



Short communication

In-farm cost of an outbreak of diarrhoea in lambs

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ARTICLE INFO

Keywords:

Lamb enteric diseases
Diarrhoea
Cost of disease
Sheep
Economic losses

ABSTRACT

This article analyses the cost of diarrhoea in lambs on dairy sheep farms located in Grosseto (Italy). Farmers' profits have recently declined due to a stable product price but increasing production costs. Animal diseases have a cascade of effects on farm productivity. Lamb enteric disease outbreaks, which result in mortality in the herd and reduced weight gain, can drastically compromise the income of farmers. An economic analysis of the impact of an outbreak of diarrhoea in lambs was thus performed, evaluating the cost of disease based on the main visible production losses (such as mortality, reduced weight gain and variation in milk production). A sensitivity analysis was also conducted by applying different observed ranges of prevalence and mortality associated with the disease. Finally, an economic scenario analysis was performed, considering different in-farm management options for delivering lambs to the abattoir, i.e. early, standard and late delivery. The results showed that a dairy sheep farm with around 300 lambs that delivers them to the abattoir at 30 days of age would experience a loss of between 50 and 1200 Euro during an outbreak of diarrhoea with a prevalence of 34.21 (23.54–44.88)% and a mortality of 15.69 (9.98–21.4)%.

1. Introduction

Sheep farming plays a very important economic, social and environmental role in the Mediterranean region (Finocchiaro et al., 2005; Ripoll-Bosch et al., 2012). Besides its primary function of producing dairy products and meat, sheep farming is strongly embedded in the culture and traditions of the area (Boyazoglu and Morand-Fehr, 2001). In Italy, despite a general trend for intensification aimed at increasing animal productivity, sheep farming is becoming less and less profitable with many farms at risk of economic marginalization (De Rancourt et al., 2006; Idda et al., 2010). In this multifactorial scenario, technical and managerial aspects of sheep farming are increasingly fundamental as they can play a decisive role in its competitiveness.

According to Rushton (2009), a change in animal disease status will have an impact on farm productivity, which is defined as the efficiency of the conversion of inputs into outputs, and consequently can produce multiple negative effects (Howe et al., 2013; Otte and Chilonda, 2000; Rushton, 2009). The impacts of diseases on animal productivity are generally classified as direct or indirect. Direct impacts can be classified as visible or invisible, whereas indirect impacts can be coded as additional costs and missed revenue (Otte and Chilonda, 2000; Knight-Jones and Rushton, 2013; Oseguera Montiel et al., 2015).

As observed by El-Tahawy (2010), diarrhoea is one of the most

common and costly diseases affecting sheep due to its effects on small neonatal individuals, and can account for up to 46% of total lamb mortality (Schoenian, 2008). Although the importance of the economic losses related to neonatal diarrhoea in lambs has been considered by other authors (Gökçe and Erdoğan, 2009; Nasr et al., 2014), literature and data on the economic impact of this syndrome are lacking. Lambs affected by diarrhoea develop watery faeces, reduced body weight, and in severe cases, death occurs. Thus, outbreaks of enteric disease in lambs can compromise farmers' yield. In addition, control measures can be difficult to apply depending on the specific farm characteristics and the kind of pathogens involved. Thus, the aim of this study was to analyse, based on empirical observations, the costs of lamb diarrhoea on sheep farms in the province of Grosseto, Italy. The analysis should help farmers and veterinarians to understand and calculate the costs for their farms and to plan economically efficient control strategies.

2. Materials and methods

The study was performed during the period October 2013 to September 2015. Data collection was implemented in a passive way by targeting farms declaring an outbreak of diarrhoea in lambs to the local VPH laboratory (IZSLT) in the province of Grosseto. Data were collected by interviewing 33 farms (82%) out of a total of 41 farms that reported

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outbreaks of diarrhoea in the period of observation, using an *ad hoc* questionnaire. The data analysis was performed in Excel. Demographic data were analysed to identify the characteristics of the sample. Managerial data were analysed to identify the main strategies of management during outbreaks, which included the time of delivery of lambs to the abattoir. Epidemiological data were analysed to identify the prevalence and mortality during the reported outbreaks of diarrhoea. Finally, economic data were analysed to identify the main costs of the outbreak in the sample. Costs were estimated by considering the main visible production losses (such as mortality, reduced daily weight gain and variation in milk production) through a partial budget analysis. This type of analysis evaluates the economic change associated with the disease without considering fixed costs (Morris, 1999). A sensitivity analysis, based on empirical data collected in the field, was also applied by varying the prevalence and mortality associated with the disease. Finally, an economic scenario analysis, based on the different times of delivery of lambs to the abattoir, was performed to evaluate three possible in-farm management options in the case of diarrhoea outbreak: 1) early delivery, 2) standard delivery and 3) late delivery. The sensitivity analysis was based on an average sheep farm (n° of lambs = 316) with an in-farm prevalence of diarrhoea (p) of 34.21 (23.54–44.88)% and a mortality (R_m) of 15.69 (9.98–21.4)%. For the purpose of quantifying the losses experienced in the study population, the prices considered were consistent with those officially paid to the farms for their products (i.e. milk and meat) and reported by ISMEA for December 2014 (ISMEA, 2014) i.e. 4.2 €/Kg for lamb meat and 0.92 €/litre for Tuscan sheep milk.

2.1. Area of study and internal environment of ovine production

The study was carried out in Grosseto, a province located in Tuscany, the second most important Italian region for sheep milk production (ISTAT, 2014). Grosseto, which extends over 4503 Km² (ISTAT, 2013), is home to about 220,000 sheep distributed among 1200 farms devoted mainly to milk production using a semi-extensive system (Anagrafe Nazionale Zootecnica, 2016; Idda et al., 2010). The predominant breed in this region is the Sarda sheep, a highly adaptable breed with a milk yield that influences importantly the cash surplus of farmers (Natale et al., 2000). The average milk production (net of lamb suckled milk) varies from 60 to 130 litres in 100 days for yearlings, from 90 to 170 litres in 180 days for ewes after their second pregnancy and from 100 to 180 litres in 180 days in mature ewes. According to the ASSONAPA breed standards, the average age of first lambing of ewes is 15 months. Lambing occurs mainly in November–December in adult ewes and in January–March in ewe lambs (Natale et al., 2000). Meat production derives mainly from suckling lambs usually slaughtered at 30 days old with an average weight as reported in Table 1 (Carta et al., 1995; ASSONAPA, 1987).

2.2. Economic analysis of diarrhoea outbreaks in lambs

When an outbreak of diarrhoea occurs in lambs, some of the affected lambs will recover and some of them will die, usually as a consequence of dehydration (Fig. 1). Affected farms will require extra labour to manage the disease and will see an increase in veterinary costs due either to visits by the veterinarians or to treatment of the disease.

Table 1
Standard weight of lambs (ASSONAPA, 1987).

Sex	Birth	Birth weight (kg)	Weight at 30 days (kg)
Male	single	3.8	10.4
	twin	3.3	8.8
Female	single	3.5	10.1
	twin	3.1	8.5

Affected lambs will have a reduced average daily weight gain (ADG). Farmers have to choose between keeping the lambs on the farm for longer in order to achieve the usual selling weight, or selling any recovered lambs regardless of their weight without waiting any longer than usual. In the first case the lambs will reach the ideal weight for selling by continuing consuming milk from their mothers, thus reducing the amount of milk available for sale. In the second case lambs will be sold at a lower weight than usual, thus reducing the revenue from meat while milk will be available for the market.

The total loss of meat from a farm (Total L_{meat}) Eq. (1) has been estimated as a function of the loss due to the mortality of lambs (L_m) and the loss in weight (L_w) due to the reduced weight of lambs affected by diarrhoea at the end of the productive cycle (i.e. 30 days).

$$\text{Total } L_{meat} = L_m + L_w \quad (1)$$

Both L_m Eq. (1) and L_w Eq. (1) are functions of the number of lambs born (N_l), the prevalence of diarrhoea on the farm (p), the mortality of the lambs during the outbreak (m), the weight of the lambs at the day of delivery to the abattoir (W_h = weight of healthy lamb or W_d = weight of lamb with diarrhoea), and the price of lamb meat (P_{lm}). Thus, the total loss of meat expressed in Euro can be calculated as in Eq. (2)

$$\text{Total } L_{meat} = [N_l * p * m * W_h * P_{lm}] + [N_l * p * (1-m) * (W_h - W_d) * P_{lm}] \quad (2)$$

which can also be expressed as:

$$\text{Total } L_{meat} = N_l * p * [W_h + W_d * (m-1)] * P_{lm} \quad (3)$$

The weight of lambs with diarrhoea (W_d) at 30 days was estimated to be 8 Kg, as previously found by Aloisio et al. (2006), while the potential weight of healthy lambs (W_h) was calculated in Eq. (4) as the average weight considering the standard data for the Sarda breed at 30 days (Table 1), a rate of twins of 25% (T_t) and the probability of having a male or female as 50% (ASSONAPA, 1987).

$$W_h = \frac{W_{hfs} + W_{hms}}{2} * (1 - T_t) + \frac{W_{hft} + W_{hmt}}{2} * T_t \quad (4)$$

During diarrhoea outbreaks, the mortality of lambs also influences the farm milk yield as an average of 1 L of milk is consumed per lamb each day. Thus, the total milk production (ΔM) gain of the farm can be estimated as in Eq. (5).

$$\Delta M = N_l * m * (30 - day_d) \quad (5)$$

where day_d = Lamb Death Day and $(30 - day_d)$ is the number of days when 1 L of milk is given to the lamb. This last can range from 29 if the lamb dies on the first day, to 0 if the lamb is delivered to the abattoir at the end of the estimated productive cycle (30 days). In this case, no milk is further saved for sale during the 30-day rearing period.

Consequently the total amount of income lost (Total L) Eq. (6) can be calculated as the sum of total meat loss (Total L_{meat}) and the total milk production gain (ΔM) due to the death of lambs.

$$\text{Total } L = \text{Total } L_{meat} - \Delta M \quad (6)$$

Finally, a sensitivity analysis was performed by applying the observed ranges of prevalence and mortality associated with the disease on a farm with 316 lambs (mean number of lambs in the sample).

2.2.1. Scenario analysis varying the day of delivery of lambs to abattoir

An analysis of different management scenarios regarding the time of delivery animals to the abattoir was performed. Three different scenarios were analysed: early (20 days), standard (30 days) and late delivery. The date of late delivery was established by calculating the day on which lambs with diarrhoea would reach the ideal weight (10 kg). In order to evaluate the weight of the lambs at different times, the average daily weight gain of healthy lambs (ADG_h) Eq. (7) and lambs with diarrhoea (ADG_d) Eq. (8) was calculated based on an average weight at birth (W_b) equal to 3.5 kg (ASSONAPA, 1987).

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