ABORTIONS IN CATTLE AND SHEEP HERDS IN ALGERIA, DESCRIPTIVE STUDY AND RISK FACTORS

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Abstract. The objective of this study is to evaluate the epidemiological situation of abortions on cattle and sheep herds and to identify some risk factors related to them. A descriptive analysis of 139 dairy cattle and 34 sheep farms showed that abortions affect 40.29% and 79.41% of cattle and sheep herds respectively; with an average abortion rate of 11.86% and 4.55% per herd respectively. The identification of risk factors was performed by univariate analysis followed by multiple logistic regression analysis. The results identified three risk factors for cattle (herd size, contact with animals from neighboring farms and presence of stillbirths/malformations) and four risk factors for sheep by univariate analysis only (housing in zriba, presence of stillbirths/malformations, infertility and presence of weak lambs). In conclusion, abortions are an important health problem in livestock farming. Identifying risk factors could help to make optimal decisions to minimize economic losses.

Keywords: Abortion threshold, Epidemiological form, Reproductive disorders.

INTRODUCTION

Algeria with an estimated herd of more than 1.9 million cattle, 26.4 million sheep and 4.8 million goats (Anagriculture, 2018), is one of the seven African countries with the largest numbers of small ruminants (Akakpo et al., 2009). However, national needs for milk and red meat are only partially covered, requiring permanent import (Bessaoud et al., 2019).

It seems that beyond the numerical importance of these farms, they continue to be marked by the extensive nature of production systems that are highly dependent on climatic hazards, fodder availability, sanitary and genetic constraints.

The health issue is largely dominated by the loss of products caused by embryo mortalities, abortions, dystocia and stillbirths. Abortions are multifactorial entities whose origin may be infectious (Dechicha et al., 2010; Clothier and Anderson, 2016; Vidal et al., 2017; Ghanem and Nishibori, 2018); other factors may also contribute to their triggering or increase their impact. Some are intrinsic, such as age, genetics or health status, others are extrinsic, such as livestock management, feeding or stress (Clothier and Anderson, 2016; Rani et al., 2018).

The incidence of abortion is difficult to assess and therefore underestimated. In general, an abortion rate of less than 5% is considered acceptable in dairy cattle farming (Holler, 2012) and a rate varying from 2 to 5% is considered normal in sheep farming (Menzies, 2007).

In Algeria, estimates of the incidence, losses and risk factors associated with abortions have been poorly studied, leading to a critical lack of data on the epidemiological situation of livestock abortions.
This situation is due to the fact that abortions are not subject to mandatory reporting; moreover, no abortive disease apart from brucellosis is legislated whatever its zoonotic impact.

The objective of this study is to assess the epidemiological situation of abortions and to identify certain risk factors associated with cattle and sheep farming.

MATERIAL AND METHODS

Location: The study was conducted in dairy cattle farms located in Blida department (36°28'N latitude and 2°49'E longitude), an area considered to be a dairy basin, located 47 km south-west of Algiers, and in sheep farms located in Djelfa department (34°65'N latitude and 3°26'E longitude), an agro-pastoral region located 300 km south of Algiers.

Sampling: For cattle herds, a stratified random sample was taken from veterinary inspection database comprising 626 approved dairy farms. The analysis was carried out using Epidata and Epi Info 6 software (Epitable Program) taking into account the weight of each stratum (subdivision) of the department, the method (1/10) with random draw for the identification of the farms to be studied and a minimum number of 4 cows per farm. A sample of 139 farms (from 4 to 154 heads) with a total of 2227 heads was defined.

For sheep herds, the determination of a representative sample was not possible due to the absence of databases of sheep farms (Transhumant and nomadic farms). We selected our sample taking into consideration the accessibility and acceptance of breeders to participate in the survey. The sample covered 34 farms (from 6 to 525 heads) with a total of 5349 heads.

Survey: Data collection was carried out by means of a questionnaire completed during an interview with the farmer during a single visit to the farm. It includes open (short answers) and closed (multiple choice answers) questions which deal with the situation of abortions, characteristics, practices and management of livestock and finally the history of the reproductive disorders in these farms.

Abortion: Abortion defined in this study is the farmer's visual observation of rejection of a non-viable fetus and /or its membranes before term in a pregnant diagnosed female.

A herd "with abortion" is qualified as such when at least one abortion has been recorded during the year preceding the survey.

The overall rate of abortion per herd is determined by the number of aborted females on the number of pregnant females in a herd during the year preceding the survey.

Risk factors: The risk factors associated with abortions are classified into three groups:

- Husbandry characteristics: herd size (number of animals), type of housing for sheep (built barn or zriba*), barn area (m^2), presence of exercise area, calving paddock,

other animal species, contact with animals from neighboring farms and hygiene in husbandry.
- Husbandry practices and management: breeding services (artificial insemination, natural mating and estrous synchronization), disposal of fetus and fetal membranes and purchasing animals without quarantine.
- History of reproductive disorders observed during the previous three years: infertility, stillbirths and malformations and birth of weak lamb (for sheep farms).

Zriba*: rudimentary constructions used as shelter in sheep farms.

Statistical analysis: The epidemiological study of abortions is carried out by a general descriptive statistical analysis with the SYSTAT software version 10.

For the study of risk factors, the variables were grouped into classes. The relationships between each of the potentially explanatory variables and the status "with or without abortions" are studied during a two-step procedure. A univariate analysis was performed using chi-square test (X^2) and exact Fischer test respectively for cattle and sheep farms. The links were considered significant for $p < 0.05$. The degree of dependence of abortions on various factors was determined by the odds ratios. The multivariate analysis was based on the logistic regressions in a model including the variables with $p \leq 0.05$ identified in the first step. It was performed on SAS software (2001).

RESULTS AND DISCUSSIONS

- **Farms characteristics:** The majority of cattle farms had between 4 and 10 heads (49.64%), stables with an average surface area greater than 100 m^2 (50.36%); an exercise area (56.83%); neighboring farms (79.14%) and satisfactory hygiene practice (89.21%); however, 87.77% of these farms do not have calving paddock.

For sheep farms, the majority of them had between 100 and 300 heads (50%), associated with other animal species (82.35%) and 55.88% housed the animals in zriba.

- **Descriptive study of abortions**

Abortions rates in cattle and sheep herds: The descriptive analysis has shown that the rates of farms with abortions are 40.29% and 79.41% respectively for cattle and sheep. A statistical comparison of herds "with abortion" in both species, shows that there are more abortions in sheep herds than in cattle herds (Table 1). These rates reveal a worrying situation where more than a third of cattle herds and more than two-thirds of sheep herds are exposed to abortion annually.

Table 1

Abortions rates in cattle and sheep herds

Animal species	Cattle		Sheep		Herds with abortions Cattle *vs* Sheep (P value)
Status	With abortions	Without abortions	With abortions	Without abortions	
Herds (n)	56	83	27	07	0.024
Rate (%) 95% CI	40.29[a] 32.50 - 48.60	59.71[a] 51.40 - 67.50	79.41[b] 63.20 - 89.65	20.59[c] 10.35 - 36.80	
P value	0.061		0.004		

The letters a, b and c in the same line mean a significant difference ($p<0.05$).

However, it should be noted that these rates represent only the visible part of the interruption of gestation and that early and late embryonic mortalities as well as early fetal mortalities are not taken into account. According to Santos et al. (2004), gestational losses in dairy cows from fertilization to term could represent up to 60%.

In practice, just a fraction of these abortions are detected by the breeder. According to Forar et al. (1996), only 20% of fetal mortalities are detected through the expelled fetal membranes between 31 and 260 days of gestation, and according to Kinsel (1999), only 46% of abortions are actually detected. Norman et al. (2012), report that the real number of abortions would be 2.2 to 5 times greater than the number of observed abortions.

Average abortion rates: The average abortion rates are 11.86% and 4.55% for cows and ewes respectively. Classification of herds shows that 89.36% and 35.71% of cattle and sheep herds respectively are above the tolerated abortion threshold (Table 2).

Table 2

Average abortion rates for cows and ewes

Herds with abortions	Pregnant females	Aborted females	Abortion rate (95% CI)	Limits per herd (%)	Herds with more than 5% abortions (%)
Cattle (n=56)	649	77	11.86[a] (9.60 - 14.58)	1.81 à 100	42 (89.36)
Sheep (n=27)	2109	96	4.55[b] (3.74 - 5.53)	0.5 à 12.5	5 (35.71)

The letters a and b in the same column mean a significant difference ($p < 0.05$).

Abortion rate calculation is decisive for the sustainability and economic viability of a farm; it makes it possible to situate oneself in relation to a threshold above which investigations must be considered. Indeed, a fetal loss of 3 to 5% per year in cattle farming (Hovingh, 2009) and 2 to 5% in sheep farming (Menzies and Miller, 1999) is considered acceptable.

However, large disparities in abortion rates have been reported in literature; for example 1.5% and 10.4% were respectively reported by Carpenter et al. (2006) and Lucchese et al. (2016) for cattle, and 12.10% and 34% were reported respectively by Benkirane et al. (2015) and Movassaghi et al. (2016) for sheep.

These variations are partly explained by the difference in abortion definition itself; indeed, Thurmond et al. (1990) define abortion as a fetal death between 52 and 260 days of gestation, while Norman et al. (2012) define it as a fetal death from 150 days of gestation.

Furthermore, the method to detect abortions differs from one study to another, some authors rely on the observation of aborted fetus and membranes while others rely on gestational and hormonal diagnosis.

Epidemiological form of abortions: Epidemiological form of observed abortions does not show a significant difference between herds with "sporadic" or "epizootic" abortions, $p = 0.079$ and $p = 0.43$ for cattle and sheep herds respectively (Table 3). According to numerous studies, the diagnosis of abortion cause can be orientated by its epidemiological form.

Table 3

Epidemiological form of abortions recorded in cattle and sheep herds

Animal species	Cattle		Sheep	
Epidemiological form of abortions	Sporadic	Epizootic	Sporadic	Epizootic
Herds (n)	36	20	11	16
Rate (%) 95% CI	64.29 [a] 51.19 - 75.54	35.71[a] 24.46 - 48.81	40.74 [b] 24.51 - 59.27	59.26 [b] 40.73 - 75.49
P value	0.079		0.43	

The letters a and b in the same line mean an insignificant difference (p> 0.05)

Sporadic abortions are more likely to be the result of congenital anomalies, hormonal imbalance or any disturbance of the fetal-placental unit (Khodakaram-Tafti and Ikede, 2005; Risvanli et al., 2009). Infectious agents such as fungal, *Ureaplasma diversum, Campylobacter fetus* and *Listeria monocytogenes* would be also responsible for sporadic abortions (Anderson, 2007; Syrjälä et al., 2007; Campero et al., 2005; Barkallah et al., 2014).

In contrast, serial abortions are more likely to result from infectious agents such as BHV-1, Schmallenberg virus and *Neospora caninum* in cows (Graham, 2013; Borel et al., 2014; Sager et al., 2005) and *Salmonella Abortusovis* which could cause serial abortions in 30 to 50% of pregnant ewes (Wirz-Dittus et al., 2010).

- **Risk Factors:** For cattle herds, the results of univariate analysis by Chi-square test reveal that herd size, presence of an exercise area, contact with animals from neighboring farms, presence of dogs in the farm, presence of stillbirths/malformations and finally infertility problems show a significant link ($p<0.05$) with herds that have abortions (Table 4).

For sheep herds, the results of univariate analysis by Fisher's exact test reveal that animals housed in zriba, presence of stillbirths and malformations, presence of infertility problems and the birth of weak lambs are significantly related ($p<0.05$) to herds that have abortions (Table 5).

Table 4

Univariate analysis of risk factors in cattle herds

Factors	Herds (n)	Without abortions (83)	With abortions (56)	% (95% CI)	OR (95% CI)	P-value
Husbandry characteristics in cattle herds						
Herd size (Heads)						**<0.001**
≤ 10	69	50	19	27.54 (18.39-39.05)	Réf	
]10 20]	45	27	18	40 (27.02- 54.55)	1.75 (0.79- 3.89)	
]20 30]	08	01	07	87.50 (52.91 -97.76)	18.42 (2.12 -159.86)	
> 30	17	05	12	70.59 (46.87-86.72)	6.32 (1.96-20.35)	
Barn area (m^2)						0.924
≤ 40	35	20	15	42.86 (27.98- 59.14)	Réf	
]40 100]	34	21	13	38.24 (23.90- 54.96)	0.83 (0.32-2.17)	
> 100	70	42	28	40 (29.33-51.71)	0.89 (0.39- 2.03)	
Hygiene						0.98
Unsatisfactory	15	09	06	40 (19.82-64.25)	Réf	
Satisfactory	124	74	50	40.32 (32.11-49.12)	1.01 (0.34 – 3.01)	
Presence of exercise area						**0.004**
No	60	44	16	26.67 (17.13- 39.01)	Réf	
Yes	79	39	40	50.63 (39.84-61.37)	2.82 (1.37-5.81)	
Presence of calving paddock						0.93
No	122	73	49	40.16 (31.89- 49.03)	Réf	
Yes	17	10	7	41.18 (21.61-63.99)	1.04 (0.37-2.92)	
Contact with animals from neighboring farms						**0.023**
No	110	71	39	35.45 (27.14- 44.75)	Réf	
Yes	29	12	17	58.62 (40.74-74.49)	2.57 (1.11-5.94)	
Presence of dogs						**0.053**
No	66	45	21	31.82 (21.85-43.79)	Réf	
Yes	73	38	35	47.95 (36.88-59.22)	1.97 (0.99-3.94)	
Presence of cats						0.49
No	113	69	44	31.63 (23.27-41.38)	Réf	
Yes	26	14	12	60.98 (45.73-74.34)	3.97 (1.82 -8.66)	
Presence of equines						0.85
No	103	62	41	39.81 (30.88-49.86)	Réf	
Yes	36	21	15	41.67 (27.14-57.80)	1.08 (0.5-2.34)	
Présence of sheep/goats						0.25
No	104	65	39	37.50 (28.80- 47.09)	Réf	

Yes	35	18	17	48.57 (32.99-64.43)	1.57 (0.72-3.40)	
Husbandry practices and management in cattle herds						
Breeding						
Natural service	57	35	22	38.60 (27.06-51.57)	Réf	0.84
Artificial insemination	46	26	20	43.48 (30.21-57.75)	1.22 (0.55-2.69)	
Both	36	22	14	38.89 (24.78-55.14)	1.01 (0.43-2.38)	
Presence of bull on the farm						0.33
No	74	47	27	36.49 (26.44-47.87)	Réf	
Yes	65	36	29	44.62 (33.17-56.66)	1.4 (0.71-2.77)	
Disposal of fetus/ Fetal membranes						
Thrown into the field	98	58	40	40.82 (31.61-50.71)	Réf	0.84
Buried	41	25	16	39.02 (25.66-54.27)	0.93 (0.44-1.96)	
Purchasing animals without quarantine						0.46
No	87	54	33	37.93 (28.45-48.43)	Réf	
Yes	52	29	23	44.23 (31.60-57.66)	1.3 (0.65-2.61)	
History of reproductive disorders in cattle herds						
Stillbirths/ Malformations						
Absence	106	73	33	31.13 (23.11-40.48)	Réf	**<0.0001**
Presence	33	10	23	44.23 (31.60-57.66)	5.09 (2.18-11.89)	
Infertility						
Absence	76	59	17	22.37 (14.46-32.93)	Réf	**<0.0001**
Presence	63	24	39	61.90 (49.56-72.88)	5.64 (2.69-11.84)	

Table 5

Univariate analysis of risk factors in sheep herds

Factors	Herds (n)	Without abortions (83)	With abortions (56)	% (95% CI)	OR (95% CI)	P-value
Husbandry characteristics in sheep herds						
Herd size (Heads)						0.57
≤10	02	01	01	50 (9.45 - 90.55)	Réf	
]10 50]	08	01	07	87.50 (52.91 - 97.76)	7 (0.21-226)	
> 50	24	05	19	79.17 (59.53 - 90.76)	3.8 (0.2-72)	
Type of housing						**0.02**
Built barn	15	06	09	60 (35.75 - 80.18)	Réf	
Zriba	19	01	18	94.74 (75.36 - 99.06)	12 (1.24-115.36)	
Presence of dogs						1
No	08	02	06	75 (40.93 - 92.85)	Réf	
Yes	26	05	21	80.77 (62.12 - 91.49)	1.4 (0.21-9.12)	
Presence of cats						0.40
No	14	04	10	71.43 (45.35 - 88.28)	Réf	
Yes	20	03	17	85 (63.96 - 94.76)	2.26	
Presence of equines						1
No	23	05	18	78.26 (58.10-90.34)	Réf	
Yes	11	02	09	52.94 (30.96-73.83)	0.31 (0.07-1.23)	
Presence of goats						0.65
No	11	03	08	72.73 (43.44-90.25)	Réf	
Yes	23	04	19	82.61 (62.86-93.02)	1.78 (0.32-9.84)	
Presence of cattle						0.40
No	20	03	17	85 (63.96-94.76)	Réf	
Yes	14	04	10	71.43 (45.35-88.28)	0.44 (0.08-2.38)	
Husbandry practices and management in sheep herds						
Breeding						0.55
Natural estrous	29	07	22	75.86 (57.89 - 87.78)	Réf	
Estrous synchronization	05	00	05	100 (56.55 – 100)	/	
Disposal of fetus/fetal membranes						0.10
Thrown into the field	03	02	01	33.33 (6.15 - 79.23)	Réf	
Buried	31	05	26	83.87 (67.37 - 92.91)	10.40 (0.78-137.83)	
History of reproductive disorders in sheep herds						
Stillbirths/Malformations						**0.011**
Absence	14	06	08	57.14 (32.59 - 78.62)	Réf	
Presence	20	01	19	95 (76.39 - 99.11)	14.25 (1.46-138.27)	
Infertility						**0.03**
Absence	16	06	10	62.50 (38.64 - 81.52)	Réf	
Presence	18	01	17	94.44 (74.24 - 99.01)	10.20 (1.06-97.40)	
Birth of weak lamb						**0.013**
No	10	05	05	50 (23.66-76.34)	Réf	
Yes	24	02	22	91.67 (74.15-97.68)	11 (1.63-73.96)	

The results of final multivariate logistic regression analysis show that for cattle: herd size, contact with animals from neighboring farms and the problems of stillbirths/ malformations are risk factors for abortions. However, for sheep herds, no factor constitutes a risk for abortion in the final analysis (Table 6).

Table 6

Multivariate analysis of risk factors in cattle and sheep herds

Factors	DDL	Khi 2 of Wald	P-value
Cattle herds			
Herd size	3	9.7368	0.0209
Presence of exercise area	1	0.0114	0.9149
Contact with animals from neighboring farms	1	5.9816	0.0145
Presence of dogs	1	1.4838	0.2232
Presence of stillbirths/malformations	1	5.0957	0.0240
Presence of infertility	1	0.8065	0.3692
Sheep herds			
Type of housing	1	0.1737	0.6768
Presence of stillbirths/malformations	1	0.0466	0.8291
Presence of infertility	1	0.0000	0.9957
Birth of weak lamb	1	0.0663	0.7968

For cattle, about herd size, we found that there are significantly more farms "with abortion" among those with large population. This finding is corroborated by some studies such as those of Jamaluddin et al. (1996) and Dougall et al. (2005), while other authors such as Lee and Kim (2007) have not reported an association.

The relationship between abortion and herd size could be explained by the increased microbial load within farms with a big numbers of heads, thus exposing pregnant females to more abortive pathogens. In addition, cleaning and disinfection procedures in large farms are more difficult to implement, compromising thereby good hygiene practices.

The presence of neighbouring farms showed a significant effect on abortions. It would seem that a probable link can be established when animals from neighbouring farms meet on the same pasture or if contaminated equipment is used in common between the different farms. Indeed, according to Reviriego et al. (2000) and Cowie et al. (2014) the use of common pastures or paths and contact with other herds is a risk factor for brucellosis in small ruminants and cattle.

The link between stillbirths / malformations and abortions in the present study could be explained by the teratogenicity of many abortifacient agents such as BVD, Blue tongue virus and Schmallenberg virus (Grooms, 2004; Kelling, 2007; Herder et al., 2012). In addition, these same agents may not cause abortion in some females when contamination occur during late gestation but allow the birth of an infected newborn which will succumb some time after birth. Syrjala et al. (2007) reported that 7% and 10% of congenital malformations cases were respectively associated with abortions and stillbirths. Moreover, Waldner (2014) reported that the stillbirth of a calf within one hour of calving would increase the risk of maternal abortion in subsequent gestations.

For sheep, there is a link between abortion and living in zriba; this type of housing is often found in steppe areas where herds are managed according to three

modes: sedentarism, semi-sedentarism and transhumance (Yabrir et al., 2015). The hygienic conditions of zriba are often incorrect, due to the high density of animals. In fact, transhumant and nomadic herders hold the largest numbers of animals and do not attach importance to the housing hygiene given their frequent movements.

In addition, the animals on these farms are constantly in contact on the grazing areas and at the watering points, thus promoting the mixing of populations and contamination by abortive agents. Indeed, according to Al talafhah et al. (2003) the level of seropositivity to brucellosis increases significantly in sheep farms practicing common grazing.

In the present study, we noted an association between farms "with abortions" and problems of stillbirths and malformations, infertility and birth of weak lamb, this can be explained by the exposure of these farms to infectious abortifacient agents. Thus, according to Gautier and Corbiere (2011), among the diseases those lead to late abortions and/or postnatal mortalities, Q fever which causes abortions almost exclusively, chlamydophylosis which leads to abortions of an enzootic nature, premature births and weak lambs and also toxoplasmosis.

Furthermore, according to Innes et al. (2009), an infection with *Toxoplasma gondii* at mid-gestation can lead to the birth of a stillborn or weak lamb, while an infection later in gestation can result in a live, clinically normal but infected lamb.

Viruses such as the Border disease virus (BDV); Blue tongue virus (BTV) or schmallenberg virus can also cause malformations, sterility, abortions, stillbirths and birth of small and weak lambs (Nettleton et al., 1998; Sperlova and Zendulkova, 2011; Herder et al., 2012).

CONCLUSIONS

The results of the present study have shown that abortions constitute an important health problem in both cattle and sheep farms, with abortion rates largely exceeding the acceptable threshold in some farms, indicating that they are a significant cause of production loss.

In addition, these abortions occur indifferently sporadically and epizootically for the two species, hence the probable involvement of infectious agents, some of which may be zoonotic.

Risk factor analysis generates information on harmful parameters for gestation, which helps to make optimal decisions in order to better manage livestock and minimize economic losses.

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