



## Stakeholder perceptions of foot-and-mouth disease control in South Africa

Laura C. Roberts<sup>a,b</sup>, Geoffrey T. Fosgate<sup>a,\*</sup>

<sup>a</sup> University of Pretoria, Faculty of Veterinary Science, Department of Production Animal Studies, Onderstepoort, 0110, South Africa

<sup>b</sup> Western Cape Department of Agriculture, Elsenburg, 7607, South Africa



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### ABSTRACT

Foot-and-mouth disease (FMD) prevention and control is a challenge worldwide but the situation in southern Africa is particularly complex because the virus is endemic in wild African buffalo (*Syncerus caffer*). The objective of this study was to compare stakeholder perceptions of the FMD control methods employed to restrict FMD virus to the infected zone of South Africa. Data collection was performed using an online questionnaire distributed to FMD experts, government veterinarians, private livestock veterinarians, people involved within the wildlife sector, and “other” occupation groups including the general public. Data were also collected using semi-structured participatory group discussions with government animal health technicians (AHT) and communal cattle owners directly affected by FMD control measures. Evaluated control methods were the disease control fence bordering the western boundary of the Greater Limpopo Transfrontier Conservation Area, clinical surveillance of livestock, movement control of cloven-hoofed animals and products, and routine FMD vaccination of cattle. These management procedures were scored according to a set of technical, economic, and ethical criteria by stakeholders, who also weighted the criteria according to their perceived importance. Scores and weights were aggregated using an additive linear model to rank control methods. Sensitivity analysis was performed using a stochastic model to explore the effects of varying inputs and the exclusion of scores from randomly selected respondent groups on the ranking of control methods. The deterministic analysis assigned the highest ranking to the disease control fence and the lowest to routine vaccination of cattle. The fence had the highest ranking in 40% of the stochastic iterations, and second, third and fourth in 26%, 20% and 14% of iterations, respectively. The inputs from the AHT and people involved in the wildlife sector were the most influential for ranking the fence as the preferred control option. The most influential criteria were the feasibility of the fence as a control option and its influence on the economics of the communal cattle owners, livestock industry in the FMD free zone, and the government. The disease control fence was the highest ranking control option but further investigations are necessary to understand the reasons for stakeholder perceptions.

### 1. Introduction

Wildlife conservation and commercialization of livestock production are both fundamental to rural development in southern Africa but the socio-economic advancement of local communities can be hindered by the incompatibility between these activities (Thomson et al., 2013). Wildlife species are reservoirs for diseases that affect livestock (Bengis et al., 2004) and this is a cause of the incompatibility. Most important in this respect is foot-and-mouth disease (FMD), a globally important transboundary animal disease (TAD) (Ferguson et al., 2013; Tekleghiorghis et al., 2016). Unfortunately, FMD management strategies in southern Africa have had unintended environmental and socio-economic consequences through the construction of disease control fencing (Woodroffe et al., 2014). These fences are designed to preclude contact between cattle and wild African buffalo (*Syncerus caffer*), the

wildlife reservoir for the Southern African Territories serotypes of the FMD virus (SAT1, SAT2 and SAT3) (Thomson et al., 2003).

Foot-and-mouth disease control in southern Africa combines disease control fencing, vaccination of cattle, movement control of cloven-hoofed animals and products, and surveillance activities (DAFF, 2014). South Africa is classified as having an FMD free zone where vaccination is not practiced (OIE, 2017). The Kruger National Park (KNP) in South Africa is one of Africa’s largest wildlife reserves. Foot-and-mouth disease is endemic in KNP and African buffalo are believed to be the major source of FMD virus transmission to domestic livestock in the surrounding areas (Bastos et al., 2003). Cattle owners on the border of the KNP, within the FMD control zone with vaccination, must present their cattle at government inspection points every week for examination by government veterinary technicians. Cattle in this zone are vaccinated every four months using an inactivated trivalent product containing

\* Corresponding author at: University of Pretoria, Faculty of Veterinary Science, Department of Production Animal Studies, Private Bag X04, Onderstepoort, 0110, South Africa.  
E-mail address: [geoffrey.fosgate@up.ac.za](mailto:geoffrey.fosgate@up.ac.za) (G.T. Fosgate).

antigens for SAT1, SAT2, and SAT3 (Lazarus et al., 2017).

The successful control of FMD depends on the co-operation of multiple stakeholder groups. Decisions with regard to animal disease control are often made at a regional or national level, but the most directly-affected people are the livestock owners and the government personnel implementing control strategies. The input of all stakeholder groups can be accommodated within a multiple criteria decision analysis (MCDA) framework, which is a set of techniques developed to facilitate well-informed and transparent decision making (Belton and Stewart, 2002). This approach enables the synthesis of potentially conflicting data in an effort to identify a preferred option, to rank available options, to shortlist options, or simply to distinguish acceptable from unacceptable options (Dodgson et al., 2009). An MCDA can incorporate stakeholder involvement at each step of the decision making process. The objective of the current study was to compare the perceptions of stakeholder groups concerning FMD control methods employed to restrict FMD virus to the infected zone of South Africa within a modified MCDA framework. Investigated stakeholder groups included communal cattle owners, veterinary animal health technicians, FMD experts, government veterinarians, private livestock veterinarians, people involved in the wildlife sector, and other occupation groups including commercial farmers in the FMD free zone and the general public.

## 2. Materials and methods

### 2.1. Study location

South Africa is classified as free of foot-and-mouth disease (FMD) without vaccination but with the presence of infected zones (DAFF, 2014). The primary infected zone is the Greater Kruger National Park (KNP), which comprises the KNP and adjoining nature reserves (Fig. 1). The KNP and adjoining nature reserves form part of the Greater Limpopo Transfrontier Conservation Area. Thembe Elephant Park and Ndumo Game Reserve in northern KwaZulu-Natal Province, bordering Mozambique and Swaziland, are also classified as FMD infected. South Africa experienced an FMD outbreak in 2011 within the FMD free zone of the KwaZulu-Natal Province and subsequently did not regain OIE recognition of the FMD free zone status until February 2014 (Zokwana, 2015). There are four primary methods of FMD control performed within South Africa: 1) Clinical surveillance of livestock, 2) Disease control fencing, 3) Movement control of cloven-hoofed animals and products, and 4) Prophylactic vaccination of cattle. Cattle within the FMD control zone with vaccination are inspected weekly for clinical signs suggestive of FMD. Disease control game-proof fencing



Fig. 1. The foot-and-mouth disease infected zone includes the Greater Kruger National Park (KNP), which is in the northeast region of South Africa and is comprised of the KNP and the adjoining wildlife reserves.

(Supplemental Fig. 1) separates FMD virus infected wildlife in the infected zone from domestic livestock in the surrounding areas. Movement control procedures (permit system) restrict the transport of FMD susceptible animals and their products within and between FMD control zones. Movements from higher to lower FMD risk areas are discouraged. Cattle within the FMD control zone with vaccination are prescribed to be vaccinated every four months using a trivalent inactivated-vaccine (containing SAT1, SAT2 and SAT3) by veterinary animal health technicians (AHT) working under the supervision of provincial government veterinarians (DAFF, 2014).

### 2.2. Study design

A multiple criteria decision analysis (MCDA) framework was modified to assess perceptions of control methods aimed at preventing outbreaks of FMD in the FMD-free zone of South Africa that originate from the infected zone. The FMD control zone with vaccination is situated between the infected and free zones. Stakeholders included cattle owners living on communal land in the FMD protection zone with vaccination (along the western boundary of the Greater Limpopo Transfrontier Conservation Area), veterinary AHT working in the protection zone with vaccination, FMD experts and researchers, South African provincial government veterinarians, national government veterinary personnel of the South African Department of Agriculture, Forestry and Fisheries (DAFF) Directorate for Animal Health, South African private livestock veterinarians, participants in the game industry and game reserve staff (wildlife sector), and other occupations within the FMD free zone including commercial cattle farmers and the general public. Private wildlife ranches and public reserves commonly have FMD susceptible wildlife species including African buffaloes and impala (*Aepyceros melampus*).

The sample size for the group discussion of communal farmers was calculated to estimate the proportion that was satisfied with the current FMD control policies. It was assumed that 75% of farmer groups were satisfied (Lazarus et al., 2017) and it was desired to estimate this proportion with 25% allowable error and at the 95% level of confidence (Fosgate, 2009). Farmers were sampled using the government FMD inspection points (dip tanks) because individual list frames were not available prior to the study and farmers in the FMD protection zone with vaccination present their cattle for inspection every week. The total number of dip tanks in the protection zone was 203 and the calculated sample size was 11 farmer groups (dip tanks to be sampled). Dip tanks were first stratified by province (Limpopo or Mpumalanga Province) and randomly selected proportional to the total number of dip tanks per province using inspection records obtained from provincial veterinarians. A committee of experienced farmers (typically 2–3 individuals per village) is responsible for maintaining the appropriate dip concentration and for providing representation for the other farmers in nearby villages. These Dip Tank Committees were contacted by the area AHT to participate in the group discussions and other farmers were also invited upon completion of the dipping session. All AHT working in the government veterinary area of the randomly sampled dip tanks were also selected for study. FMD experts were identified based on the publication of three or more peer-reviewed articles identified through an English language literature review and were contacted via email. South African government veterinarians were contacted via email using addresses obtained from the DAFF website and from the organizers of the South African Society for Veterinary Epidemiology and Preventive Medicine conference. South African private livestock veterinarians were contacted via the local rural veterinarian email listserv, which had 491 members at the time of the study. Participants in the game industry and game reserve staff (wildlife sector group) were contacted via email using the Wildlife Ranching South Africa mailing list of 1970 people. Employees of the KNP were also contacted via email using information available from the South African National Parks Veterinary Wildlife & Services office at Skukuza,

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