

Foot and mouth disease: the experience of South Africa

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Summary

Foot and mouth disease (FMD) is endemic in African buffalo (*Syncerus caffer*) in the Kruger National Park (KNP) and surrounding game parks in South Africa. The last outbreak of the disease in domestic stock outside the FMD control zone occurred in 1957. Due to the success in containing the disease, the country was accorded zone freedom from FMD without vaccination by the Office International des Epizooties (OIE: World organisation for animal health) in 1995. This status was lost in September 2000 when the first-ever recorded case of serotype O in South Africa was diagnosed in a piggery in KwaZulu-Natal after the illegal feeding of untreated swill. In November 2000, an outbreak of FMD caused by serotype South African Territories (SAT) 1 was diagnosed in a feedlot within the free zone of Mpumalanga Province. The SAT 1 outbreak was traced to cattle in the FMD control zone south of the KNP after the game-proof fence surrounding the KNP was severely damaged by floods. This enabled buffalo to come into direct contact with cattle outside the KNP. A further outbreak caused by SAT 2 was diagnosed within the FMD control zone in February 2001, also as a result of buffalo having escaped from the KNP. All these outbreaks were successfully contained, with the re-instatement of zone freedom from FMD without vaccination by the OIE in May 2002.

These outbreaks made it necessary to re-examine the methods of control and containment of FMD that have been practised for many years and which are in line with accepted international practices. The authors describe the rationale for the different control strategies that were followed, the need for a multidisciplinary approach to disease control, the interface between control and technological and diagnostic support and the lessons learned. Some suggestions for future control strategies are also offered.

Keywords

African buffalo – Control strategies – Feedlots – Foot and mouth disease – Logistic support – Multidisciplinary approach – Office International des Epizooties – South Africa – Zones.

Introduction

Hutcheon recorded the first official outbreak of foot and mouth disease (FMD) in South Africa in 1892, following an outbreak in Griqualand West (19). The scourge was, however, well known to several farmers and, according to information obtained from elderly inhabitants, FMD had been prevalent in

South Africa for many years before this outbreak was reported. In the two subsequent years, mild epizootics occurred in different parts of the country, without assuming serious proportions (19).

In April 1903, FMD reappeared in South Africa through the importation of cattle from Argentina to the Cape Peninsula

(19). Fortunately, the disease was confined to two foci only and both premises were immediately placed under strict quarantine and thoroughly disinfected. There was no further evidence of the disease, and the quarantine restrictions were lifted in July of the same year (19).

After the great rinderpest pandemic of 1896 to 1905, FMD disappeared from southern Africa until April 1931, when the disease reappeared in Zimbabwe (19). This caused great concern at the time as the ability of buffalo to provide a reservoir of infection was unknown and many people believed that the infection had been re-introduced by imported animals or animal products, although no evidence for this could be found (19).

The epidemiology of the disease became clear when the African buffalo (*Syncerus caffer*) was shown to maintain the three South African Territories (SAT) serotypes in southern Africa (7, 8, 13). In South Africa, the infection is endemic in the Kruger National Park (KNP) where buffalo provide the principal reservoir of infection (9, 21). To prevent spread of the disease from infected buffalo to susceptible livestock, game-proof fences were erected around the KNP and cattle were vaccinated to prevent disease. As no outbreaks of FMD had occurred in other areas of South Africa since 1957 and no vaccination is practised elsewhere, the country successfully applied to the Office International des Epizooties (OIE: World organisation for animal health) in 1995 for a zone to be recognised as free of FMD without vaccination. The KNP is recognised as the only infected zone in the country. In accordance with OIE recommendations, the area immediately adjacent to the KNP constitutes a buffer zone where all cattle are vaccinated bi-annually against FMD while a surveillance zone is situated to the west of the buffer zone. These two zones constitute the FMD control zone (6) (Fig. 1).

South Africa lost the OIE status after an outbreak of FMD, caused by serotype O virus, was diagnosed on 14 September 2000 in a piggery in the district of Camperdown in KwaZulu-Natal (Fig. 2). This was followed by an outbreak of SAT 1 that was diagnosed on 29 November 2000 in a cattle feedlot in the district of Middelburg in Mpumalanga (Fig. 2). Trace-back actions following the outbreak on the feedlot established that the disease originated from buffalo/cattle contact in the surveillance zone of Nkomazi, bordering the southern KNP, also in the Mpumalanga Province (Fig. 2). This was diagnosed on 15 December 2000 on the basis of clinical disease and confirmed by virus isolation and serological testing. On 1 February 2001, FMD lesions caused by serotype SAT 2 were detected in cattle at a dipping tank in the Mhala District of the Limpopo Province, which also borders the KNP (Fig. 2). Partial sequences of the viral protein 1 (VP1) gene indicated that the causal virus was similar to viruses previously isolated in buffalo from the adjoining KNP (Fig. 3).

In summary, two outbreaks occurred in the zone previously recognised by the OIE as FMD-free without vaccination (Camperdown and Middelburg feedlot), as well as two

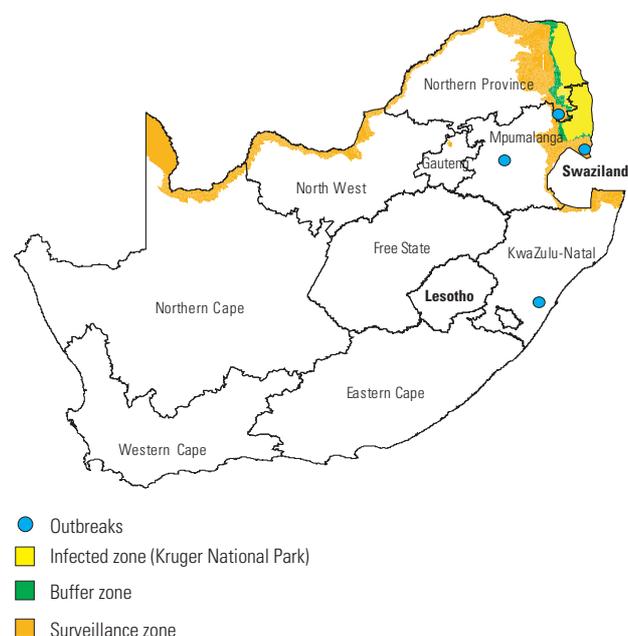
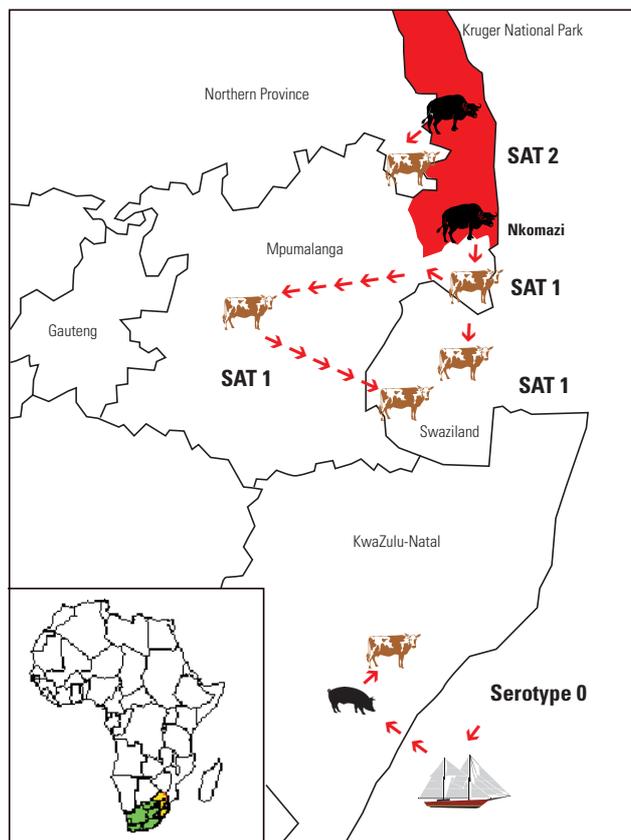


Fig. 1
Foot and mouth disease control zone surrounding the endemically infected Kruger National Park and extending along the borders of South Africa



SAT : South African Territories
→ : spread of the disease

Fig. 2
Regions in South Africa affected by the foot and mouth disease outbreaks during 2000 and 2001

Links between various outbreaks and species are also shown

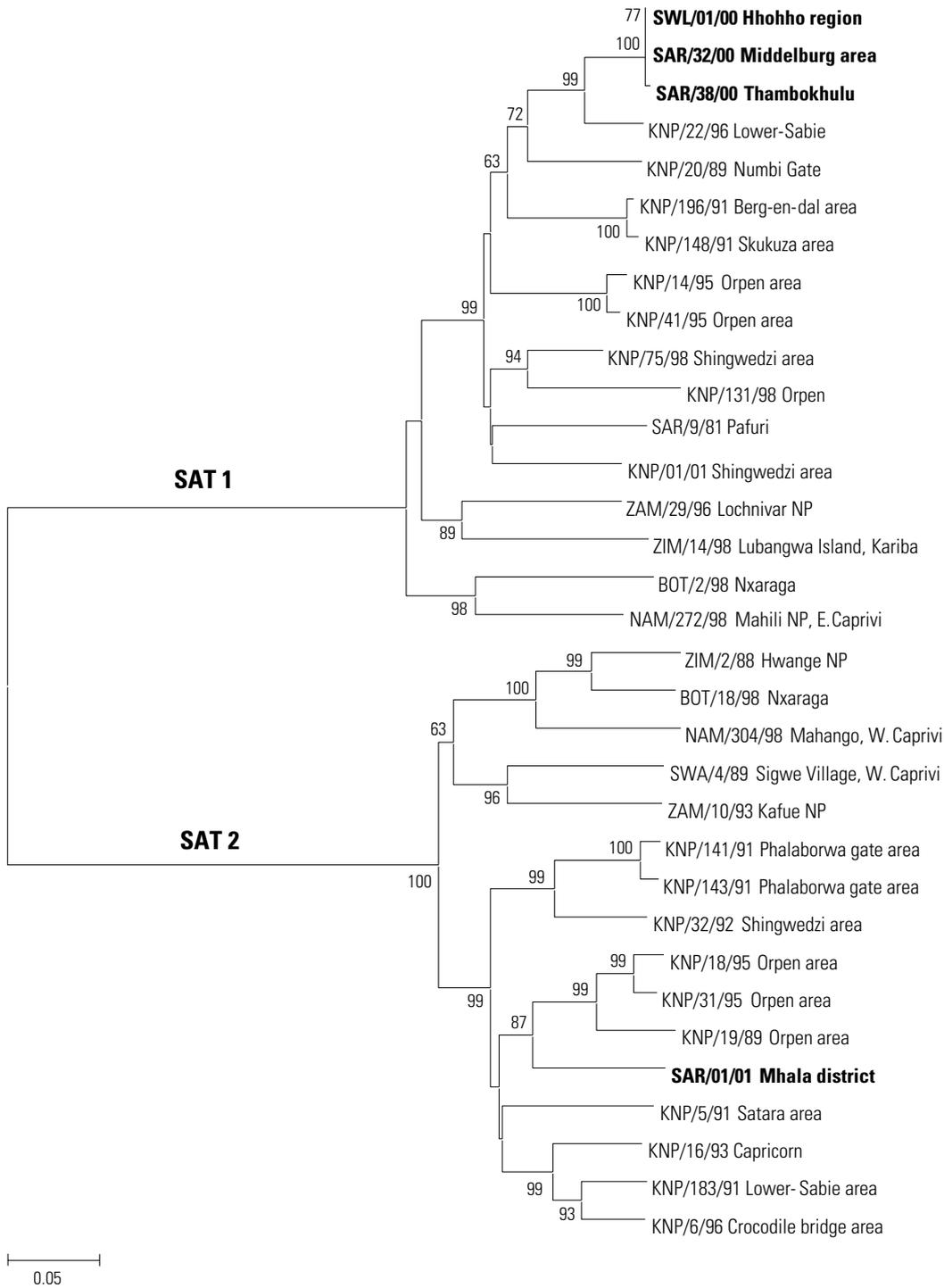


Fig. 3
Neighbour-joining tree depicting viral protein 1 (VP1) gene relationships of South African Territories (SAT) 1 and 2 viruses in southern Africa

Confidence levels were assessed by 1,000 bootstrap replications

Viruses isolated during the outbreaks are indicated in bold type

All other viruses were obtained from buffalo in South Africa (KNP), Zambia (ZAM), Zimbabwe (ZIM), Namibia (NAM/SWA) and Botswana (BOT)

outbreaks in areas previously excluded from the disease-free zone, i.e. within the FMD control zone (Nkomazi and Mhala). The outbreaks in Camperdown (serotype O), Middelburg (SAT 1) and Nkomazi (SAT 1) are described in detail. The outbreak at Mhala (SAT 2) will not be described because of the epidemiological similarities of the outbreak with that at Nkomazi. The outbreaks within the previously FMD-free zone resulted in the temporary loss of zone freedom from FMD accorded to South Africa by the OIE.

Foot and mouth disease control policy in South Africa

Foot and mouth disease is listed as a controlled disease in South Africa in the Animal Diseases Act, 35/1984. Prior to the outbreak of the disease in the free zone in 2000, the FMD control zone comprised the endemically infected KNP, the surrounding buffer zone and a FMD surveillance zone. The latter stretches from the Ingwavuma area in northern KwaZulu-Natal bordering southern Mozambique, along the borders of Swaziland, the western edge of the KNP, Zimbabwe and Botswana (Fig. 1). The control area is defined by natural geographical borders, roads and fences. Vaccination is performed twice a year in a small buffer zone along the southern and western boundaries of the KNP using trivalent SAT 1, 2 and 3 vaccines. Strict movement control is enforced to prevent the movement of vaccinated animals and animal products from the control area to the free zone. The regulations promulgated in terms of the Act lay down detailed requirements for disease control and measures to be taken in the event of an outbreak, as well as measures to prevent the introduction of the disease through imports of animals and animal products.

Surveillance activities within the FMD control zone are carried out by para-veterinary personnel (animal health technicians) under the supervision of State veterinarians. The frequency of inspection of cloven-hoofed livestock in the FMD control zone varies from 7 to 14 days (7 days in the buffer zone and 14 days in the surveillance zone). Serological surveillance is conducted on an ongoing basis to determine the immune status of animals within the buffer zone. Serum samples are submitted for testing prior to the translocation of animals from the surveillance zone to the rest of the country. Surveillance is carried out on an ongoing basis within the KNP and adjoining private game reserves to monitor the incidence of the disease in wildlife – specifically in African buffalo and impala (*Aepyceros melampus*).

In the free zone, surveillance is conducted on an ongoing basis by State veterinarians, animal health technicians and private veterinarians in the course of their normal duties, such as testing herds for bovine tuberculosis and brucellosis and other disease control interventions.

In contrast to the situation in most developed countries, the livestock management practices in South Africa consist of a

mixture of highly commercialised farms, communal grazing areas and game farming. Internationally accepted disease control strategies are easily enforced within the commercialised farming areas, while the traditional communal grazing areas and game farms offer unique challenges and opportunities for different approaches to disease control and disease risk management. In the communal grazing areas, which are in many instances dispersed in and around commercial farms, individual farming units are often not identifiable through clearly marked fenced-off areas or other geographical entities. While animals are housed or kraaled in separate groups at night, farm management facilities, such as dipping tanks and grazing, are shared during the day between several owners, resulting in frequent contact between livestock and creating large epidemiological units for disease control purposes. Game farming, on the other hand, often involves large fenced-off units scattered between commercial and communal grazing areas. Disease surveillance on these farms consists mainly of random serological sampling, while movement control is regulated in accordance with the Animal Diseases Act.

Outbreak of foot and mouth disease serotype O in KwaZulu-Natal

The Province of KwaZulu-Natal is divided into 51 administrative districts. Foot and mouth disease last occurred in the Dundee district of this Province in 1938. The Province maintains a surveillance zone in the north, along the international borders with Mozambique and Swaziland (Fig. 1). Foot and mouth disease vaccinations were performed along the border with Mozambique between 1988 and 1993, but this activity was discontinued in anticipation of the application to the OIE in 1995 to obtain freedom from FMD without vaccination.

A private veterinarian was called to investigate deaths in pigs on a farm in the Camperdown district following suspicion of pesticide poisoning from containers in which swill was stored. However, on the detection of vesicular lesions, the local State Veterinarian was alerted and investigations commenced. Samples taken from the pigs on Tifton Farm on 14 September 2000 were confirmed positive for FMD serotype O at the Exotic Diseases Division, Onderstepoort Veterinary Institute (EDD-OVI) in Pretoria the following day. This serotype has never occurred before in South Africa (18). The virus is suspected to have been brought into the country in swill derived from galley waste from a ship that had docked at Durban Harbour. The swill was later fed to the pigs on Tifton Farm (Fig. 4, original FMD outbreak).

Partial sequencing of the 3' end of the VP1 gene and phylogenetic analysis indicated that the virus was a member of the pan-Asian serotype O lineage, which indicated Asia or the Middle East as the probable origin (18).

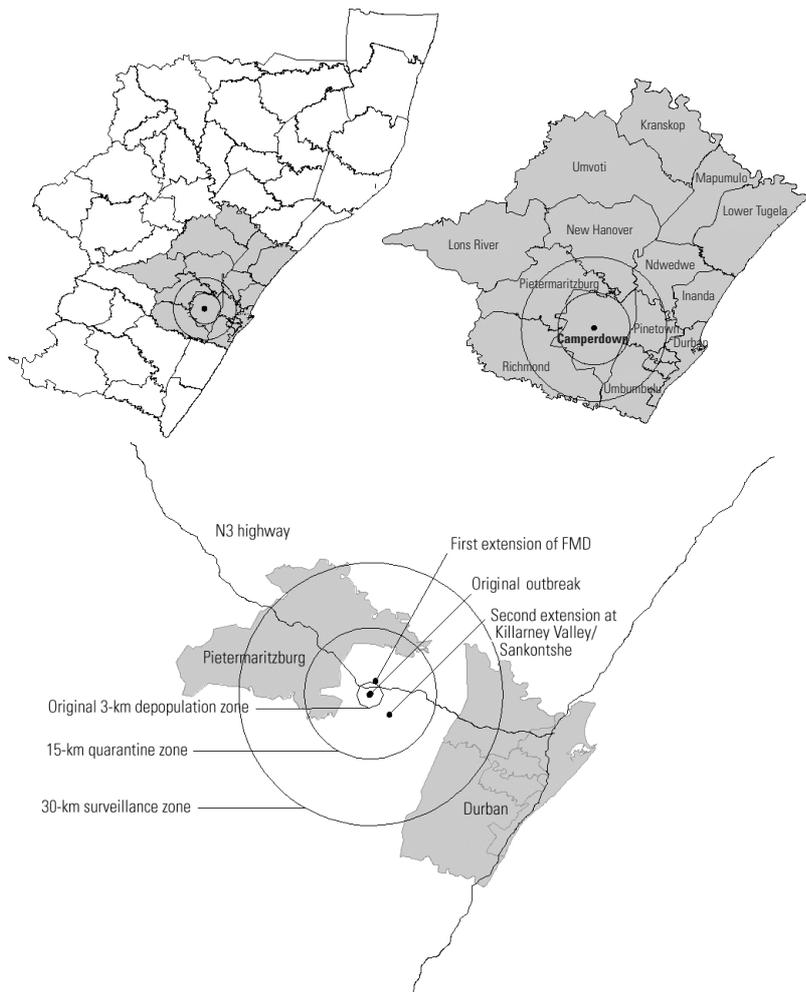


Fig. 4
Foot and mouth disease control districts in KwaZulu-Natal Province (showing all 51 districts)

The district of Camperdown affected by serotype O outbreak, as well as the 15 other districts placed under quarantine, are indicated in grey. The circles denote the various zones established around the outbreak focus for control measures

Stamping-out of all cloven-hoofed animals on the affected farm with supporting control measures in a radius of 30 km surrounding the area was instituted immediately on 15 September. This involved the erection of a physical cordon around the infected farm, the establishment of roadblocks at all access points within a 10-km radius and intensification of inspections on all farms within the 30-km radius. A total embargo on the export of cloven-hoofed animals and products from the district of Camperdown and an additional 15 magisterial districts within KwaZulu-Natal was also enforced by legal notice in the Government Gazette of 22 September 2001.

For the first time in the history of FMD control in South Africa, extensive use was also made of logistic support provided by the South African National Defence Forces (SANDF), South African Police Services (SAPS), disaster management units and road traffic control. This is described in more detail under ‘Logistic support services’ below.

The farms immediately surrounding the primary focus of infection were inspected daily for possible spread of the disease. On 20 September, fresh clinical lesions were detected in a bovine on an adjoining farm (Fig. 4, original FMD outbreak) and confirmed positive for serotype O on the same day. The decision was taken to cull all animals on this farm and to depopulate all cloven-hoofed animals on 14 farms within a radius of 3 km of the original infection based on geographical boundaries. Culling operations commenced on 21 September and were completed on 1 October.

On 10 October, the disease was detected and confirmed in cattle on a farm (Fig. 4, first extension of FMD) just outside the 3-km depopulated zone and on 23 October, further spread of the disease was confirmed on a farm in the Killarney Valley, south-east of the last infection (Fig. 4, second FMD extension at Killarney Valley/Sankontshe). The culling area was enlarged to include these two extensions as well as neighbouring farms, with all animals destroyed and buried by 8 November.

On 8 November, serological results obtained by liquid phase blocking enzyme-linked immunosorbent assay (ELISA) (12) indicated that there were possibly serologically positive animals at a dipping tank in the Valley of a Thousand Hills outside the 30-km restricted zone. This dip tank is located in a vast communal grazing area without fencing between properties and consequently it was decided to discontinue the culling operation and commence limited ring vaccination pending confirmation of the results by virus neutralisation assay (17). The control measures were also immediately extended to include a larger area. The results obtained three days later indicated that the disease had not spread and the World Reference Laboratory (WRL) at Pirbright later confirmed these results. The emergency control measures were subsequently reduced to the original restricted area, but the decision was nevertheless taken to complete the limited vaccination programme in the district of Camperdown.

A total of 367,168 physical inspections and 34,324 serological examinations were recorded during the period from 16 September until the end of January 2001 within the infected and surveillance zones and surrounding areas. Game animals were also inspected and serologically surveyed. Negative results were obtained on three game reserves bordering the infected area.

No pigs were vaccinated due to the unavailability of a suitable vaccine. Cattle on two stud farms within the vaccination zone were not vaccinated to serve as sentinel animals. Movement restrictions were lifted on 1 February 2001, with the exception of the district of Camperdown that will remain a FMD control zone until officially declared free from infection by the OIE. Restocking of the previously infected farms commenced on 2 February 2001 after sentinel animals had been introduced and monitored serologically.

Continuous serological surveillance and clinical inspections within the restricted and free areas have continued for a period of 12 months since the detection of infection, confirming that the disease did not spread further than the infected premises identified during the original outbreak investigations.

Outbreak of foot and mouth disease caused by serotype SAT 1 in the districts of Middelburg and Nkomazi, Mpumalanga Province

Suspicion of FMD infection was raised by Swaziland when cattle from the Kanhym feedlot on Arendsfontein farm in the Middelburg District of Mpumalanga, South Africa, were sent to the abattoir in Manzini, Swaziland, on 23 November 2000

(Fig. 2). The EDD-OVI confirmed that the disease was caused by serotype SAT 1. An investigation was immediately conducted on Arendsfontein farm, which was placed under quarantine and all livestock movements were stopped from Arendsfontein and a surrounding area of 10 km. Clinical lesions were detected in 30 cattle on Arendsfontein and confirmed as SAT 1.

Cattle in the feedlot were sourced from Namibia (30% to 40%), Mpumalanga (30% to 40%), the Free State Province (5% to 10%) and the Eastern Cape Province (5%). Small numbers were also derived from the Western and Northern Cape Provinces. However, subsequent investigations pointed to possible illegal movement of cattle from the surveillance zone close to the KNP.

Partial nucleotide sequencing of the 3' end of the VP1 gene and phylogenetic analysis indicated that the isolate obtained from Kanhym (i.e. the feedlot: isolate SAR/32/00) was 100% homologous over the region sequenced to the isolate from the abattoir in Swaziland (SWL/012/00) (Fig. 3), indicating that the Swaziland incident was derived from the feedlot in South Africa. The viruses were also related to viruses previously isolated from buffalo in the south of the KNP (KNP/22/96 and KNP20/89) (Fig. 3), and therefore eliminated the notion that the outbreak may have been caused by cattle imported from neighbouring countries.

Following the diagnosis of FMD (SAT 1) in the feedlot, backward tracing and the close relationship of the virus to buffalo isolates from the KNP (Fig. 3) indicated the Nkomazi area (Fig. 2) as a probable source of the infection. On 15 December 2000, cattle with suspicious fresh lesions were found at the Thambokhulu communal dip tank, and the virus isolated (SAR/38/00) was 100% homologous over the region sequenced to the Kanhym virus (SAR/32/00) (Fig. 3). Subsequently, serological evidence of infection was obtained on 5 additional farms and at 12 communal dip tanks, all in the Nkomazi area, while old lesions were reported in cattle on 4 farms and at 2 communal dip tanks. The entire Nkomazi area was declared an infected zone.

Control of the outbreak in the feedlot at Arendsfontein

The Arendsfontein farm is a dedicated feedlot for cattle (14,308), sheep (2,445) and pigs (48,376), with excellent record-keeping. The cattle and sheep were housed in separate fenced facilities approximately 300 m from the pig unit, with no immediate physical or human contact between the two units. Strict bio-security to prevent cross-contamination between the feedlot and the pig unit was maintained, with disinfection of all humans and vehicles entering and leaving the infected area. The feedlot and main piggery on Kanhym were identified as the infected zone, although no clinical cases or serological evidence of disease were observed in the piggery.

A sanitary cordon was placed within a 10-km radius on surrounding farms, with movement control on animals and animal products complemented by intensive serological surveillance and daily physical inspections. Quarantine notices were served on all surrounding farms (28 owners) and all livestock were inspected and subjected to serological surveillance (Fig. 5).

Following confirmation of FMD, a policy of emergency vaccination was adopted. The main reason for favouring vaccination rather than immediate stamping-out was the almost impossible logistic effort required to ensure complete bio-security during culling operations of such large numbers of animals in such a small area. The strict control measures in

place at the feedlot and the infrastructure complemented that of the quarantine restrictions and strengthened the decision. The main focus of control was to limit virus excretion within the cattle feedlot and to take all the bio-security steps necessary to prevent the disease from spreading to the piggery which housed almost 50,000 pigs.

All cattle in the feedlot were vaccinated twice with a trivalent SAT 1, 2 and 3 vaccine. The commercial breeding cattle (1,200 head) were vaccinated while they were still on grazing pastures. Only after the second vaccination were they moved to the northern part of the feedlot, furthest away from the section where clinical FMD occurred. By moving the commercial breeding cattle into a section of the feedlot, a 5-km

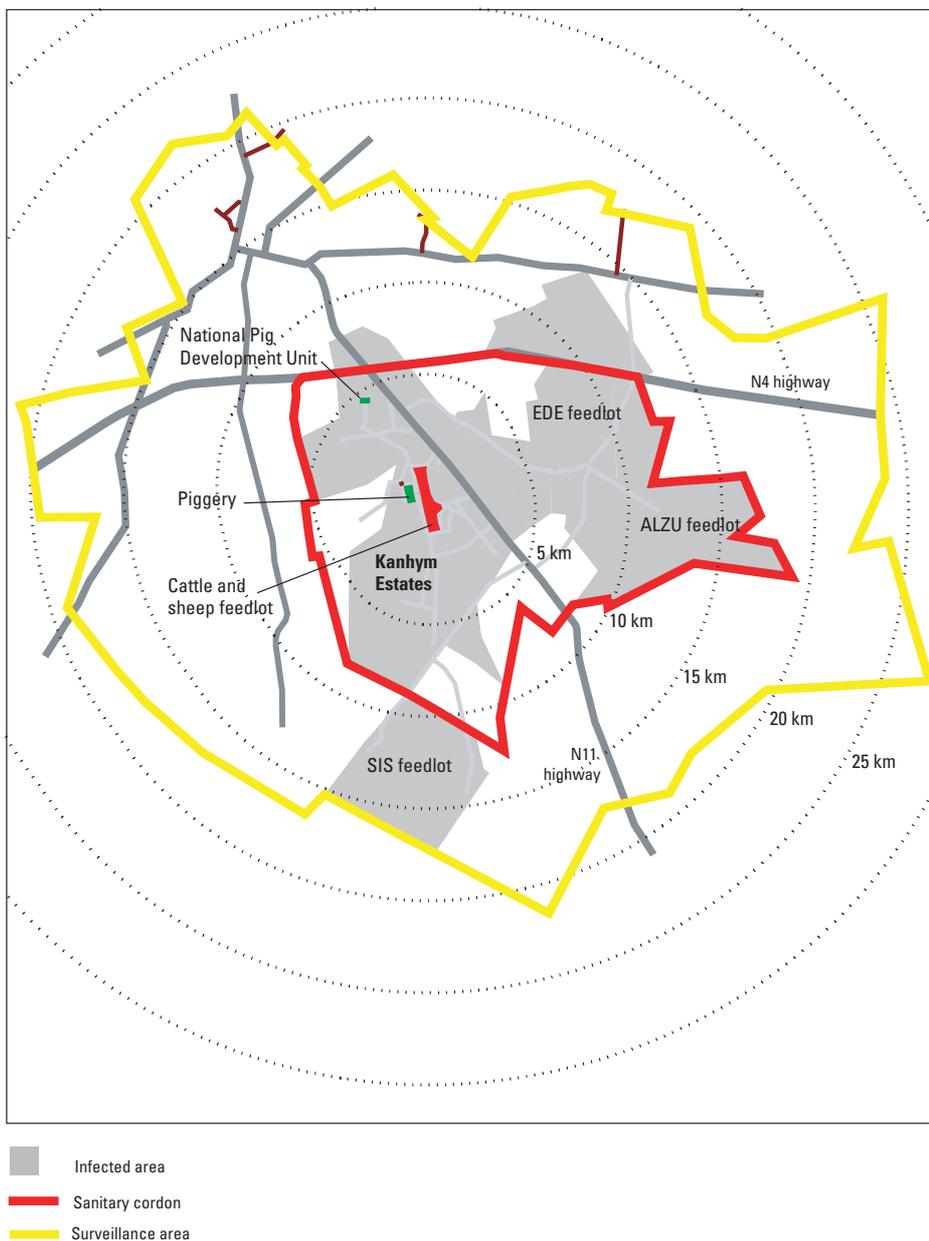


Fig. 5
Feedlot at Kanhym showing the area infected by foot and mouth disease and surrounding surveillance zone

animal free zone was created around the infected farm. The 2,445 sheep in the feedlot were vaccinated once with the trivalent vaccine.

The vaccinated commercial cattle (branded with an F) were released to grazing at the end of March 2001 and kept in two separate groups away from the feedlot and the piggery. Inspection of these cattle was performed once a week and all animals were bled monthly. Slaughtering of the entire herd of vaccinated commercial cattle was completed by 5 December 2001. The meat was deboned and released for local consumption only.

The last clinical cases in cattle on the feedlot were observed on 14 December 2000. On 15 January 2001, controlled slaughter for local consumption commenced at selected quarantine abattoirs under strict veterinary supervision. All sheep were slaughtered by the end of February and all feedlot cattle by 19 March.

To protect the piggery, pigs were vaccinated once only with a double oil emulsion adjuvant containing two SAT 1 strains produced by the EDD-OVI. The piggery was not infected at any stage, as indicated by serological results produced using the liquid phase blocking ELISA prior to vaccination and the 3ABC ELISA post vaccination. Porkers (44,000 animals) were inspected clinically and loaded in sealed limed vehicles and transported to slaughter at officially approved abattoirs on dedicated days under strict veterinary control. Veterinary

officials accompanied vehicles to the abattoir, which was disinfected thoroughly after the slaughter of each consignment. The pH of carcasses was monitored to ensure that the level had dropped below 6 within 24 h, and the meat was deboned. A further waiting period of three weeks was enforced for the meat, pending the serological results of samples collected on the slaughter line and on the farm. Bones and offal were destroyed under strict control. Meat was released for local consumption only.

From 19 March to the end of March, disinfection of the entire feedlot with agricultural lime and a commercial quaternary ammonium and biguanidine viracidal preparation was implemented, after which 200 sentinel cattle were introduced. These animals were bled before entering the feedlot and twice while in the feedlot, and were inspected every second day. At the beginning of May, quarantine was lifted on the feedlot and the piggery. In the first week of May, Kanhym estates began introducing new animals to the feedlot.

Control of the outbreak in Nkomazi

A game-proof fence to prevent contact between game and livestock surrounds the KNP. Due to aging, upgrading of the 2.4 m-high electrified perimeter fence commenced in 1998. The upgrading was about 70% complete by 7 February 2000 when a devastating freak flood damaged or swept away most of the fence along the southern boundary of the KNP. This resulted in buffalo moving out of the KNP into the adjacent Nkomazi area in far greater numbers than ever before (Fig. 6)

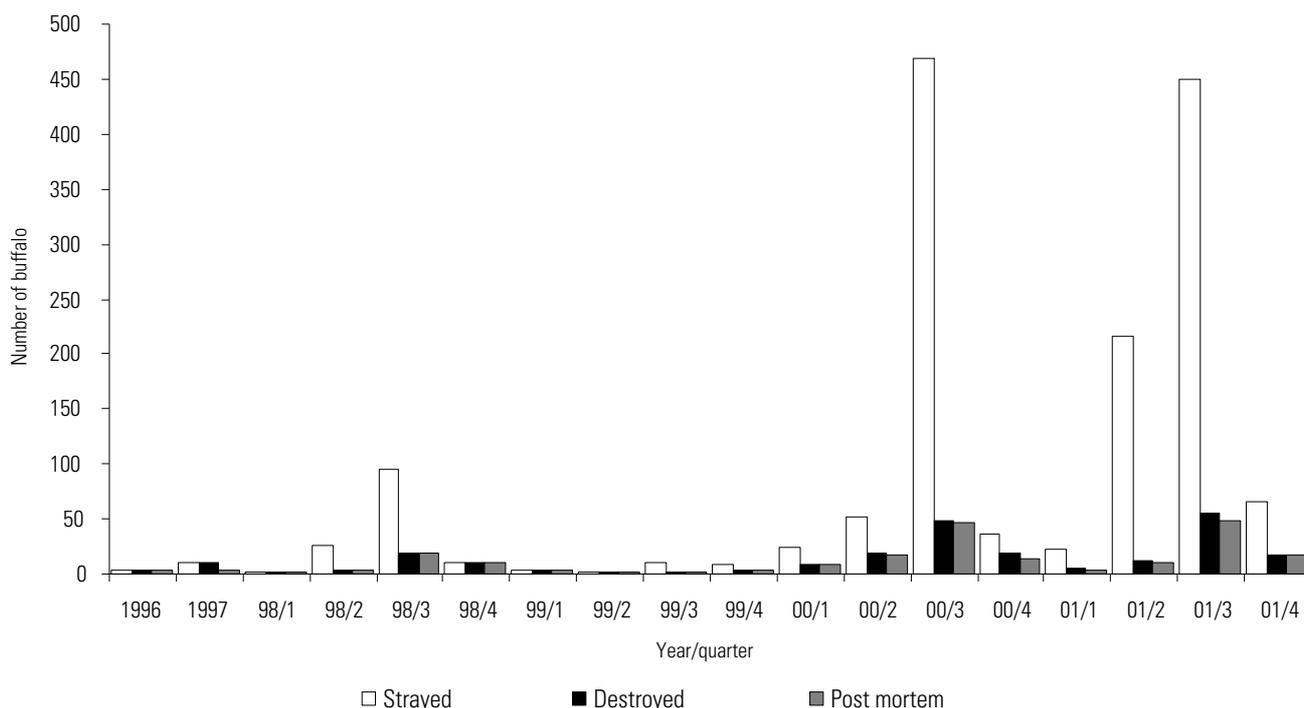


Fig. 6
Observed increased numbers of buffalo that escaped from the Kruger National Park to the Nkomazi area in 2000 and 2001 after damage to the park game fence, compared with similar observations between 1996 and 1999

and contact between buffalo and cattle was observed. However, no disease was detected in contact cattle herds during official inspections or reported by owners.

All indications were that the disease in the feedlot at Middelburg had started in the Nkomazi area. All animal movement from and within the Nkomazi area was stopped, and routine surveillance actions were intensified and strengthened by collection of serum samples from cattle and goats throughout the area. Serological surveillance was complicated due to the fact that the entire Nkomazi area had been subjected to compulsory vaccination in the past. Serological tests had previously revealed that some cattle vaccinated regularly in the past remained serologically positive for up to five years after the last vaccination (W. Vosloo and B.J.A. Du Plessis, personal communication). Antibodies to non-structural proteins (NSPs) were subsequently detected at several farms, indicating the presence of infection.

Roadblocks were established to control movements from the Nkomazi area. An intensive vaccination campaign in cattle, sheep and goats was launched in the infected zone. Cattle were vaccinated twice with a trivalent (SAT 1, SAT 2 and SAT 3) vaccine containing alhydrogel/saponin as adjuvant, while goats and sheep (regarded as a lower risk for possible disease dissemination) were vaccinated once only.

Stamping-out was not considered a control option because the outbreak occurred in the FMD control zone, and vaccination would not affect the zone recognised as free from FMD without vaccination. The geographical extent of the outbreak also rendered stamping-out an impractical, uneconomical and unacceptable control option. Movement control and vaccination were therefore the principal components of the control strategy for the outbreak.

Support services aiding the control of foot and mouth disease

Critical to the success of the FMD campaigns were laboratory diagnostic testing and logistic support.

Diagnostic support services

South Africa has a level 3 bio-containment facility that is responsible for the diagnosis of, and research into, highly contagious diseases such as FMD and African swine fever (ASF). Vaccines against the SAT types of FMD are also manufactured at the EDD that currently forms part of the OVI, an institute of the Agricultural Research Council of South Africa.

Although FMD has not occurred in the free zone of South Africa since 1957, the Government recognised the need to possess a strategic facility where expertise can be maintained for diagnosis and vaccine production of FMD and other exotic diseases. The EDD was inaugurated in 1981 and has performed research and diagnosis on FMD in southern Africa with excellent results (1, 2, 3, 4, 5, 9, 10, 11, 14, 20, 21, 22, 23, 24, 25, 26). The laboratory has built up a large database of partial VP1 gene sequences. These data were used to assist in the determination of the possible origins of the outbreaks.

As a result of regular research activities, as well as routine serological screening for the internal movement of animals and for exports and imports, the necessary expertise was available when the outbreaks occurred in the country. This was essential for the laboratory to function under the pressure generated by the number of samples submitted.

The EDD employs sufficient staff to routinely manage between 20,000 and 30,000 serological tests per year. The workload increased to nearly 75,000 tests per year during the period of the outbreaks, while the number of clinical samples submitted for virus isolation and polymerase chain reaction (PCR) also increased dramatically.

Another challenge was the fact that three different serotypes caused outbreaks over a period of five months. Due to the physical separation and vast distances between the different outbreaks and the demands on personnel, it was decided that the serological surveys for each outbreak would include only the serotype involved in that specific outbreak. After the animals in the feedlot and in the control zones were vaccinated with the trivalent vaccine, sera were tested for antibodies to all three SAT serotypes to ensure that sufficient immunological cover had been achieved. This meant that the laboratory had to ensure that sera were tested for the correct antibodies. This hampered speed, as the sera had to be batched according to serotype. In addition, all sera had to be tested for the presence of antibodies to NSPs to determine the spread of the outbreaks.

The EDD-OVI normally provides the Directorate of Veterinary Services (DVS) with FMD vaccine containing five SAT strains (two SAT 1, two SAT 2 and one SAT 3 strains) in saponin/alhydrogel. Therefore, when serotype O was diagnosed in KwaZulu-Natal, the vaccine had to be imported. The vaccine used during the outbreak at the feedlot in Middelburg was a formalin and binary ethyleneimine inactivated vaccine against FMD, produced at the EDD-OVI according to the processes described in the *OIE Manual of Standards for Diagnostic Tests and Vaccines* (15). The vaccine used in cattle, sheep and goats was prepared using aluminium-saponin adjuvant (ALSA). The vaccine used in pigs contained a double oil emulsion adjuvant and only two SAT 1 strains. The vaccine strains were all viruses isolated from buffalo in the KNP, except for one SAT 2 isolate from western Zimbabwe, but has broad antigenic coverage. Since it was demonstrated that the outbreaks were most

probably caused by infected buffalo, and buffalo can carry all three serotypes, the trivalent vaccine was used to prevent any further incidences. During the period from 1999 to 2000, the EDD delivered 150,000 trivalent doses of vaccine to the DVS. This increased to 519,600 during the period from 2000 to 2001.

Logistic support services

Within the first week after the disease was diagnosed in KwaZulu-Natal, it became evident that, contrary to past experiences with outbreaks of FMD in the control zone, the available personnel within the national and provincial Veterinary Services of the country would not be sufficient to control the outbreak in the free zone effectively. Due to the long period since the last outbreak of FMD in livestock in South Africa, there was also a lack of experience and exposure within the contingent of professional and technical staff to mobilise effective logistic support. Available contingency plans focused on possible outbreaks in the FMD control zone, where movement restrictions were easy to institute, and were not easily applicable to the free zone where free movement of animals and animal products occurred. Assistance was obtained from the SANDF and a Joint Operational Command (JOC) was established with representatives from the SANDF, officials from the national and provincial Veterinary Services, Road Traffic Inspectorate (RTI), SAPS, disaster management units and policy-makers within the farming community and nature conservation.

Extensive logistic support was provided by the SANDF, consisting initially of the deployment of two companies, air support and mobile patrols with horses and motorbikes. This was later expanded to a total contingent of more than 900 SANDF personnel to man and operate more than 72 roadblocks, man and patrol bio-security cordons, provide mobile decontamination points, operate an around-the-clock information and alert unit, assist with the disposal of culled animals, provide intelligence back-up, erect and man animal quarantine and holding camps, dispose of confiscated animals and animal products and undertake reconnaissance operations to identify and implement new or extended control areas, cordons and roadblocks. The additional personnel included staff permanently employed by the SANDF but also volunteers from home defence units, farmers and retired veterinary personnel.

The JOC held two meetings every day for the entire duration of the outbreak during which activities were planned, evaluated and adapted where necessary. The JOC operated on the principle that decision-making in respect of disease control strategies was the responsibility of veterinary professionals and technical staff, whilst implementation of logistic support to back-up disease control strategies was the responsibility of the SANDF in collaboration with veterinary staff and other support services.

The principle of a JOC was implemented immediately in a similar fashion to control the disease outbreaks in the Mpumalanga Province, with close cooperation once again from the SANDF, RTI, SAPS and other support services.

The operational costs borne by the National Department of Agriculture to contain the outbreaks in KwaZulu-Natal, Mpumalanga and Mhala from September 2000 to February 2001 amounted to approximately ZAR75 million (US\$8 million). The total operational costs, including those of the support services, are estimated at ZAR90 million (approximately US\$9 million).

Lessons learned during the control of foot and mouth disease in South Africa

Foot and mouth disease is primarily perceived as a trade-sensitive disease by most developed countries. International convention requires that all countries participating in the international trade of animals and animal products should abide by the rules to render the required sanitary guarantees for trade, provided the rules are applied in a scientifically justifiable manner. However, this perception sometimes appears to be in conflict with socio-economic practices as farmers who, for example, do not directly benefit from international trade or do not actively participate in the export of animals and animal products, may fail to understand the rationale for culling healthy animals.

In KwaZulu-Natal, it was extremely difficult to convince farmers in communal grazing areas to submit their animals for culling and, when culling was discontinued, to present their animals for vaccination. Cattle are reared and kept for a variety of reasons including ceremonial uses, as dowries (*lobola*), and for ploughing, manure, meat and milk. To convince these farmers that their animals must be killed to serve a purpose outside their framework of values or existence is difficult, if not impossible. The establishment of an acceptable platform for negotiation for compensation for animals to be culled becomes even more difficult when communal farmers have different perceptions as to the value of their animals compared to commercial cattle.

The press did not readily understand why FMD raises so much international concern and reaction, whilst not being a zoonosis and causing few mortalities in livestock. Many of the media inquiries focused on this aspect without really conveying to the public and livestock owners the rationale for controlling the disease to maintain access to international trade in animals and animal products. It became evident that the establishment of Internet sites and the issuing of regular press statements must be supplemented by a transparent and continuous rapport with the media.

The outbreaks, especially in KwaZulu-Natal and the feedlot at Middelburg, illustrated that although there are general guidelines available for the control of an outbreak of FMD, there is no blueprint or tailor-made guideline for every circumstance. Decisions based on the unique prevailing circumstances of each outbreak that are taken within the first 48 hours after detection of disease determine the success or failure of an operation. In both of these outbreaks, vitally important decisions had to be taken immediately after confirmation of the diagnosis, which in the end proved to be successful in the relatively rapid containment of the outbreaks.

An important business activity on the feedlot was a system of contract or custom feeding, whereby the feedlot feeds animals for outside customers in addition to those animals procured by the feedlot company for their own account. Private individuals who make use of the custom feeding system source these animals throughout the country, without necessarily considering disease risk management before the animals enter the feedlot system. This obviously creates an additional disease risk over and above the acceptance of animals into the feedlot system originating from FMD control zones. In a review of the FMD control policy after the outbreaks, it was ruled that no animals from an official disease control zone or procured by private individuals will be accepted into a feedlot system.

The importance of human movements in the area of an active outbreak is often under-estimated as a possible cause of disease dissemination. Human movement was suspected as the cause of some extensions of the infection, especially in the outbreak in KwaZulu-Natal. Therefore special care should be taken to apply the strictest possible control on human movements and disposal of protective clothing, as well as control of personnel moving between farms to conduct inspections. Restrictions posed on the removal or movement of other agricultural products or farm produce within an infected area must also be justified scientifically to limit losses.

Experiences in the outbreaks raised unresolved questions about the status and role of carrier animals in the epidemiology of the disease, the advantages and disadvantages of total stamping-out versus a modified or controlled stamping-out policy and the role of advanced diagnostic techniques, such as tests measuring antibodies to NSPs of FMD virus to distinguish between infected and vaccinated animals. The qualifying periods for the different categories of zone freedom from FMD with and without vaccination prescribed in the OIE *International Animal Health Code* appear to be unrealistically long (16). They therefore need to be reviewed, taking the total spectrum of risk mitigation factors into consideration, to determine justifiable and realistic waiting periods for a country to qualify for disease freedom or to regain the status lost as result of an outbreak.

Any country experiencing an outbreak of FMD can expect questions or trade restrictions from regular trading partners. In

the era before zone or country freedom from disease became a prerequisite for trade, trade partners in general tended to accept the guarantees provided concerning the successful containment or eradication of an outbreak in a given locality within a country. However, the experience of South Africa was that the entire country, irrespective of the size or magnitude of an outbreak and regardless of the fact that outbreaks only affected small portions of the country, was under suspicion. The perceived over-reaction had a serious negative impact on international trade in animals and animal products and certain non-animal farm produce, even though adequate sanitary guarantees could be given for the remainder of the country not affected by the disease.

Laboratory results must imperatively be generated independently from State interest to ensure the objective interpretation of results. However, in the event of a major disease crisis where the available resources of a laboratory are utilised to the limit, additional funding and resources should be made available by government without having an effect on the impartial relationship that must exist between the laboratory and the State. Since two separate entities, namely the DVS representing the Government and the EDD-OVI – a para-statal body and part of the Agricultural Research Council – were involved in the outbreaks and had the task of trying to elucidate the epidemiology of the outbreaks, it was of utmost importance that a good working relationship and effective communication existed between the laboratory personnel and Government officials.

The danger of complacency arising among staff who do not perceive FMD as a real threat creates problems when mobilising personnel in the event of an outbreak. This was especially true in South Africa where very few personnel had previous experience in the control of an outbreak of FMD. The key to the successful containment of any outbreak of FMD is immediate and decisive action. It is, however, important that personnel be brought to a high level of commitment as soon as possible after deployment and that they are knowledgeable in the identification and recognition of the disease. A transition period of 'over-reaction' was expected, i.e. having difficulty distinguishing between possible suspicious clinical lesions and other obvious causes of lesions in the mouth and on the feet. Numerous false alarms were triggered by the simultaneous occurrence of an abnormally high incidence of lumpy skin disease resulting in confusing lesions in the mouth – especially in cases of secondary infections of mouth lesions. In the arid and semi-arid areas of the country where cattle are mostly reared on natural grazing, injuries to the dorsum of the tongue due to dry grass lodged in the buccal papillae causing 'FMD-like' lesions also resulted in many false alarms.

The multidisciplinary approach followed in South Africa for the containment and control of outbreaks illustrated that the veterinary services of a country urgently need to utilise external logistic expertise and operational planning for the successful

control of a disease that threatens to become a national disaster. Expertise in logistic and operational planning was available from other disciplines, such as the security services and disaster control units. They were used maximally and with great success in combating the outbreaks of FMD in South Africa, particularly in the control of people and vehicles.

Control strategies and the rationale for making decisions to control an outbreak rapidly and effectively should imperatively be left to the veterinary administration of the country concerned and this needs to be backed up by the required political and financial support. ■

La fièvre aphteuse : l'expérience de l'Afrique du Sud

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Résumé

La fièvre aphteuse est enzootique parmi les populations de buffles d'Afrique (*Syncerus caffer*) du Parc national Kruger et d'autres parcs de la région. Le dernier foyer signalé parmi les animaux domestiques en dehors de la zone de contrôle date de 1957. Pour avoir réussi à maîtriser la maladie, le pays s'est vu reconnaître par l'OIE, en 1995, le statut de zone indemne de fièvre aphteuse où n'est pas pratiquée la vaccination. L'Afrique du Sud a perdu ce statut en septembre 2000 lors de l'apparition du premier cas dû au sérotype O jamais enregistré dans le pays, dans un élevage de porcs de la province du KwaZulu-Natal, imputé à l'utilisation illégale d'eaux grasses non traitées pour l'alimentation des porcs. En novembre 2000, un foyer de fièvre aphteuse dû au sérotype SAT 1 a été détecté dans un parc d'engraissement situé dans la zone indemne de la province de Mpumalanga. Le foyer à virus de sérotype SAT 1 a été attribué à des bovins de la zone de contrôle de la fièvre aphteuse, située au sud du Parc national Kruger. Un buffle était entré en contact avec du bétail suite à de graves dégâts occasionnés par les inondations à la clôture à gibier entourant le parc. Un autre foyer a également été détecté dans la zone de contrôle de la fièvre aphteuse en février 2001. Un buffle échappé du Parc national Kruger était également à l'origine de ce foyer à sérotype SAT 2. Tous ces foyers ont été maîtrisés et l'Afrique du Sud a recouvré en mai 2002 le statut de zone indemne de fièvre aphteuse sans vaccination.

L'apparition de ces foyers a imposé un réexamen des méthodes de lutte et de confinement de la fièvre aphteuse en application depuis de nombreuses années et conformes aux pratiques acceptées à l'échelle internationale. Les auteurs expliquent les arguments qui ont conduit à l'adoption des différentes stratégies de prophylaxie, la nécessité d'une démarche pluridisciplinaire dans la lutte contre la maladie, l'interaction entre prophylaxie, aide technologique et appui au diagnostic, ainsi que les enseignements tirés de l'expérience. Ils avancent également quelques propositions de stratégie de lutte pour les années à venir.

Mots-clés

Afrique du Sud – Approche pluridisciplinaire – Appui logistique – Buffle d'Afrique – Fièvre aphteuse – Office international des épizooties – Parcs d'engraissement – Stratégies de lutte – Zones. ■

Fiebre aftosa: la experiencia de Sudáfrica

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Resumen

La fiebre aftosa es endémica en las poblaciones de búfalo africano (*Syncerus caffer*) del Parque Nacional Kruger y de otros parques de la región. En 1957 ocurrió el último brote señalado entre animales domésticos fuera de la zona de control de la fiebre aftosa. El éxito obtenido por Sudáfrica en la contención de la fiebre aftosa le valió en 1995 el reconocimiento de la OIE como país con zona libre de fiebre aftosa sin vacunación. El país perdió ese estatus en septiembre de 2000 con la aparición por primera vez en Sudáfrica de un brote debido al serotipo O, en una explotación porcina de la provincia de KwaZulu-Natal, seguramente como consecuencia de la alimentación ilegal de porcinos con desperdicios que no habían sido tratados. En noviembre 2000 se detectó un brote de fiebre aftosa debido al serotipo SAT 1 en la zona libre de la provincia de Mpumalanga, en un lote de animales de engorde. El brote debido al serotipo SAT 1, según pudo determinarse, tenía su origen en bovinos domésticos de la zona de control de la fiebre aftosa al sur del Parque Nacional Kruger, que estuvieron en contacto con búfalos después de que la valla de protección contra animales salvajes que rodea el parque resultara dañada por inundaciones. En febrero de 2001 se diagnosticó un nuevo brote en la zona de control de la fiebre aftosa, causado en aquella ocasión por el serotipo SAT 2 y provocado también por un búfalo que se había escapado del Parque Kruger. Todos estos brotes fueron controlados y el país recobró el estatus de su zona libre de fiebre aftosa sin vacunación en mayo de 2002.

Todos esos brotes obligaron a revisar los métodos aplicados durante muchos años para controlar y contener la fiebre aftosa, acordes con las prácticas internacionalmente aceptadas. Los autores exponen el razonamiento subyacente a las distintas estrategias de control que se instituyeron, la necesidad de adoptar un planteamiento multidisciplinar para luchar contra la enfermedad, la interrelación entre las medidas de control, las labores de diagnóstico y el apoyo tecnológico y por último las lecciones extraídas de la experiencia. Efectúan asimismo algunas sugerencias de cara a futuras estrategias de control.

Palabras clave

Apoyo logístico – Búfalo africano – Estrategias de control – Fiebre aftosa – Lote de animales de engorde – Oficina Internacional de Epizootias – Planteamiento multidisciplinar – Sudáfrica – Zonas.

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