

In-farm cost of an outbreak of diarrhoea in lambs

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Highlights

- Increased knowledge in lamb losses for farmers better returns
- Cost of disease's knowledge is fundamental to allocate farmers resources
- In-farm reduced income during lambs' diarrhoea outbreaks were assessed
- Simulation of different income/lamb's delivery time to abattoirs were explored

Keywords

Lamb enteric diseases, diarrhoea, cost of disease, sheep, economic losses

Abstract

This article analyses the cost of lambs' diarrhoea in the dairy sheep farms located in Grosseto (Tuscany-Italy). Recently the outcomes of farmers are lowered due to the stability of market price and the growth in production costs. Animal diseases have a cascade of effects on the farm productivity. Particularly lamb enteric disease outbreaks, being causative of mortality in the herd and reduced weight gain, can drastically compromise the income of farmers. The economic analysis of an outbreak of diarrhoea in lambs for the farmer was thus performed in terms of evaluation of cost of disease considering the main visible production losses (such as mortality, reduced weight gain and variation in milk production). A sensitivity analysis was also applied, varying the prevalence and mortality associated with the diseases. As well an economic scenario analysis was performed considering different in-farm management option for delivering lambs to the abattoir, i.e. anticipated delivering, standard and late delivering. Results shows that a milk sheep farm with around 300 lambs, delivering them to the abattoir at 30 days of age, during an outbreak of lamb's diarrhoea, with a prevalence of 34,21 (23,54-44,88)%, and a mortality of 15,69 (9,98-21,4)%, experiences a drop of production between 670 and 1400 Euro.

1. Introduction

Sheep farming plays a very important economic, social and environmental role in the Mediterranean areas (Finocchiaro et al., 2005; De Rancourt et al., 2006, Ripoll-Bosch et al, 2012, Ripoll-Bosch et al, 2013). Besides its primary function of producing meat and dairy products, sheep farming is strongly embedded with the culture and traditions of the Mediterranean areas (Boyazoglu and Morand-Fehr, 2001). This is true also in Italy, where sheep milk production is situated in less developed, rural and mountainous areas where the production systems are interrelated with local tradition and local sheep breeds (Boyazoglu and Morand-Fehr, 2001; De Rancourt et al., 2006). Sheep farming in Italy is present in different areas characterized by different degrees of intensification mostly in relation to the environmental conditions. As for others animal productions in Europe, the dairy sheep production in most European Mediterranean regions, which includes the Italian case, has encountered important challenges in the last few decades as a consequences of various drivers of change such as depopulation and abandonment of agriculture in rural areas (MacDonald et al., 2000; Strijker, 2005) but also due to more specific factors related to the socio-economic, physical and structural context in which farms operate as analysed by Ripoll-Bosch et al (2012).

In Italy, despite a general trend of intensification aimed at increasing animal productivity, sheep farming is becoming less and less profitable with lots of farms at risk of economic marginalization and risks in generational turnover of the farmers (De Rancourt et al., 2006, De Rancourt and Carrère, 2010, Idda et al., 2010). In this multifactorial scenario, technical and managerial aspects of sheep farming seem to be increasingly fundamental as they can play a decisive role for its competitiveness. In particular, the improvement of the health management through, for instance, a proper disease management strategy can be key to stem losses and increase farmers' production efficiency. It is worth to remember indeed the devastating effects that animal diseases can produce on animal systems by strongly lowering productivity, depress investments, limit access to markets and, increase mostly risks and vulnerability (Otte and Chilonda, 2000; Perry and Randolph, 2003; Howe et al., 2013). Despite many of these effects are disease-specific, we can observe as animal diseases engender a multitude of impacts on economy and society which are able, as in the case of sheep farming in Italy, to strongly limit not only the production of food but also the whole socio-cultural and environmental system related to this.

According to Rushton (2009) a change in animal disease status will have an impact on its productivity, which is defined as the efficiency of the conversion of inputs into outputs, and consequently this can produce multiple negative effects on farm productivity (Otte and Chilonda, 2000). In literature impacts of diseases are generally classified as direct and indirect on animal productivity. Direct impacts can be classified as visible and invisible, whereas indirect impacts can be coded as additional costs and revenue missed (Matthewman and Perry, 1985; Bennett et al., 1997; Rushton et al., 1999; Otte and Chilonda, 2000; Perry and Randolph, 2003; Otte et al. 2008; Knight-Jones and Rushton, 2013; Oseguera Montiel et al., 2015). The economic impact of a disease is thus a complex matter and many analytical methods have been developed in order to address decisions on disease control issues in different environments, accordingly with resources and data available (Morris, 2009, Rushton, 2009).

As observed by El-Tahawy in 2010, among different diseases affecting sheep, diarrhoea is one of the most common and costly disease due to its effects on neonatal small ruminants, which can account to 46% of the total lamb mortality (Schoenian, 2008). Although the importance of the economic losses related to neonatal diarrhoea in lambs have been observed also 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 lambs' enteric disease can compromise

farmers' yield. In addition, as directly observed, control measures can also be difficult to be applied and economically important due to specific farming characteristics and to the kind of pathogens considered that is often associated with a high transmissibility from infected animals, and the ability to persist in animals and environments. It is therefore difficult for farmers to decide which strategy and control measures would be economically beneficial for their farm. An increased knowledge of the economic results associated with diarrhoea in lambs can thus be useful to decide the strategy options to mitigate the impact of the disease. Thus, the aim of this study is to analyse, based on empirical observations, the economic impact of lamb diarrhoea in the sheep farms of the province of Grosseto in Italy. The analysis finally intends to help farmers and veterinarians to understand and calculate the costs for their farms and to plan for economically efficient control strategies. A second outcome regards the implication of institutional arrangements able to better support the provision of veterinary services on the territory.

2. Materials and methods

The study was performed during the period October 2013- September 2015 in three phases: i) desk study, ii) data collection, iii) data analysis. During the desk phase, three main activities were carried out: i) a literature review of the economic studies related to ways of analysing animal diseases, ii) a campaign to inform farmers about the research project, and related main topics, in order to enhance their participation during the data collection phase, and iii) the elaboration and testing of the questionnaire used for the data collection. The questionnaire, which was developed *ad hoc* for the purpose of the research project and the characteristics of the study population, aimed to collect demographic, managerial, epidemiological and economic data on the sheep farms that are experiencing outbreaks of lambs' diarrhoea in the study area.

The data collection (phase 2) was implemented by targeting the farms declaring to experience an outbreak of lambs' diarrhoea to the local VPH laboratory (IZSLT) in the province of Grosseto. Data were collected interviewing 33 farms (82%) out of a total of 41 farms that reported to experience problems of lamb's diarrhoea in the period of observation.

The data analysis (phase 3) was performed in Excel. Demographic data were analysed to identify the characteristics of the sample observed. Managerial data were analysed to identify main strategies of management during the outbreaks which include the time of delivering to the abattoir. Epidemiological data were analysed to identify prevalence of and mortality during the reported outbreaks of lambs' diarrhoea. Finally, economic data were analysed to identify main economic implications of the outbreak of lambs' diarrhoea in the sample observed. In order to estimate the economic impact of diarrhoea the following aspects were considered through a partial budget analysis: reduction in the income due to the outbreak such as mortality, reduced live weight, reduced daily weight gain and variation in milk production. The partial budget analysis allows to evaluate 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 time of delivering of lambs to the abattoir, was performed to evaluate three possible in-farm management options in case of diarrhoea outbreak: 1) anticipated delivering, 2) standard and 3) late delivering. The sensitivity analysis has been performed on the average sheep farm over the study population (n° of lambs=316) with an in-farm prevalence of lamb's diarrhoea (p) of 34,21(23,54-44,88)% and a mortality (R) of 15,69(9,98-21,4)%. With 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 production (i.e. milk and meat) and reported by ISMEA (Italian Institute for the food agriculture market) for December 2014 (ISMEA, 2014) - 4.2 €/Kg for lamb meat and 0.92 €/lt for the Tuscany sheep milk.

2.1. Area of study and internal environment of ovine productions

The area of study of this project is Grosseto, a province located in Tuscany which is the 2th Italian Region for sheep milk production (ISTAT, 2014). Grosseto, extended over 4503 Km² (ISTAT, 2013), is homeland of about 220.000 sheep distributed in around 1200 farms (Figure 1) devoted mainly to milk production using semi-extensive system (Anagrafe Nazionale Zootecnica, 2014, Idda et al., 2010). The predominant breed over the territory is the Sarda breed, an highly adaptable sheep for which the milk yield represent by far the most important trait that influence the cash surplus of farmers (Natale et al., 2000). The average milk production (net of lamb suckled milk) varies from 60 to 130 lt in 100 days for yearlings, from 90 to 170 lt in 180 days in ewes of second birth and from 100 to 180lt in 180 days in mature ewes. Accordingly with the ASSONAPA breed standards, the average age of first lambing of ewes is 15 months. Ewes, have an average annual fertility rate of 96% and annual prolificacy from 110 to 150%. Lambing occurs mainly in November-December for adult ewes and in January-March for ewe lambs (Natale et al., 2000). Meat production derive mainly from suckling lambs slaughtered usually at the age of 30 days old with an average weight as reported in Table 1 (Carta et al., 1995, ASSONAPA, 1987).

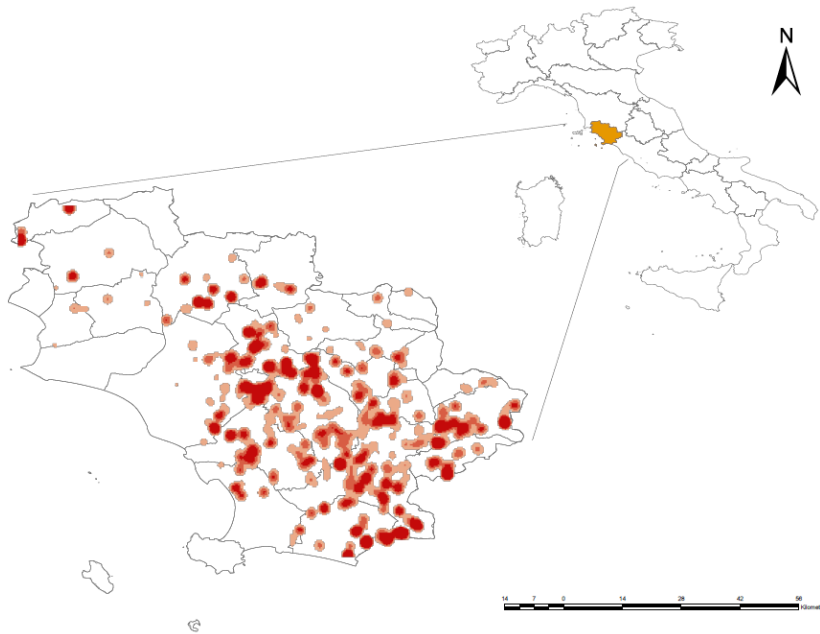


Figure 1: Kernel density map showing the location of sheep in the Grosseto province.

Table 1: General parameters of the production model.

Parameter	Value(s)	Reference/Equation								
Average day of suckling lambs sold for slaughter	30 days	Carta et al., 1995, ASSONAPA, 1987								
Weight of lambs at 30 days	<table border="1"> <thead> <tr> <th>Sex</th> <th>Birth</th> <th>Birth weight</th> <th>Weight at 30</th> </tr> </thead> <tbody> <tr> <td></td> <td></td> <td></td> <td></td> </tr> </tbody> </table>	Sex	Birth	Birth weight	Weight at 30					ASSONAPA, 1987
Sex	Birth	Birth weight	Weight at 30							

			(kg)	days	
				(kg)	
	Male	single	3.8	10.4	
		twin	3.3	8.8	
	Female	single	3.5	10.1	
		twin	3.1	8.5	
Twins rate (T_r)	25%				ASSONAPA, 1987
Probability of having male/female	50%				Assumption
Average weight at birth of (W_b)	3,5 kg				(ASSONAPA, 1987)
Average weight of healthy lambs at 30 days (W_h)	9,85 kg				$W_h = (W_{hfs} + W_{hms})/2 * (100 - T_r) + (W_{hfs} + W_{hmt})/2 * T_r$
Average milk consumption of suckling lambs	1 lt/day				Personal communication/Assumption
Weight of lambs with diarrhoea at 30 day (W_d)	8 kg				Aloisio et al., 2006
Average Daily Gain for health lamb (ADG_h)	0,21kg				$ADG_h = (W_h - W_b)/30$
Average Daily Gain for lamb experienced diarrhoea (ADG_d)	0,15 kg				$ADG_d = (W_d - W_b)/30$

2.2. Lambs diarrhoea epidemiological and economic model

When diarrhoea enters a nursery of lambs, part of the affected lambs will recover and part of them will die, usually as a consequence of the dehydration and thus the overall mortality will increase (Figure 2). Affected farms will have extra labour to manage the disease as well as an increase of veterinary costs due either to the veterinarian visits and to the treatment of the disease. Affected lambs will have a reduced average daily gain (ADG). As a consequence, farmers could choose among keeping the lambs in the farms for extra days in order to achieve the weight for selling or selling the recovered lambs at the weight reached without waiting extra days. In the first case the lambs will reach the ideal weight for selling consuming a major amount of milk from their mothers, for the typical characteristics of the local production system, reducing the quota of milk production. In the second case lambs will be sold at lower weight, thus revenue from meat will be lowered while a major quota of milk production will be available for the market.

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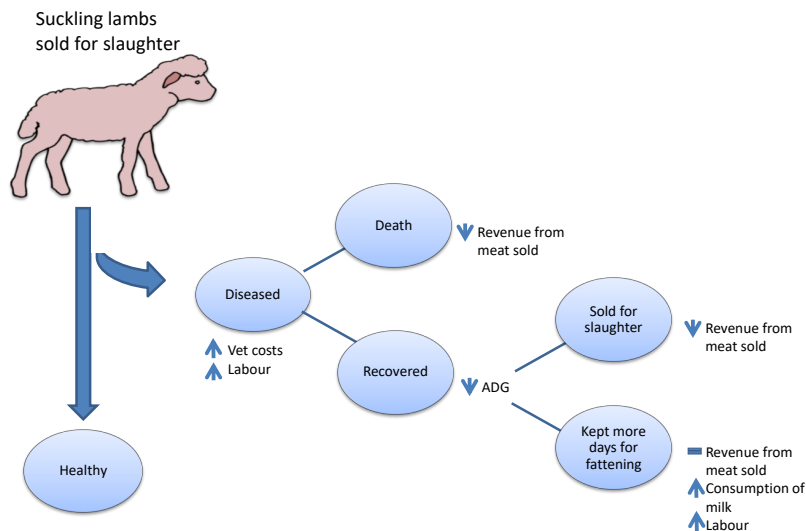


Figure 2: Flow diagram of the influence of lamb's diarrhoea on the production process.

2.3. Economic analysis of in farm lamb's diarrhoea outbreaks

For the purpose of the research project the costs of lamb's diarrhoea have been estimated through the epidemiological information and productivity parameters collected from the study population during the period of observation in order to estimate the reduction of farmers' income (Table 1).

As first consequence we have recorded from farmers experiencing lambs' diarrhoea outbreaks a drop of production of lambs' meat due to mortality and reduced weight at the day of delivery to the abattoir for the number of lambs with diarrhoea.

Thus, the total loss of meat of the 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 the lamb with diarrhoea at the end of the productive cycle (i.e.30 days).

$$[eq 1] \text{ Total } L_{meat} = L_m + L_w$$

Both L_m [eq 1] and L_w [eq 1] are function of the number of the lamb at born (N_i), the prevalence of the diarrhoea in the farm (p), the mortality of the lambs during the outbreak (m), the weight of the lamb 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 the lamb meat (P_m).

$$[\text{eq 2}] L_m = N_l * p * m * W_h * P_{tm}$$

$$[\text{eq 3}] L_w = N_l * p * (1 - m) * (W_h - W_d) * P_{tm}$$

Thus, the total loss of meat of the farm expressed in Euro can be calculated as in [eq 4-5]

$$[\text{eq 4}] \text{Total } L_{meat} = [N_l * p * m * W_h * P_{tm}] + [N_l * p * (1 - m) * (W_h - W_d) * P_{tm}]$$

$$\text{Which is: } [\text{eq 5}] \text{Total } L_{meat} = N_l * p * [W_h + W_d * (m - 1)] * P_{tm}$$

The weight of lambs with diarrhoea (W_d) at 30 days was estimated 8 Kg, as previously found in other studies (Aloisio et al., 2006), while the potential weight of healthy lambs (W_h) was instead calculated in [eq 6] as an average of weight considering the standard data for Sarda breed weight 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) (Figure 3).

$$[\text{eq 6}] W_h = \frac{W_{hfs} + W_{hms}}{2} * (1 - T_t) + \frac{W_{hft} + W_{hmt}}{2} * T_t$$

In addition to this, during diarrhoea outbreaks, the mortality of lambs influences the farm milk yield as a consequence of the milk used to feed lambs, which has been estimated as 1lt lamb/day in average. Thus, the total milk production gain of the farm has been estimated as in [eq 7].

$$[\text{eq 7}] \Delta M = N_l * m * (30 - day_d)$$

Where $day_d = \text{Death Day}$ and $[(30 - day_d)]$ helps to estimate the number of days when the 1 lt of milk is given to the lamb. It can vary from 29, if the lamb exits from the farm the first day (died) to 0 if the lamb is delivered to the abattoir on the estimated productive cycle (30 days). In this final case, no milk is saved for being sold on the market in the 30 days considered period.

Consequently the total amount of the income lost ($Total L$) [eq 8] 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.

$$[\text{eq 8}] \text{Total } L = \text{Total } L_{meat} + \Delta M$$

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

2.3.1. Scenario analysis varying the day of lambs delivering to abattoirs

An analysis of scenario for different management decision regarding the days of delivering animals to the abattoirs has been performed. Three different scenarios were analysed: anticipated delivering (20 days), standard (30days) and late delivering. The date of late delivering was established calculating the day in which the lamb with diarrhoea would reach the ideal weight (10kg) (Figure 3). In order to evaluate the weight of the lambs at different times, the average daily gain of healthy lambs (ADG_h) [eq 9] and the one of lambs with diarrhoea (ADG_d) [eq 10] were calculated considering the average weight at birth (W_b) equal to 3,5kg (ASSONAPA, 1987).

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$$\text{[eq 9] } ADG_h = \frac{W_h - W_b}{30}$$

$$\text{[eq 10] } ADG_d = \frac{W_d - W_b}{30}$$

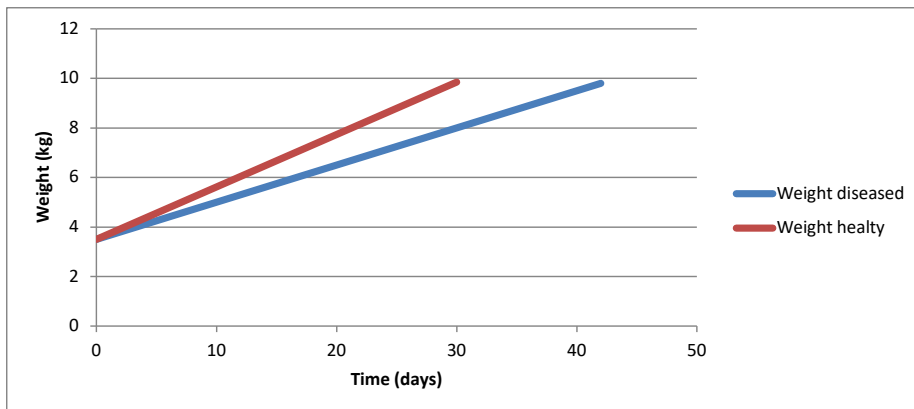


Figure 3: Growth pattern for a diseased and a healthy animal.

In the case of anticipated delivering of lambs to the abattoir, the low income from meat yield would be decreased by an increment of milk yield, while in case of late delivering the losses in milk production due to suckling lambs should be added.

3. Results

3.1. Characteristics of the sheep farming

As expected, the farmers in the study population confirmed that the majority of the sheep raised are Sarda sheep (88,24%), accordingly with the typical sheep production in the province of Grosseto. The flocks were composed of an average of 445 head/farm, with the 44% of the farms with an average consistency of 300-500 heads/farm. The average extension of the enterprises was around 100 hectares with the 66% of the territory destined to pasture. Nevertheless the higher prize for biological products and the semi-extensive characteristics of this enterprise, only the 33% are registered as biologic farming. The enterprise management is, in the 73% of the cases, direct with exclusive family manpower with an average of 2,2 manpower's/farm. The level of instruction of the entrepreneur was for the 73,53% of middle school. The income of those enterprises is mainly based on milk and meat yields, rarely farms are devoted to others productions such as: farming of others animals (29,41%), vegetable-fruit production (20,56%), forage production for market (11,76%), production of alternative energy (8,82%). Only the 14,71% of the farms market directly their products and only the 8,82% market their own transformed products.

3.2. Estimation of in-farm production losses

The in-farm production losses during an outbreak of diarrhoea in lambs (p=34,21% m=15,69%) with an average standard delivery of lambs to the abattoir at 30 days, associating the losses of meat

production due to mortality and the reduced weight gain with the variation (increase) of milk yield in case of lamb mortality, were estimated to growth as average from around 780 Euro to 1260 Euro. The observed variation depends to the day in which theoretically mortalities occur. In fact the total loss of income will be higher the closest the mortalities will be to the day of delivery to the abattoir (Figure 4).

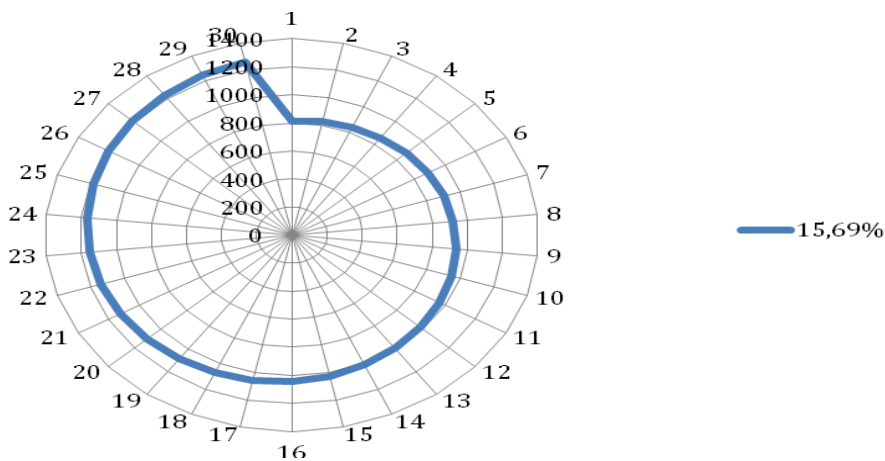


Figure 4: Estimation of total (meat+milk) production losses in the average farm with a diarrhoea outbreak (p=34,21%) in lambs with a mortality of 15,69% varying the day of lambs' death (1st-30th day).

As expected, the economic losses will growth at the increase of mortality (Figure 5). As recorded by farmers, by applying the 95% confidence limit, to prevalence (p=34,21%) and mortality (m=15,69%), the prevalence of respectively 23,54-44,88% and 9,98-21,4% to the average farm with an outbreak of diarrhoea (n°of lambs=316), they fluctuate from 660 to 1370 Euro (Figure 5). If we consider also the minimum mortality (3%) and maximum mortality (80%) registered in the observed farm (n=33) they can range from 500 Euro to 2160 Euro (Figure 5).

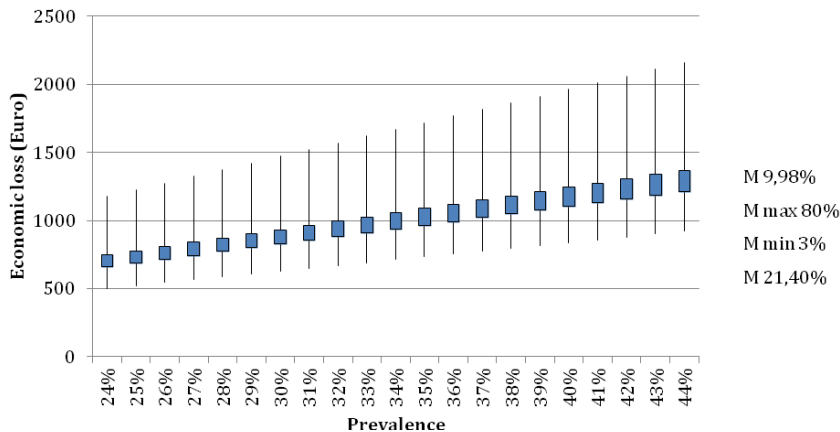


Figure 5: In-farm economic losses of the average farm with a lambs' diarrhoea outbreak in the prevalence range observed in the territory for the mortality rate confidence limit of 95% CL 9,98-21,40% and the min and max mortality registered in the observed outbreak (min=3%- max 80%).

3.2.1. Variation of total estimated economic losses varying the day of delivering of lambs to the abattoirs

Three different options for delivering animals to the abattoir were considered, such as anticipated (20 days), standard (30 days) and late delivery (42 days). The daily growth rate for lambs with diarrhoea was calculated as 0,15 kg/head, thus theoretically an average lamb with diarrhoea will reach 6,5 kg at 20 days, and the 30 days old healthy lamb's weight ($\bar{x}=9,85$ Kg) at 42 days. Figure 6 shows the economic losses for each diseased lamb of Sarda breed in relation to the day of abattoir delivery (from 20 to 42 days), considering the difference in milk yield versus a standard delivery (30 days). Even if the economic losses from meat will be recuperated at the 42nd day, the total economic losses will be higher for the reduced amount of milk sold which is instead used to feed the lamb. Applying the average prevalence ($P=34,21\%$) and mortality ($m=15,69\%$) registered in the territory to the average farm ($n^{\circ}\text{lamb}=316$), the economic loss in a farm with a diarrhoea outbreak delivering lambs to the abattoir at the average of 20 days of age will be 1160Euro, while at 42 days will be 1450Euro.

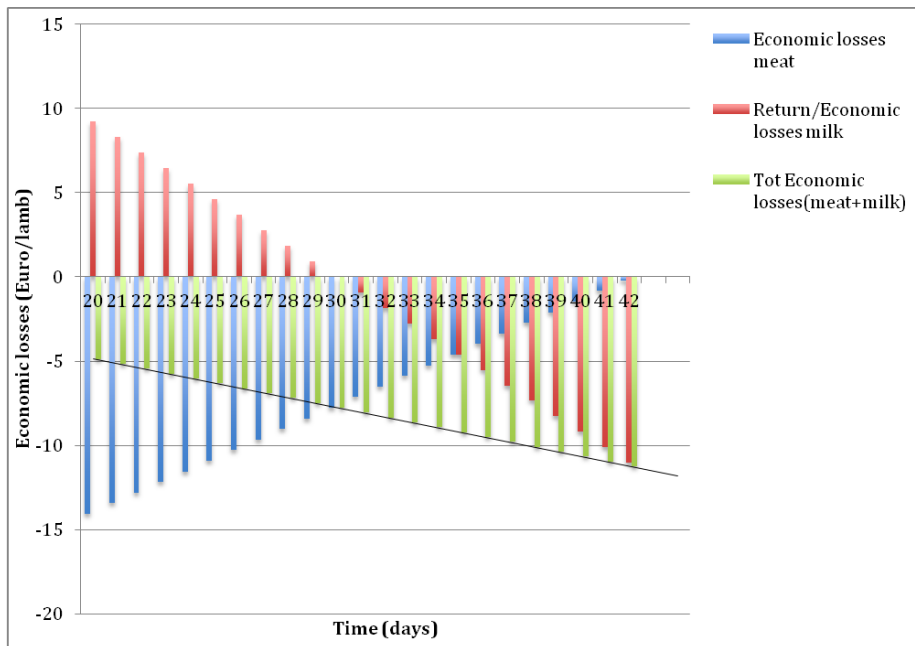


Figure 6: Economic losses for each lamb of Sarda breed in relation to the day of abattoir delivery.

4. Discussion

In this study, we provide evidence of the economic losses due to potential loss of production during a diarrhoea outbreak in lambs. The production losses such as lamb mortality (balanced by increased milk production sold) and low lambs' pondered weight, may vary between 670 Euro to 1370 for the average farm. This estimation has been produced using as example the average farm located in Grosseto, where the observed farm (n=33) had an average number of lambs of 316, an in-farm prevalence of diarrhoea of 34,21 (23,54-44,88)%, with a mortality of 15,69 (9,98-21,4)%. The estimated drop of production may be very important as the farm net income for the Tuscany's sheep and goat farming system may be around 11.000 Euro as calculated for 2013 by the Farm Accountancy Data Network (European Commission, 2016).

Obviously the economic losses during diarrhoea outbreaks in lambs will growth, at the increase of mortality and, as well, depending to the day of death of ill lambs. They will be higher when the death of the animal destined to die will be closer to the day of delivering to the abattoir (Figure 4). In fact, the longest the diseased animal will survive, the major amount of milk will be consumed from lambs and consequently the less can be sold (Figure 4). On the contrary the soonest the ill animal will die, the major amount of milk could be sold and thus could balance part of the drop of meat production. Figure 5 shows how the economic losses during an outbreak of diarrhoea in the average farm can differ varying the prevalence and mortality observed in the studied farms varying from a minimum of 500 Euro to a maximum of 2160 Euro. This estimation is based considering an ideal delivering to abattoir at 30th day of age.

Simulations were performed in relation to the different management choice relating the time of delivering animals to the abattoirs (anticipated, standard or delayed) during lamb's diarrhoea outbreaks. In the study area, two different management options were observed on this regard. There were farmers trying to steam losses selling earlier the lambs to avoid the spreading of the disease, limiting the mortality and the loss of money from the low weight of carcasses, others were keeping some days more the lambs in the farm in order to allow them to gain more weight before sending them to the abattoir. This study shows that, in a standard setting, is economically preferable to anticipate the delivery of the lambs to the abattoir, as at 20 days the losses will be around 1160 Euro, than to wait for the lambs to "recuperate" weight, as at 42 days the losses will be around 1450 Euro. This can be explained by the major impact that milk yield has got in the study area than the meat one, accordingly with the type of production (milk dairy farm) of the farm of the territory.

Of course the estimation in this study are only indicative as the reality may differ depending on the cause of diarrhoea and the different sanitary measures and treatment that could be applied. The different farmers' management options during lamb's diarrhoea outbreaks, such as more frequent cleaning operations and pharmacology treatments of ill animals will increase the costs associated with the outbreaks. This data were not considered in this study as being diarrhoea a multifactor disease, they can differ from pathogen to pathogen and from different management options. In addition it is worth to remember that also the day of delivering of lambs to abattoir may differ in case of pharmacology treatment for the eventual suspension's time of the drugs used. Furthermore the day of mortality, as well as the day of delivering of lambs to the abattoir, should be considered only as an indicative average day, as there is no fixed day for lambing in a flock, or for lambs getting the disease and furthermore lambs are delivered to abattoirs in batch and not individually. Finally, it is also important to remember as these estimations were depending upon the farmers' willingness to share information, as no standardized dataset or individual records were available due to the traditional type of farming.

Finally it is worth to notice as to avoid the economic losses associated with diarrhoea lambs' outbreaks, prophylaxis of diarrhoea should be implemented as well as fast and reliable diagnosis in

order to control the spread of the disease at its own development. On this regard it would be appropriate to have in-farm sanitary plan to prevent and manage the diseases. Nowadays the European trend is to demand sanitary plans to farmers themselves (Umali et al., 1994, Ahuja, 2004, Castillo-Salgado, 2010). In our project the majority of the farms were small family enterprises with an entrepreneur level of instruction of middle school (73%). In this kind of context often there isn't enough scientific knowledge, nor economic allowance, for the implementation of sanitary plans, thus would be very important to support this small production by public veterinary support. In this way would be fostered not only the economic benefit of the rural traditional productions but would be controlled also the spreading of zoonosis, which can be often associated with lamb's diarrhoea (e.g. cryptosporidiosis, giardia, salmonella).

5. Conclusion

This study confirms the high impact that diarrhoea outbreak's in lamb can have over the economy of the sheep farms. In fact the drop of production, such as low lamb pondered weight and lamb mortality balanced by milk production, may vary between 670 and 1370 Euro, considering an average farm with 316 lambs, a prevalence of diarrhoea of 34,21 (23,54-44,88)% and a mortality of 15,69 (9,98-21,4)% and a standard delivery to abattoir. This drop of production may be very important for farmers as their net income was calculated by FADNS in 2013 as around 11.000 Euro (European Commission, 2016).

An anticipated delivering (e.g. 20 days of age) of the lambs to the abattoir would be economically beneficial, compared to a late delivering (e.g. 42 days of age) waiting for the ill lambs to gain the expected weight at 30 days of age, due to the increased income from milk production once the lambs are slaughtered. These data, even if, merely indicative, as the reality may be different due to the type of pathogen and different sanitary approaches, can be useful to understand the economic effect of diarrhoea in lambs, a disease which is often underestimated by farmers. The knowledge of the cost of a diarrhoea outbreak may be useful to promote the use of proper prophylaxis, fast diagnosis and correct management of the outbreaks.

Finally, these results can be a useful starting point to don't underestimate the importance of lambs' diarrhoea at least due to its important negative economic effect. The economic losses of lamb diarrhoea in such a small production system, like the sheep dairy system in Grosseto analysed in this paper, can be extremely important due to the actual criticalities raised by the increasing of production costs and the stagnancy of the products' prices which are already compromising the profitability of this farming system. Indeed, despite the relative low production of the sheep dairy system observed in the case study, it should be acknowledged its high environmental and social importance in Grosseto. This sheep farming system is indeed located in a rural area, which is unfavourable for other productions, where plays a very important role in the maintenance of tradition and environment. Keeping healthy this small farming system can help to generate positive social and environmental effects which cannot be valued only in monetary terms (Morris, 2009).

Conflict of interest

Acknowledgement

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