis state Inter Quartile Ranges

As expected, morbidity rate of FMD infection was estimated to be higher in high livestock density regions (changes between 30% and 70% depending on animal species and breed) compared to that of low livestock density regions (changes between 15% and 50% depending on animal species and breed) ($P < 0.05$). On the other hand, morbidity rate amongst Holstein and crossbred cattle was higher than that of local bred cattle. The lowest morbidity rate was for goats. The differences of morbidity rates amongst cattle breeds and that between sheep and goats in both regions were statistically significant at $P < 0.05$.

Number of FMD outbreaks in Turkey in 1999. The statistics published by the General Directorate of Disease Protection and Control of the Ministry of Agriculture related to the number of FMD outbreaks in Turkey have frequently been criticized for not being reliable (Adibes et al., 1998). For this purpose, the experts were asked if the statistics depict actual field conditions in Turkey, if not, how much the actual figure of FMD outbreaks differs from the officially reported statistics.

The median and IQR values for this figure were estimated to be 30% and 12–50%, respectively.

Magnitude of expenditure for FMD outbreak management. The median and IQR values of the expert opinions on the relative magnitude of FMD outbreak management costs compared to cost of vaccine alone are presented in Table 10.

As seen from the table, "cost of vaccination & disinfection" and "other costs" in high livestock density regions were stated to be 4 and 3 times higher than the cost of vaccine, respectively. On the other hand, these costs were 5 and 4 times higher than cost of vaccine, respectively in low livestock density regions. The differences between high and low livestock density regions for each cost component were found to be statistically significant at $P < 0.05$.

Magnitude of expenditure for annual FMD vaccination programmes in Turkey. Similarly, the DEOS results on the relative magnitude of the costs of FMD control compared to the cost of vaccine in routine disease prevention activities are presented in Table 11.

As can be seen from the table, "cost of vaccination & disinfection" and "other costs" were stated to be 3 and 2 times higher than cost of vaccine both in high and low livestock density regions, respec-

Table 10. The median and Inter Quartile Range values of the expert survey on the relative magnitude of FMD outbreak management costs compared to cost of vaccine (cost of vaccine = 1)

Cost items	Regions	
	high livestock density	low livestock density
Cost of vaccination and disinfection**	4 (3–10)*	5 (3–8)
Other costs***	3 (2–5)	4 (2–7)

The differences of the values between high and low livestock density regions were statistically significant at $P < 0.05$ for each cost component

*the data in parenthesis state Inter Quartile Ranges

**includes cost of stocking vaccine, personnel (vet, vet technician and driver), travel, disinfectant

***includes disease surveillance, diagnosis, quarantine and other overhead costs

Table 11. The median and Inter Quartile Range values of the expert survey on the relative magnitude of the costs of annual FMD control programmes compared to the cost of vaccine (cost of vaccine = 1)

Cost items	Regions	
	high livestock density	low livestock density
Cost of vaccination and disinfection**	3 (2–5)*	3 (2–5)
Other costs***	2 (1–3)	2 (1–3)

The differences of the values between high and low livestock density regions were statistically significant at $P < 0.05$ for each cost component

*the data in parenthesis state Inter Quartile Ranges

**includes cost of stocking vaccine, personnel (vet, vet technician and driver), travel, disinfectant

***includes disease surveillance, diagnosis, quarantine and other overhead costs

tively. The differences between high and low livestock density regions for each cost component were found to be statistically significant at $P < 0.05$.

DISCUSSION

FMD related production losses

The literature related to the impact 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.

This section, therefore, is focussed on the evaluations of the research findings, and comparison of the research finding with the limited literature. It is worth mentioning in advance that many factors (such as type of FMD virus strains, environmental factors, characteristics of farming systems in different countries and regions, combating effort for FMD etc.) affects the FMD induced losses and morbidity and epidemiology of infection. These factors must be taken into consideration when making comparisons between published findings.

Mortality rates due to FMD infection. The median values of increase in the mortality rate due to FMD in this study were 1–5% in adult cattle, 5–20% in young cattle, 2% in sheep and goats and 10–15% in lambs and kids.

Adibes et al. (1998) reported FMD related mortality rate in Holstein cows as 6% in Turkey. No FMD related mortality was reported for cross and local breed cows in their study. The figures reported for Holstein, cross and local breed calves, lambs and kids were 47.1%, 16.7%, 9.5%, 9.7% and 13.3%, respectively. These figures are in line with the median values of the Delphi survey except that for Holstein cows.

Zog (1992) assumed the FMD induced mortality rate was 1–5% depending on breed, which was supported by the findings of the Delphi Survey.

On the other hand Brownlie (2001) reported the rate as 2% in mature cattle and 60–90% in calves in the UK. The latter is notably higher than that reported by the studies conducted in Turkey. Lower mortality rate due to FMD in young cattle in Turkey than that in developed countries would be explained by several factors: Firstly, the disease is endemic in Turkey; therefore, calves would have better resistance to FMD infection thanks to maternal antibodies. Secondly, Turkey conducts annual FMD vaccination programmes that have not been permitted in the majority of the developed countries in recent years.

Milk yield depression due to FMD infection. Nazlioglu and Orun (1969) studied milk yields of different species and breeds of livestock before and after FMD infection in Turkey. They observed 20–44% milk yield loss in cows, and 19.6% losses in sheep. Adibes et al. (1998) reported FMD induced milk yield depression in Holstein, cross and local breed cows as 37%, 17% and 5%, respectively. Tufan (1993) reported on average 19% milk yield loss due to FMD in Turkey, but he did not differentiate the losses by breed. Power and Harris (1973) stated 25% depression in the lactation yield of Holstein cows in the UK. Neither of these studies differentiates the milk yield loss according to reversible and irreversible effects of the infection. However, estimated milk yield loss due to FMD in this research is in fair agreement with those reported in the literature except that for local breed cows reported by Adibes et al. (1998).

Increase in abortion rate due to FMD infection. Adibes et al. (1998) reported FMD related abortion rates of 28.8% in Holstein cows and 4% in cross bred cows and 0% in Holstein and cross bred heifers. The figure reported for cross bred cows is similar to that of the general opinion of experts (5%), but that for Holstein cows is high compared to that of our experts (10%). On the other hand, abortion rates of 0% in Holstein heifers reported by Adibes et al. (1998) are questionable. Such a low figure may be because the rate was calculated from observation of few animals (only 8 heifers) by Adibes et al. (1998).

Zog (1992) assumed figures between 4–10% according to his communication with experts, which agrees with our study finding.

Delay in "age at first calving" and "calving interval" due to FMD infection. Zog (1992) stated delay in "age of first calving" and "calving interval" as 2 months and 1–3 months, respectively. General trend of the expert opinion in our study agrees with these findings.

Live-weight loss due to FMD infection. Nazlioglu and Orun (1969) and Adibes et al. (1998) reported live-weight loss due to FMD infection in Turkey of 6.2% and between 10–27%, respectively. Power and Harris (1973) reported live-weight loss due to FMD infection as 12.5% in the United Kingdom, and Kazimi and Shah (1980) observed on average 26.1 kg body weight loss (about 15% loss) in local cattle in Pakistan. The median value of expert opinion (15–25%) in this study is within the range of the above published figures.

FMD control during outbreaks

Morbidity rate. The experts were asked about FMD induced morbidity rate for different livestock species and breed both in low and high livestock density regions. Previous studies reporting the morbidity rate did not differentiate the rate according to livestock density. The comparison is, therefore, made on average morbidity rate for cattle and small ruminants. The average morbidity rate was 49% in cattle and 32% in small ruminants in this study.

Adibes et al. (1998) reported the morbidity rate for exotic cattle as 60–90%, for cross breeds as 70–83% and for local breed cattle as 52–68% and local breed sheep as 50–100% in ten provinces in Turkey. The figures reported for cattle are in line with the results reported in our study, whereas, the figure for sheep is much higher than that of our study. However, it should be noted that the figures for sheep in the study of Adibes et al. (1998) were obtained from only 3 sheep farms.

Tufan (1993) reported the average mortality rate in cattle and small ruminants in 3 different provinces (Van, Konya and Denizli) in Turkey as 52.8% and 54.4%, respectively.

The lower mortality rate reported for small ruminants in this research may be for two different reasons. Firstly, the question was asked of all experts, but some of them worked in areas where the small ruminant population was too small; therefore, their expertise on this question would be questionable. Secondly, latent infections are often observed in small ruminants.

Number of reported outbreaks. This was the only question the experts initially hesitated to answer. In the first round, some of the experts did not answer it. We contacted them (via either telephone or personal visit) to further explain the objective of the study and the confidentiality of the information. At that point, only one expert still refused to express an opinion.

Adibes et al. (1998) argued that FMD is under-reported in Turkey and the real incidence of outbreaks could be 2 or 3 times greater than the officially reported figures. The general tendency of our experts also implied under-reporting of the number of FMD outbreaks in Turkey. However, the median value of the expert opinion was much lower (the median value was 30% and the IQR was between 12–50%) than that reported by Adibes et al. (1998). It should, however, be noted that the figures reported by Adibes et al. (1998) were based on personal feelings of the authors.

We asked the experts to estimate the average figure for the whole country rather than that for the region where they worked. However, two of the experts working in less developed regions of Turkey reported the figures as 300% and 500% higher in their regions respectively in the first round. In the second round we asked them to estimate the figure for Turkey rather than their own regions. They then corrected their figures to 50% and 30%, respectively in the second round.

The number of FMD outbreaks is crucial information in the FMD induced losses/costs at national scale. However, under-reporting of FMD outbreaks is likely to exist in Turkey, particularly in less-developed regions of Turkey where veterinary infrastructure for combating outbreaks is inadequate, which makes combating the disease too difficult for the vets.

General discussion

This study demonstrated that information required for economic analysis of FMD induced losses and cost of control activities, which were either unavailable or unreliable, can be obtained via the Delphi expert opinion survey. The majority of the answers obtained from the experts were as expected. However, it was the first time the Delphi survey technique has been used to obtain information about contagious disease in Turkey. Therefore, the experts were not familiar enough to answer all questions easily. They were eager to answer all questions; however, since they all work as civil servants, they were reluctant to express their opinion on the actual number of disease outbreaks.

There is scope to improve the quality of the data obtained by the DEOS. The following are suggestions for future studies of this type in order to improve the quality of the estimates and narrow the IQRs:

Experts are not necessarily only vets for all questions. Farmers faced with FMD infection or other people involved in disease control (e.g. researchers) may have better observation and knowledge of some technical and economic parameters of the FMD induced losses.

Experts for each question should state their "level of expertise", so that a researcher is able to omit answers to some questions for which the stated level of expertise is inadequate.

It is likely that each FMD virus strain has a different impact on infected animals, and consequently on disease control efforts. Therefore, the impact of FMD on the production parameter and government expenditure for combating and controlling the disease should be evaluated under several types of FMD virus strains. This would, however, greatly expand the questionnaire form. Therefore a balance between accuracy and complexity should be sought.

In order to improve the estimate on "number of FMD outbreaks", differentiating the estimate according to the regions may improve the estimates and better reflect the under-reporting problems in each region of Turkey.

Horst et al. (1998) argued that the conjoint analysis technique has several advantages over the DEOS because a whole experiment can be done in one session, which overcomes loosing experts in further rounds of the DEOS, and the CA provides an easy way to check the inconsistency of the answers given by the respondents. We do not consider them as clear advantages to improve the quality of estimates in this research, as all experts were involved in the second round of the DEOS, and IQR values are used in DEOS to detect inconsistent answers of respondents.

However, the pros and cons of obtaining information via individual contacts (as we preferred in this research) and a gathering of experts in a round-table meeting or workshop, which are generally preferred in conjoint analysis and the other elicitation techniques described in the introduction section, should be explored. In our opinion, organising a round-table discussion or workshop may improve the quality of results related to FMD induced production losses, but would not be suitable for sensitive questions such as the expert opinion on 'the reliability of the officially reported FMD outbreaks in Turkey'.

Acknowlegdement

We thanks Dr. Mehmet Orman, a bio-statistician working at Faculty of Veterinary Science, Ankara University, for his help for the statistical analyses, and vets working at the Ministry of Agriculture for joining the DEOS.

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Received: 05–01–11
Accepted after corrections: 05–10–20

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