Annual livestock mortality in a mixed farm in Botswana reveals seasonality and differences in species, age, and risk factors

Solomon S. Ramabu¹ | Kebadire Tloatleng² | Molefe Tladi² | Nicodimus Mosweu² |
Maungo Molatole³ | Esau E. Waugh³ | Saber Y. Adam³

¹Botswana University of Agriculture and Natural Resources, Department of Veterinary Sciences, Private Bag 0027, Gaborone, Botswana.  
²Botswana University of Agriculture and Natural Resources, Department of Animal Sciences, Private Bag 0027, Gaborone, Botswana.  
³College of Animal Science and Technology, Yangzhou University, Yangzhou 225009, PR China.

Abstract: Livestock mortality in a farm with cattle, sheep, goats, pigs, and ostriches in Botswana was investigated by collecting data weekly from March 2020 to February 2021. Post-mortem examinations were performed on a few animals from each livestock species. A questionnaire was administered to nine experienced practicing veterinarians to rate selected risk factors relevant to livestock mortality. Simple arithmetic was used to compute absolute mortality and mortality rates. Differences in mortality rates between animal groups were determined using a statistical difference calculator. Absolute mortality was highest in summer and autumn and lowest in winter. Mortality was highest in goats and least in sheep. The mortality of young animals was more than twice that of adults. All Ostriches (n=3) died. Conversely, sheep died at a lower rate (p < 0.05) than other livestock. There was no significant difference (p > 0.05) between the mortality rates of pigs and goats. Although the mortality rate of Friesian cattle (11.1%) was almost twice that of Tswana cattle (6.7%), the difference was not significant (p > 0.05). Interestingly, the mortality rate of Tswana goats was significantly higher (p < 0.05) than that of Saanen goats. Post-mortem identified Haemonchosis, heartwater, poor nutrition, and poor hygiene as a cause or suspected cause of livestock mortality. Experts rated several risk factors as either considerable causes, contributory causes, or aggravating livestock mortality. The importance of livestock mortality and the major risk factors associated with such mortality are discussed.

Keywords: absolute mortality, livestock, mortality rate, risk factors

1. Introduction

Mortality is an essential variable in livestock population and productivity at national and individual farm levels. The national mortality rate in Botswana was 12.4%, 15%, and 18.3% for cattle, sheep, and goats, respectively, in 2014 (Anonymous 2014), and all relatively high compared to elsewhere, including the United States of America (Wong et al. 2021). Cattle and calf losses from predator and non-predator causes in the United States during 2010 was 4.3 percent. Surveys in the U.S.A. found that the mortality in growing pigs averaged 4.5 to 5 percent (Anonymous 2011). Mortality in sheep and lamb still in the United States in 2004 was 5.6% and 9.4%, respectively (Wong et al 2021; Anonymous 2011). To monitor livestock productivity, it is thus important to determine the mortality rate. Livestock mortality tends to vary with season (Vrieling et al 2016; Li et al 2017). In the winter snow season in Tibet, increased livestock mortality is observed caused by snow disasters (Li et al 2017). Livestock mortality is associated with drought, which can be exacerbated by climate change, according to reports from Africa (Vrieling et al 2016; Dzavo et al 2019; Vetter et al 2020). Poor nutrition, common during drought, is associated with livestock mortality. Young animals are anecdotally considered more at risk of death than adults. Other major determinants of livestock mortality include infectious diseases, gastrointestinal parasites, and toxicites (Zhao et al 2013; Penrith et al 2015; Herzog et al 2020). We report absolute annual livestock mortality in a mixed farm with indigenous Tswana cattle, indigenous Tswana sheep and goats, Holstein Friesian cattle, Saanen dairy goats, and the Large White breed of pigs and ostriches. We also determined mortality rates and major risk factors for livestock mortality.

2. Case procedures and observations

A mixed farm in Gaborone, Botswana with coordinates S -24.580874 E25.966465 was puporsefully chosen to determine annual livestock mortality. The farm consisted of indigenous Tswana sheep and goats, Saanen dairy goats, indigenous Tswana cattle, Holstein Friesian dairy cattle, Large white breed of pigs, and ostriches. Data were collected weekly...
from March 2020 to February 2021, recording the number of animals that died, specifying species, breed, and whether the animal was young or adult.

2.1. **Absolute mortality and mortality rates**

Absolute mortality, defined as the sum of animals that died was computed for all animals irrespective of species or age, different livestock species, adults, and young animals. Annual mortality rate was calculated by dividing the number of dead animals by the mid-year population size and expressed as a percentage and determined for different livestock species and breeds. A statistical difference calculator accessed on March 25, 2021, was used to compare mortality rates between animal species.

2.2. **Post-mortem findings**

Typical cases of each livestock species were subjected to post-mortem examination and major findings and cause or suspected cause of death were documented.

2.3. **Risk factors for livestock mortality**

A questionnaire was designed to evaluate possible risk factors for mortality in the different livestock species and administered to a panel of nine practicing veterinarians. The evaluation of risk factors was done as described by Bonde and Sørensen using a 5-point scale (Bonde and Sørensen 2004).

3. **Results and Discussion**

3.1. **Absolute mortality and mortality rates**

The farm incurred an annual loss of 77 animals translating into 14.8% of the farm’s mid-year population size. There was a seasonality effect, with most animals dying in summer and autumn, peaking in February when rainfall is highest (Figure 1). In agreement with this finding seasonal livestock mortality was previously reported in dairy cows in Italy and in cattle, sheep, and goats in Afghanistan (McConnel et al 2008; Fusi et al 2017; Armengol and Fraile 2018; Wong et al 2021). Seasonal infectious disease cycles are a contributing factor (Brooks-Pollock et al 2015; Martinez 2018). Goats accounted for most mortality followed by pigs (Figure 2). Consistent with anecdotal evidence, mortality rate in young animals exceeded that of adults by more than two-fold (Figure 3). Young animals are more susceptible to determinants of disease. In farming systems that are relatively more efficient, achievable livestock mortality rate averages from 2% to 5% (SA 2018; Anonymous 2011). In contrast, the mortality rate of most livestock species in the current study exceeded 10%, including 22%, 44%, and 100% for goats, pigs, and ostriches, respectively (Table 1). These mortality rates are consistent with those reported nationally for cattle (12.4%), sheep (15%), and goats (18.3%) by Statistics, Botswana (Anonymous 2014). At these extremely high mortality rates, the livestock industry in Botswana is bound to perform poorly. Already there is either stagnation or even a decline in the population sizes of cattle, sheep, and goats nationally (Anonymous 2014). This is happening against increasing demand for protein of animal origin worldwide (Godde et al 2021).

![Figure 1](https://www.malque.pub/ojs/index.php/avr)


**Table 1** Livestock annual mortality rate by breed at a farm in Botswana from March 2020 to February 2021.

<table>
<thead>
<tr>
<th>Livestock group</th>
<th>Mid-year population size</th>
<th>Number of deaths</th>
<th>Mortality rate (%)</th>
<th>National mortality rate (2014)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cattle</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tswana</td>
<td>75</td>
<td>5</td>
<td>6.7</td>
<td></td>
</tr>
<tr>
<td>Friesian</td>
<td>45</td>
<td>5</td>
<td>11.1</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>120</td>
<td>10</td>
<td>8.3</td>
<td>12.4</td>
</tr>
<tr>
<td>Goats</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tswana</td>
<td>118</td>
<td>35</td>
<td>29.7</td>
<td></td>
</tr>
<tr>
<td>Saanen</td>
<td>62</td>
<td>5</td>
<td>8.1</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>180</td>
<td>40</td>
<td>22.1</td>
<td>18.3</td>
</tr>
<tr>
<td>Sheep</td>
<td>104</td>
<td>2</td>
<td>1.9</td>
<td>15</td>
</tr>
<tr>
<td>Pigs</td>
<td>50</td>
<td>22</td>
<td>44</td>
<td></td>
</tr>
<tr>
<td>Ostrich</td>
<td>3*</td>
<td>3</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

* - number at the beginning of the year is used because all animals had died by mid-year. *Post-mortem findings*
3.2. Post-mortem findings

To gain insight into the causes of livestock mortality, a few carcasses from each livestock species on the farm were subjected to post-mortem examination (data not shown). A definitive diagnosis of wireworm (Haemonchus contortus) was determined for typical young goats that died in large numbers. Thus, significant goat and sheep mortality can be attributed to wireworm infestation, particularly following increased rainfall (Rajakaruna and Warnakulasooriya 2011; Ramabu et al 2020). Other causes of mortality were suspected, including Ehrlichia ruminantium, commonly known as heartwater in ruminants. Heartwater is endemic in the study area (Batisani 2013). Salmonellosis or Colibacillosis was suspected to be a contributing cause of mortality in piglets. Notably, the mortality of dairy cattle and ostriches that were examined was attributable to poor nutrition. Drought conditions in Botswana periodically cause starvation and mortality in communally reared cattle in the traditional sector. Drought-related cattle mortality is a reality in sub-tropical environments (Rajakaruna and Warnakulasooriya 2011; Ramabu et al 2020). In farmed livestock such as dairy animals and ostriches, nutrition-related mortality reflects shortcomings in herd health management on the farm.

3.3. Risk factors for livestock mortality

Recognising the importance of risk factors for livestock mortality, we designed a questionnaire to determine the relevance of selected common risk factors to the mortality of different livestock species on the farm. A panel of practising veterinarians evaluated the risk factors using a 5-point scale where 1 represented irrelevant and 5 represented the main cause of mortality (Table 2). This study found that gastrointestinal nematodes and poor nutrition constituted considerable causes of mortality of sheep, goats, dairy cattle, and ostriches. In a prior study (McConnel et al 2008) nutrition management practices were identified as contributing factors for mortality of dry dairy cows. Consistent with other findings (Rajakaruna and Warnakulasooriya 2011; Wong et al 2021), metabolic diseases were rated as a significant cause of mortality in dairy cows. Inadequate nutrition exacerbates metabolic disease in cows with high milk yield. The importance of infectious diseases as an impediment to livestock production is not in doubt (Brooks-Pollock et al 2015; Martinez 2018; Wong et al 2021). In agreement, infectious agents were rated as a contributory cause of mortality of all livestock species. Interestingly, infectious agents were less of a risk than gastrointestinal nematodes, poor nutrition, and iron deficiency in piglets.

The evaluation indicates that external parasites and extreme weather are relevant to sheep and goat mortality as contributory causes. External parasites, particularly ticks, transmit infectious diseases in Botswana, including heartwater and Anaplasmosis (Batisani 2013; Ramabu et al 2018). Poor hygiene, presents a health risk for pigs. Poor hygiene was found to be a contributory cause of pig mortality. Toxicity or poisoning is pertinent to mortality of goats and cattle. In Botswana, cattle and goat deaths have been associated with the consumption of poisonous plants, most commonly Dichapetalum cymosum (Penrith et al 2015). Experts suggested several other risk factors, including unknown reasons, inbreeding, poor manure and herd health management, and predation.

Table 2 Risk factors for mortality in livestock in a mixed farm under Botswana conditions. The relevance (1-5) of risk factors was evaluated by experienced practising veterinarians on a 5-point scale and reported as a median.

<table>
<thead>
<tr>
<th>Risk factor</th>
<th>Goats</th>
<th>Sheep</th>
<th>Beef cattle</th>
<th>Dairy cattle</th>
<th>Pigs</th>
<th>Ostriches</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gastrointestinal nematodes</td>
<td>4</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2.5</td>
</tr>
<tr>
<td>External parasites</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Poor nutrition</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Infectious agents</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Toxicity or poisoning</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Extreme weather</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metabolic diseases</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poor hygiene</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Iron deficiency in piglets</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3.5</td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unknown cause, Inbreeding, Poor herd health and manure management, Heartwater, Predation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*1 = not relevant; 2 = aggravates problem; 3 = contributory cause; 4 = considerable cause; 5 = main cause

4. Conclusions

Overall annual livestock mortality rate was found to be considerably much higher than in in developed countries attributable mainly to poor nutrition and gastrointestinal nematodes.

Acknowledgments

We thank Dr ME Mochankana for contributing to data collection and John Phuthego’s assistance at the post-mortem.

Ethical Considerations
It is not necessary since the case is observational

**Conflict of Interest**

The authors declare that there is no conflict of interest.

**Funding**

There was no funding from any agency.

**References**


