An analysis of the 1978 African swine fever outbreak in Brazil and its eradication

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Submitted for publication: 18 August 2009
Accepted for publication: 26 August 2010

Summary
The aim of this paper is to evaluate the African swine fever (ASF) outbreak that began in 1978 in Paracambi municipality, Rio de Janeiro State, Brazil, and the steps taken by the Brazilian authorities to eradicate the disease. The presence of ASF in the country was confirmed by isolating the virus, and its pathogenicity was certified by the laboratory of the Plum Island Disease Center, New York, United States. Even before the laboratory results became available, the Brazilian Agriculture Ministry declared an Animal Health Emergency, in which the official Veterinary Services adopted rapid control measures to restrain and eradicate the disease. These control measures contributed to the reorganisation of the national swine industry and stimulated the use of high-technology production techniques, as well as an improvement in herd health consciousness. All this contributed to Brazil becoming the largest meat exporter in the world.

Keywords
African swine fever – Brazil – Epidemiology – Eradication – Exotic disease – Pig.

Introduction

African swine fever (ASF) is a highly contagious disease of swine that can occur in peracute, acute, sub-acute and chronic forms. It is caused by the ASF virus (ASFV) (22, 14), which is the only known arbovirus with a DNA genome, and is the sole member of the genus *Asfivirus* within the newly designated *Asfarviridae* family (5).

African swine fever was first reported in East Africa by Montgomery (19), who described it as a disease of domestic swine that resembled classical swine fever (CSF) both clinically and pathologically. In sub-Saharan Africa, ASF is maintained in a sylvatic cycle, infecting both wild suidae (e.g. warthogs and bushpigs) and the argasid (soft-bodied) tick *Ornithodoros porcinus porcinus* (7).

Outbreaks have inflicted considerable economic losses worldwide, especially in countries that do not have prevention and control programmes in place, including many parts of Africa, as well as the island of Sardinia (13).

Outbreaks of ASF were notified to the World Organisation for Animal Health (OIE) in 2007 and 2008 in Angola, Armenia, Azerbaijan, Benin, Burkina Faso, Democratic Republic of the Congo, Georgia, Ghana, Guinea Bissau,

Madagascar, Mauritius, Mozambique, Namibia, Nigeria, Russia, Tanzania, Togo, Uganda and Zambia, but these reports do not reveal the full scale of the problem in countries where the disease is endemic (21). In Brazil, a serious outbreak of ASF occurred in 1978, and caused huge economic losses to the country before it was eradicated. Intensive epidemiological work was carried out by researchers from various Brazilian and international institutions, involving a number of public authorities. This led to Brazil being declared 'free of African swine fever' (Fig. 1) in 1984.

This paper celebrates 25 years of ASF eradication in Brazil by providing details of this outbreak, which began in Paracambi municipality (Rio de Janeiro [RJ] State, Brazil), and evaluating the government actions which culminated in the eradication of the disease in Brazil in 1984.

Document analysis

The research used the documents available in official and personal archives, as well as the Biblioteca Nacional de Agricultura (the national agriculture library) and the Federal Senate Library, including official acts and presidential decrees, in addition to White Papers from ministries and normative instructions from the National Secretariat for Agricultural Defence. Reports from international organisations were also analysed, as well as those of Veterinary Services in the regions where ASF occurred. After primary and secondary sources had been identified, these were consolidated in research reports. Newspaper, magazine and news agency reports were found in abundance, many of them including the same information.

República Federativa do Brasil
Ministério da Agricultura
Secretaria Nacional de Defesa Agropecuária

SECRETARIA DE DEFESA SANITÁRIA ANIMAL
ATO ADMINISTRATIVO DE 05 DE DEZEMBRO DE 1984

De acordo com as normas prescritas no capítulo 2.4.2. – Peste Suína Africana, do Código Zoossanitário Internacional, do "Office International des Épizooties" – OIE e considerando que:

– o País adotou a política de sacrifício sanitário em todos os focos de peste suína africana;

– o último caso clínico da doença ocorreu em 15 de novembro de 1981;

– os resultados dos exames realizados desde aquela data foram negativos para o vírus da peste suína africana;

– os exames sorológicos realizados em regiões anteriormente afetadas ou de grande concentração de suínos, não revelaram a presença de anticorpos para o vírus da peste suína africana;

– a vigilância epidemiológica foi realizada de acordo com as normas vigentes, examinando-se suínos em frigoríficos (abate) e nas propriedades (reprodutores);

– as técnicas empregadas, tanto na identificação viral, como na pesquisa de anticorpos, foram as de referência internacional;

– o reservatório invertebrado do vírus da peste suína africana, o carrapato do gênero *Ornithodorus*, não foi constatado no país, bem como suínos selvagens não existem nas zonas de suinocultura e/ou onde ocorreram focos;

o Ministério da Agricultura, através da Secretaria de Defesa Sanitária Animal, da Secretaria Nacional de Defesa Agropecuária, declara a **República Federativa do Brasil país livre de peste suína africana.**

Para manutenção da atual situação sanitária terá continuidade, em programa específico, a vigilância em peste suína africana, agora exótica para o país, e as atividades de controle e erradicação da peste suína clássica.

GUILHERME DE CARVALHO CELEBRINI
Secretário

REFERENDO

JOSÉLIO DE ANDRADE MOURA
Secretário Nacional de Defesa Agropecuária

NESTOR JOST
Ministro da Agricultura

Fig. 1
Declaration of freedom from African swine fever, Brazil, 1984

Statements from those directly involved in the eradication programme and personal observations during the eradication campaign

Members of the Central Coordination Commission (CCC) for Eradication of African Swine Fever, who played a central role in the decision-making process, were interviewed, as well as people involved in epidemiological research, laboratory diagnosis, health education and social communication. No individual interviews with pig farmers were carried out, as there had been other studies covering their experiences. However, their opinions were studied by reading the bulletins of farmer associations, syndicates and cooperatives, and through local and national media.

Study trips and research linked to the theme

African swine fever is of great interest in scientific and technical terms, because there have been only a small number of successful eradication programmes. Sharing information about these experiences is very useful, so the first author of this paper (J.A. Moura), while occupying various positions in the Ministry of Agriculture, Animal Production and Food (MAPA) in Brasilia, Brazil, visited Portugal and Spain seven times and Cuba nine times, as well as Haiti, the Dominican Republic, Italy, France, South Africa, Angola and Mozambique. During a number of meetings of the OIE, this topic was discussed with delegates and with members of the International Zoo-sanitary Code Permanent Commission (now known as the Terrestrial Code Commission) and the Scientific and Technical Department. The results of these discussions are considered later in this paper.

African swine fever in Brazil, primary area of occurrence

The index case in Paracambi municipality, RJ, was notified to MAPA on 13 May 1978. In Presidential Decree no. 81.798, issued on 15 June 1978 (9), MAPA declared an Animal Health Emergency and adopted immediate measures to contain and eradicate the disease, following the guidelines in the OIE *International Animal Health Code for Terrestrial Animals* (now known as the *Terrestrial Animal Health Code*). The Presidential Decree was issued less than 15 days after the first positive laboratory diagnosis of ASF. This federal legislative document set out a unified plan for government actions during the emergency phase, and also specified actions that Brazil's armed and auxiliary forces should take during the eradication process. This was to restrict and prevent the movement of people, animals and vehicles.

The Decree stipulated that the following procedures should be carried out:

– immediate communication about the occurrence of ASF to neighbouring countries, to countries with which Brazil had bilateral animal health agreements, and to the OIE, and other international organisations, especially the Food and Agriculture Organization (FAO) of the United Nations, the Pan-American Health Organization, the Pan-American Center for Foot and Mouth Disease and the Inter-American Institute for Agricultural Cooperation (IICA);

– prohibition of the movement of swine within and from affected and risk areas;

– immediate slaughter and cremation of all animals within the affected areas;

– cleaning and disinfection of contaminated vehicles, buildings and objects, including their destruction in cases where cleaning and disinfection were deemed not to provide sufficient security;

– prohibition of exhibitions, fairs and other events where animals would congregate;

– prohibition of feeding swine with leftover food;

– development of a programme of animal health education and communication to raise community awareness of emergency animal health activities;

– developments in the technologies used in the production of anti-ASF vaccines and adoption of new inspection criteria. After these changes had been made, vaccination against classical swine fever (CSF) was intensified, with a total of 35 million doses being given. This was to facilitate the rapid diagnosis of ASF, since CSF and ASF can coexist on the same farm or in the same animal (4);

– introduction of incentives for animal health assistance to pig farms, and notification of all pathogenic observations in swine.

The Decree also gave both official and private veterinarians the power to immediately adopt any necessary emergency animal health measures (9).

The epidemiological examination of the initial outbreak location indicated that the first animal died on 30 April 1978, and between then and 13 May 1978, out of the

1,000 animals on the farm, more than 200 died as a consequence of ASF. The owner of the farm was a police officer stationed at Galeão International Airport (later renamed Antonio Carlos Jobim International Airport) in Rio de Janeiro. Taking advantage of failures in the security system at the airport, he had collected leftovers from meals served on international flights to feed to his animals, including food from a Portuguese and a Spanish airline. At that time ASF was endemic in both Portugal and Spain. The farm was 52.24 km from the airport (18).

As the number of swine kept on the farm increased, the owner could not obtain enough airport leftovers (Figs 2 & 3) to feed them, so from April 1978 he began to supplement the leftovers with balanced commercial rations. This change coincided with the first appearance of clinical signs in the animals, and the first pig died at the end of April. The owner thought initially that the disease must have been caused by the new feed, not the leftovers, and that perhaps this feed was contaminated or unsuitable (16). He contacted Dr Francisco de Assis Moreira Filho, the veterinarian who was responsible for the mill that produced the animal feed.

After examining the animals, Dr Filho initially concluded that the outbreak was of CSF. However, the owner of the farm stated that he regularly vaccinated his animals against this disease. When swine in the region around the farm became infected with ASF they typically showed signs of light haemorrhaging only, as the resistance to CSF that they had acquired provided some protection against ASF, thus further confusing the initial diagnosis. On 10 May 1978 Dr Filho took samples from different animals at different stages of the illness (Fig. 4), and carried out necropsies at the then Animal Biology Institute of the Brazilian Agricultural Research Corporation, which was 17.5 km from the affected farm and close to the Rural Federal University of Rio de Janeiro (UFRRJ). According to a report by Tokarnia *et al.* (20), one of the pigs 'showed haemorrhaging in diverse forms, various organs, lymph nodes and serosas which impress due to their extension, gravity and frequency, as well as marked pulmonary lesions (fibrous pleurisy and hepatisation of the pulmonary parenchyma)'.

At this time, Professor Dr Wilhelm Otto Daniel Neitz, a South African scientist with extensive experience of ASF and the author of international publications on the theme, was lecturing on a postgraduate course at UFRRJ. He visited the farm and examined dead and sick animals on

Fig. 3
Leftover food from Rio de Janeiro airport used in swine feed found on the farm where the primary African swine fever outbreak occurred in Paracambi municipality, 1978

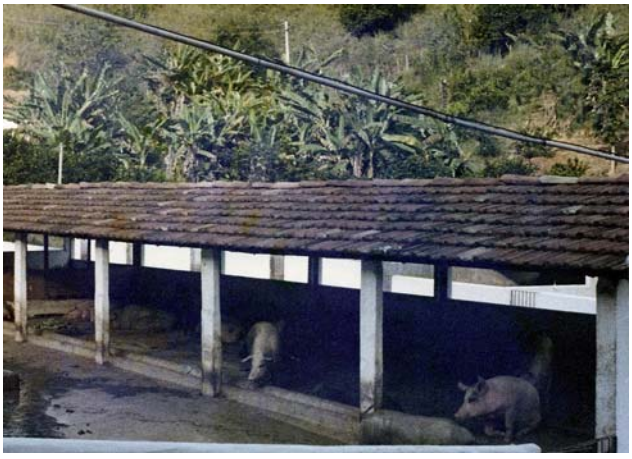

Fig. 2
Poorly built pigsties on the farm in Paracambi municipality, Rio de Janeiro, where the primary case of African swine fever was discovered, 1978

Fig. 4
Dead animals from the primary outbreak location, Paracambi municipality, Rio de Janeiro, 1978

site. The dead animals showed various stages of clinical manifestation of disease. Dr Neitz studied the epidemiological reports, and concluded that this was a serious outbreak of ASF. He demanded that information about the outbreak be communicated immediately to the Brazilian animal health authorities, so that the designated emergency measures for this type of occurrence could be taken. At this time, according to Tokarnia *et al.* (20), he was shocked to see some employees of the farm slaughtering animals so that the meat could be sold. In the period between the first appearance of animals with symptoms and the implementation of the emergency animal health measures, various animals had been sold, and on learning this the Brazilian Ministry of Agriculture made it clear that this was a serious error and must not be repeated (18).

The National Secretariat for Agricultural Defence, which was a sub-department of MAPA headed by Dr José Alberto da Silva Lira, determined that a technical team called the Secretariat of Animal Health Defence should be formed within the National Secretariat to deal with the outbreak. The Secretariat of Animal Health Defence was led by Professor Ubiratan Mendes Serrão and included Rômulo Costa, Carlos Lima and Sérgio Bogado. There were also representatives of the Pan-American Health Organization (PAHO), the National Reference Laboratory for Animals (LANARA, today LANAGRO), as well as specialists in ASF. The specialists went to the farm and collected more samples for laboratory analysis. The team also advised the local animal health authorities to request a military police presence in the locality, so the police could ensure that the outbreak location was quarantined and could prevent the transit of animals and people until the remaining animals had been slaughtered and cremated (Figs 5 & 6) and the property disinfected (9).

Fig. 5
Opening pits for disposal of swine in the farm where the primary outbreak of African swine fever occurred, Rio de Janeiro, 1978

Fig. 6
Swine ready for cremation in Paracambi municipality, Rio de Janeiro, 1978

As well as the initial outbreak, secondary points of outbreak soon appeared. These secondary outbreaks typically occurred in herds that were kept in the slums and outskirts of Rio de Janeiro, in locations without suitable housing or technology, and in which basic feed was composed of leftovers and foodstuffs scavenged from rubbish tips (18). Swine from the first area affected had been sold to the Nova Brasília slum in the city of Rio de Janeiro before animal movement was prevented.

The material collected for diagnosis from the farm was sent to the laboratory at the Plum Island Animal Disease Center in the United States. The ASF virus was isolated from these samples and the illness reproduced. Technical cooperation was also received from international organisations, as well as the governments of Portugal, Spain, France, the United States and Canada. Specialised consultation and provision of equipment meant that two diagnostic laboratories could be set up in Brazil, one on Fundão Island under the UFRRJ, and another organised by LANARA in Pedro Leopoldo, Minas Gerais State (6).

The disease spread, as mentioned above, because of the sale of swine from the affected farm to slums in Rio de Janeiro before animal movement was prevented (Fig. 7). But it also spread because of the soil and water characteristics, and because meat-buyers and people in

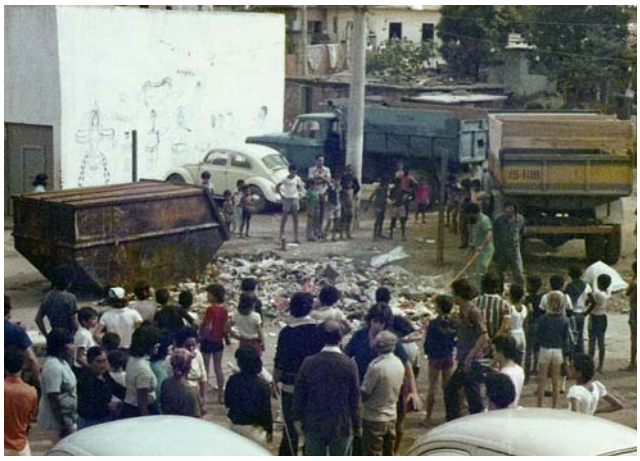

Fig. 7
The dump in the Nova Brasília slum, Rio de Janeiro city, 1978
The Agriculture Ministry intervened to purchase and slaughter swine from this dump

transit in the area took animals and products to other municipalities within RJ State and to other States, e.g. Espírito Santo State.

One pig from the initially affected farm had been sold to the Nova Iguaçu municipality, also in RJ State, and others had been sold to butchers in Magé (RJ), Alcântara (RJ) and São Gonçalo (RJ) municipalities to feed workers building a road. Others had been sold directly to consumers and butchers from Duque de Caxias (RJ) and Governador Island (RJ). The Caxias (RJ) municipality served as a focus for dissemination to other cities in RJ, such as Friburgo, Petrópolis, Cordeiro, Campos dos Goytacazes and Teresópolis. A total of 24 notifications occurred in RJ State. Samples were collected from each notified herd of swine and tested. In June and July 1978 this produced 18 positive and six negative results. By 14 August, ASF had spread to ten other states, as shown in Table I. With the exception of Piauí State and Pará State, which are in the north, the states affected by the disease were in the centre and south of the country.

Tito Livio Machado Jr, head of the MAPA epidemiology team, part of the CCC for Eradication of ASF, and subordinate to the team led by Professor Ubiratan Mendes Serrão, reported (18) that after examining the outbreak areas in Ourinhos municipality, São Paulo State, he returned to Rio de Janeiro to interview the owner of the farm where the outbreak had begun. The owner mentioned in this interview with Dr Machado that in his first interview after the outbreak he had omitted to say that he had given some piglets to a barbecue restaurant to be cooked for a meal to celebrate the marriage of his niece. After the celebration, the leftovers from the meal were taken to a nearby pig farm. Ministry of Agriculture inspectors visited this farm, and found animals with

Table I
Occurrence of African swine fever: laboratory diagnoses made by the Federal University of Rio de Janeiro, May to August 1978, Brazil

State	Number of samples		
	Positive	Negative	Total
Rio de Janeiro	18	6	24
Minas Gerais	6	4	10
Paraná	22	14	36
São Paulo	32	20	52
Santa Catarina	11	5	16
Goiás	5	4	9
Piauí	2	0	2
Espírito Santo	2	0	2
Rio Grande do Sul	0	3	3
Pará	5	0	5
Mato Grosso	1	0	1
Total	**104**	**56**	**160**

Source: (11)

various stages of ASF. The restaurant was situated close to a petrol station (Atlantic) on the Via Dutra, the main highway between Rio de Janeiro, São Paulo and the southern states of Brazil. The station was used regularly by lorries transporting pigs from São Paulo and other southern states for slaughter in Rio de Janeiro. However, when the truck drivers arrived in Rio they found that the price for live pigs was lower than the average in other states they had passed through, so they took the animals back with them to slaughter in southern states in which the prices were higher than in Rio de Janeiro.

Vaccination against classical swine fever and the epidemiology of African swine fever

Dissemination areas of African swine fever in Pará State

In May 1978, the owner of some land in Pará State in the north of the country, in the municipality of Cachoeira do Arari, went to Rio de Janeiro, where he read many of the newspaper articles about the geographical spread of the swine fever which had hit the national swine-rearing industry. Believing that these reports described CSF not ASF, he bought crystal violet vaccinations against CSF in Rio de Janeiro (the problems associated with this vaccine are discussed below). These were sufficient for his own herd and four neighbouring herds. Just a few days after returning to Pará State and using the vaccines, animals at all five properties showed clinical signs of ASF. Samples were sent for laboratory diagnosis, and tested positive.

Scientific observations of the presence of African swine fever virus in crystal violet vaccinations

At this time, the production of crystal violet vaccinations used samples from dead animals, and it was found that some of these samples had been infected with ASF. The presence of ASFV in strains used in the production of crystal violet vaccinations was first detected by Andrade (1). Until his research this was an issue that had been rarely considered, but his findings made it clear that the vaccine was a factor in the simultaneous appearance of ASF at various points across the country. This had serious social and economic repercussions. Andrade used suspensions of ASFV in crystal violet at concentrations similar to those used in the preparation of the vaccine; the virus was multiplied in leukocyte cultures and the illness reproduced in pigs. According to Andrade (2), his findings, together with the earlier observations, confirmed that crystal violet vaccine was implicated in the dissemination of ASF in Brazil. In addition, the FAO sent a mission to the Government of Brazil and they too found evidence of ASFV in CSF vaccines. Laboratory experiments indicated the presence of ASFV in primary seed and vaccines from three laboratories producing crystal violet. The Maisons Alfort laboratory in France also found ASF antibodies present in swine serum collected in Rio Grande do Sul and São Paulo States. This indicated the possible presence of ASFV as the result of a separate introduction distinct from that responsible for the index case in Paracambi, RJ.

This underlined the importance of active epidemiological surveillance to control possible movement of the virus through swine or derived products, including laboratory management (in the case of infected vaccines) and control of the disposal of leftovers from the airport (in the case of infected food).

Thiago de Mello (personal communication), representing Brasilia University and the CCC for the Eradication of ASF, in a confidential letter to the Minister of Agriculture stated:

'ASF…is clinically impossible to discriminate from classical swine fever. Nevertheless, for the latter, there are modern vaccines available, with no collateral risks for young pigs or gestating sows. These vaccines are easy to produce in cell cultures and rabbits, in both cases without contact with the ASF virus. They are totally different from crystal violet vaccine, which is of doubtful efficacy and is no longer used in other countries to combat classical swine fever. Crystal violet vaccine is obtained from the viscera and blood of swine and it is difficult to know if one of the donors may be infected without evidence of the disease, either classical swine fever or ASF.'

The letter continued:

'Modern vaccines, without residual pathogenicity, use three principal types of attenuated viruses: Chinese, Thiverval (French) and GPE (Japanese) samples. These vaccines give solid, long-lasting immunity in vaccinated pigs from 40 days of age; pregnant sows transmit protective antibodies to their young, until they can receive the vaccine.'

Thiago de Mello went on to request:

'For these reasons, I take the liberty of suggesting that the necessary authorisations be provided as quickly as possible, so that Brazilian laboratories can produce these vaccines; at the same time the laboratories should be requested to offer the vaccines in as short a time as possible.'

Due to the importance of the use of vaccine against CSF, the Minister of Agriculture revoked Ministerial White Paper no. 408 of 27 July 1965, which had provided the approved instructions for control and use of vaccines. This enabled the person who was responsible for putting plans for the eradication of the disease into practice to make the relevant provisions.

The National Secretariat for Agricultural Defence, taking into account the ministerial decision, the proposals approved by the CCC, and the need to update legislation to support the production and control of CSF vaccines, issued a new White Paper, no. 190, on 21 December 1978, which set out new rules. These rules covered the control, harmfulness and security of the product and use of new technologies.

In the southern states, after the high number of ASF cases that occurred in June and July 1978, the number reduced significantly in August, followed by a period of epizootiological silence. Some cases then appeared in December 1978, and these can probably be attributed to CSF vaccines (6).

Clinical and laboratory diagnosis

The first clinical diagnosis carried out in Brazil was complex, as this was a disease little known or studied by field veterinarians. Clinical diagnosis is simpler in outbreaks of highly virulent ASF, where the mortality rate can reach 100%. In the low-virulence ASFV cases, clinical diagnosis is more difficult. As well as epidemiological analysis, observations such as the fever temperature and anato-morpho-pathological analysis of necropsy findings are important. The necropsy findings that lead to a positive diagnosis include an enlarged spleen with a dark red to black colour, along with haemorrhagic and thickened gastroenteric, lymphatic and renal nodes.

Because ASF and CSF are frequently confused with each other, differential diagnosis is necessary. As well as the epidemiological history, there are diagnostic clues that can indicate which virus is responsible for the disease; for example, pigs with ASF do not have conjunctivitis or encephalitis, and, if they do not have a high fever, can maintain good body condition. Classical swine fever carriers show depression, rapid weight loss and strong-smelling diarrhoea. Differential diagnosis was also carried out for diseases such as erysipelas, salmonellosis and eperythrozoonosis.

Collection of material for laboratory examination

This was one of the critical points in the Brazilian Programme for the Eradication of African Swine Fever. The country did not have known ASF-specific antigens in cell cultures or immune serum. The material for laboratory examination was collected with the help of FAO, PAHO and IICA, which also supported technological developments. This support was vital in setting up the UFRRJ Virology Laboratory on Fundão Island, and another laboratory at LANARA in Pedro Leopoldo, Minas Gerais State. The initial diagnosis was carried out in the Animal Disease Center at Plum Island in the United States. Later, samples were sent to the Veterinary Research Laboratory in Maisons Alfort, France, the Pasteur Institute in Paris, and virology laboratories in Spain and Portugal, on which Brazil depended for specialised consultants who played a vital role in establishing laboratory diagnosis procedures in the country.

Much of the material sent was not suitable for analysis. Material collection was recommended as follows:

a) serum: 10 ml of blood from the jugular vein was to be collected using sterilised syringes, needles and flasks. After coagulation the coagula was to be removed and clean serum sent for analysis (many serum samples were sent to the laboratory haemolised and in a condition unsuitable for diagnosis)

b) organ fragments: the tonsils, lymphatic ganglions (gastro-hepatic, mandible, cervical, internal iliac), spleen and liver were preferred. Separate flasks were to be used for each animal. They were to be sealed carefully and labelled, and sent with the appropriate form to the laboratory within 12 hours of collection, using a thermal box and ice.

Errors noted by the laboratories included forms incorrectly filled in, broken flasks, cotton caps, loss of identification and flask caps, failure to maintain the correct temperature, putrefied material, use of virucidal preservatives, and samples containing organ fragments that were not large enough. These problems led to a significant number of inconclusive or negative results.

Laboratory methods

Laboratory methods and procedures used at this time included the following.

a) A haemoadsorption test, which consisted of the adherence of the haemacias to the cells present in a culture inoculated with virus with haemadsorbing capacity (such as ASF). This, multiplying in the interior of the cell, caused a series of alterations, especially to the cytoplasm membrane. Cultured leukocytes from healthy pigs were used. The cells involved in the reaction are monocytes and macrophages which, when they suffer alteration to the cytoplasm, acquire the ability to absorb the erythrocytes of pigs attacked by the disease present in the exam culture.

b) Immunoelectro-osmophoresis, an immunodiffusion technique whereby the antigen and antibody come into contact and precipitate in agar. The technique used electrophoresis (electrical-current-induced ions in an electrical field migrate to the pole of opposite charge) to produce precipitation bands, reducing diffusion time from between 16 h and 20 h to 1h 30m, reaching 30 min for ASF.

c) Immunofluorescence: conjugation of antibodies with fluorescent substances (fluorophores), so that the antibodies can be identified when combined with the antigen. Two techniques were used:

– the direct technique is used in antigen research. The antibody conjugated with fluorophore is incubated, with the antigen being studied for a few minutes. The specific combination of antigen–antibody acquires fluorescence when lit with ultraviolet light;

– the indirect technique is used in antibody research. The serum being studied, which contains a known antigen (in this case ASF), is incubated then put into contact with the conjugated antiserum. If antibodies appear in the serum being studied (ASF), they are fixed to the antigen and react with the conjugate, acquiring fluorescence when lit with ultraviolet light.

Laboratory results

Table II shows the laboratory results for tests for ASF carried out between 1978 and 1984.

Serology results

Table III shows serology results for ASF samples from 1980 to 1984.

Table II
Laboratory diagnosis of African swine fever in Brazil from 1978 to 1984

Year	Number of samples examined	Number of positive samples
1978	511	207
1979	202	17
1980	270	0
1981	202	7
1982	221	0
1983	427	0
1984	244	0
Total	**2,077**	**231**

Source: (11)

Table III
Serological investigation of African swine fever in Brazil from 1980 to 1984

Year	Numer of sera examined	Positive sera	
		Number	Percentage
1980	49,643	80	0.16%
1981	51,118	48	0.09%
1982	59,506	0	0
1983	86,298	0	0
1984	41,804	0	0
Total	**288,369**	**128**	**0.04%**

Source: (11)

International and national epidemiological factors

According to FAO data (7), the consumption of pork has increased more than that of all other meats in the last 50 years. It grew from 16 million tonnes in 1950 to 88 million tonnes in 2000, with an anticipated consumption of 94 million tonnes in 2050. In the last 10 years, pork has been the most widely consumed meat throughout the world, above poultry (62 million tonnes), beef (51 million tonnes) and sheep and goat meat (16 million tonnes) (7).

This increase in consumption has led to the development and modernisation of pig farming worldwide. The expansion of the international trade in pork and its industrialised products has also increased concerns about pig health. Notification of ASF is obligatory in countries affiliated to the OIE, and the standards contained in the *Terrestrial Animal Health Code* must be observed.

The importance of eradicating ASF has become evident in several countries, because of the serious damage caused to farmers, the high cost of compensation for animals slaughtered on affected farms, the loss of production and profit, and the disruption of commercial activities, as well as indirect damage caused by interruption of the trade in pigs and pig products, e.g. the damage caused to the seed and grain industries. The socio-economic and epizootiological repercussions of ASF have meant that it is considered to be the most threatening illness for world pig farming.

The OIE called an emergency meeting in 1977 to deal with ASF, because there had been a high rate of diffusion of ASFV, with the number of cases increasing in several countries, especially on the Iberian peninsula. Epizootiological studies carried out by the OIE showed the possibility of serious and long-lasting threats to all of Europe. The emergency meeting was held in the city of Ávila, Spain, with representatives from Germany, Belgium, Spain, France and Portugal, and European Union observers. Classic emergency measures were recommended; namely, rapid diagnosis and active surveillance for prompt emergency action, certification of pig farms, creation of an emergency compensation fund with fair and rapid compensation for farmers affected by health measures, and the creation of a Health Defence Council in which the farmers would play an active role.

In the first stage of the eradication of ASF in Brazil, between May 1978 and December 1979, a total of 675 notifications were made, with 713 samples collected for laboratory examinations. Of these, 224 tested positive for ASF in 18 states and 131 tested positive for CSF (11). Between 1980 and 1984, 1,364 samples were collected. Only seven tested positive for ASF in 1981, with an epidemiological silence thereafter.

Active, rigorous surveillance, especially for swine red-disease and swine reproductive diseases, and collection of material for serological examinations were important in controlling the disease. Between 1980 and 1984, 288,369 serum samples were collected. Only 128 tested positive between 1980 and 1981 and none did so from 1982 to 1984, with the positives for the whole period (1980 to 1984) making up only 0.04% of the total (Table III).

The epidemiological study and tracking meant that it was possible to link the primary focal point in Paracambi, RJ, with the outbreak in Ourinhos municipality, São Paulo State, spread through contact between pigs at the Atlantic petrol station as they were transported between Rio de Janeiro and São Paulo. The source of other outbreaks was identified as the use of contaminated CSF crystal violet vaccine. There was a different source for the outbreak in Santa Catarina State: refugees from the war in Angola had landed by boat in Itajaí, bringing with them infected pigs.

It was because of contaminated CSF vaccines that ASF arrived in Paraná via the municipalities of Ourinhos and Jacarezinho, in São Paulo State (10).

On the whole, attack rates in Brazil were generally lower than expected for an exotic virulent infectious disease, except in Paracambi, where an acute form of the disease existed. Nevertheless, it must be noted that ASF did not spread to the maximum possible extent because of the strategy of immediately slaughtering both animals diagnosed with ASF and animals with which they had had contact.

After the emergency phase, rigorous epidemiological surveillance was maintained in an active search for residual cases of the disease. Different strategies were used in different regions of the country, and particularly intense measures were applied in the southern states. This work, together with effective control of CSF vaccine production and increased vaccination coverage, led to a gradual increase in the number of areas free from ASF.

Pig farming in Brazil after African swine fever

There are 40 million pigs in Brazil. The country has the second-largest pig herd on the American continent and the fourth-largest in the world. It is concentrated in the south of the country, which has 44% of the national herd and contributes 73% of the meat production.

An analysis of data from the Agribusiness Commercial Exchange on meat exports from Brazil shows that pork exports increased by 578%, from US$166 million in 1997 to U$1,126 billion in 2007 (12).

Brazilian pork production in 2008 was about 2.8 million tonnes (carcass equivalent) (3). Of this total, internal consumption was 2.3 million tonnes, corresponding to a consumption of 12.7 kg per person, of which 60% was processed and 40% unprocessed. Exports reached 528,000 tonnes, of which 99% was unprocessed and 1% processed. Pork products were exported to 61 destinations, including Russia (53%) and Hong Kong (11%).

These figures make it possible to affirm that Brazilian pig farming not only recovered after the difficult epizootiological experience of ASF, but showed an improved performance after it.

The FAO mission to the Brazilian government produced a report that included virological and epidemiological observations (6) and resulted in the TCP/BRA/0105 Project – Assistance for the Eradication of African Swine Fever in Brazil. The mission included the following scientists: Dr Ramón Carnero Cabrera, virologist from the Central Veterinary Laboratory in Maisons Alfort, France; Dr Robert F. Sellers, epidemiologist, director of the Animal Virus Research Laboratory, Pirbright, United Kingdom (a reference laboratory for the OIE); and Dr Franz J. Peritz, a specialist in preventive veterinary medicine and regional officer for animal production and health, from the FAO Regional Representation in Santiago, Chile.

The virologist on the mission, Dr Cabrera, analysed all serological protocols and diagnoses carried out by the Brazilian laboratories, and organised a seminar with Brazilian technicians at LANARA in Pedro Leopoldo, at which he confirmed that the procedures used in Brazil corresponded to internationally accepted norms. Scientific observations led to the conclusion that 'a functional control system had been established for the control and eradication of ASF' (6). Dr Cabrera also confirmed that the eradication programme that developed from 1978 onwards had worked efficiently, following acceptable norms for the control of ASF. He recommended the creation of a central diagnostic laboratory, with biosecurity installations for isolating animals. In the specific case of ASF in Brazil, especially because of the variable pathogenicity of the causal agent, it was impossible to differentiate ASF from CSF or swine cholera without virological tests, and it was therefore necessary to vary the laboratory tests. As a result, it was thought best to work to eradicate both ASF and CSF simultaneously, which required an efficient surveillance system, supported by a competent system of laboratory diagnosis. Dr Cabrera concluded that the plan presented by the National Secretariat for Agricultural Defence was comprehensive and well planned for achieving the defined objectives.

The first analyses showed that the disease was restricted to Rio de Janeiro State, and the slaughter of the total pig population of the state was proposed to protect the high-technology pig farming in the country. Although this slaughter was carried out, a second outbreak occurred in São Paulo State. In this state, during the period from 1978 to 1982, a total of 52 cases were notified, of which 20 were diagnosed in the laboratory as negative and 32 positive.

Social communication and information-sharing – community participation

Through programmes of social communication and information-sharing, farmers were encouraged to notify illness in pigs. Farmers and veterinarians received telephone numbers for free direct dialling so that they could notify the authorities as easily as possible.

It is clear that pig farmers actively participated in the eradication campaign. In Santa Catarina State, 75% of focal points were notified within 10 days and 82% within 14 days after identification of the first case. Prompt notification is important because if notification is delayed ASF could spread further before the Official Veterinary Services are able to apply eradication measures.

The ASF eradication programme is the largest eradication programme ever to have been implemented in Brazil. It included active community involvement, with pig farmers taking part through their associations. Suggestions were put forward through numerous meetings and directly by community and association leaders. Almost all the suggestions were accepted, including:

– clearing of information for sharing only after careful analysis

– participation of breeder associations at national and state level in the decision process, through official representation on ASF eradication commissions

– training of Brazilian technicians in the laboratory diagnosis of ASF

– participation of technicians from countries that have experienced the disease (Portugal, Spain, France, Italy, Cuba) in the development of control methods for the disease

– the creation of specialised laboratories for the diagnosis of ASF in southern states

– training of field agents, including international representatives, for preliminary diagnosis on the farm

– policies to compensate farmers for animals that are slaughtered, as a stimulus to reporting incidences of sickness

– commercialisation and campaigns to encourage the use of vaccines against CSF

– the urgent federalisation of meat inspection in abattoirs where pigs are slaughtered and/or meat products are produced

– a national campaign to stimulate the consumption of pork and other products made from pigs

– the guarantee by the National Supply Superintendency (*Superintendencia Nacional do Abastecimento*) to maintain pork availability in abattoirs and supermarkets, through pork meat price control relative to other meats

– revision of prices paid to the industries by the Brazilian National Supply Company (*Companhia Nacional de Abastecimento*) to guarantee a minimum price equivalent to eight times that of the same weight of corn (according to final conclusions presented by the associations to the government during the development of the National Plan for the Development of Pig Farming)

– an urgent official assessment of the prospects for the survival of Brazilian pig farming, at technical and political levels, based on the reality of disease in the country.

Role of national media

At the time of the outbreak Brazil was going through a phase of political liberalisation, which included the revoking of institutional acts in 1978 and redemocratisation following the end of the military regime which had been imposed in Brazil in 1964. The Brazilian press fulfilled its investigative role, creating a platform for divergent opinions. At times this confused the public because of the variety of opinions expressed. The ASF crisis was given headline coverage in all Brazilian newspapers, including the front pages and economic and political sections, as well as specialised agricultural sections. This led to the formation of a social conscience about animal health and participation in the decision-making process.

The approach to ASF eradication was democratic, free and independent, with no censorship in communication. As a result there was a large degree of participation by organised civil society through associations, syndicates and federations. The federal and state authorities acted firmly and with technical expertise to meet the objectives of the eradication programme, from the identification of the primary point of outbreak onwards. The national press had never before had the same degree of freedom to investigate an issue that it had with ASF.

The ASF outbreak coincided with a visit from Prince Akihito, heir to the throne of Japan, to commemorate 70 years of Japanese migration to Brazil (Brazil has the largest population of Japanese origin of any country outside Japan). But even this visit received less attention from the media than ASF.

The role of official bodies in the African swine fever eradication process

Official bodies, especially the Brazilian Society of Veterinary Medicine and the Federal Council of Veterinary Medicine, had important roles in the continuous formation and execution of plans during the ASF outbreak. As ASF was an exotic illness, it had not been well studied in the academic field. Congresses, symposiums and training courses played an important role in the standardisation of concepts, diagnostic methods, and guidelines for sample collection for laboratory and differential diagnosis. These bodies arranged for official notes and pamphlets, advertised the evolution of the disease in the national media, and took steps to inform veterinary professionals and answer their questions. Private veterinarians were ill prepared to control this disease and the standardisation of procedures for veterinary professionals in Brazil was one of the most important means of

distributing knowledge about ASF. The ASF outbreak could have had a smaller impact if veterinary professionals had been better prepared to take emergency measures (17).

Financial resources

The direct and indirect costs of emergency actions reached US$13 million, including compensation for the loss of income from the slaughter of 66,902 pigs. As well as direct losses, there was a reduction in pork consumption of 40% and a consequent reduction in the slaughtering trade. This had a negative effect on the sector, with many small producers leaving the business. The emergency action caused unemployment in 2,000 families who depended on pig farming (15). Lost profits are not included in these figures. The financial resources spent in the eradication of ASF are shown in Table IV.

Table IV
Federal resources in the Brazilian African Swine Fever Eradication Programme from 1978 to 1986

Phase	Value in ORTN	Value in US$	Value in R$[a]
Emergency (1978–1979)	1,796,984	10,835,885	24,922,535
First stage (1980–1983)	358,865	2,163,994	4,977,186
Second stage (1984–1986)[b]	1,312,328	7,913,327	18,200,652
Total	**3,468,177**	**20,913,206**	**48,100,373**

ORTN – *Obrigação Reajustável do Tesouro Nacional* (government-indexed public debt securities adjusted automatically for past inflation)
(a) Brazilian real (b) Estimated values
Source: (11)

However, in Brazil, the eradication of ASF cost less than in other countries. In Portugal the eradication campaign lasted for 42 years, initially using vaccination and other relatively inefficient methods, which led to the spread of the disease to the whole Iberian peninsula and France. The Republic of Cuba slaughtered more than 500,000 pigs in two stages during a decade-long eradication programme. The Dominican Republic and Haiti slaughtered their entire swine population, after unsatisfactory results with the initial selection of areas and animal categories, and Italy has still not solved the problem of ASF, which persists on the island of Sardinia.

Brazilian legislation that supported the eradication

The successful and rapid eradication of ASF in Brazil was also due to recent changes in Brazilian legislation and ministry structures. The organisation of the animal health sector in Brazil dates from the beginning of the 20th Century. The Division of Veterinary Medicine and Health Inspection of Cattle was created through Decree no. 7.622 of 21 October 1909, as an integral part of the Animal Industry Department. This body was responsible for the following:

– study of animal illnesses

– preventive measures against epidemics

– animal health inspection of animal shows, markets, housing and abattoirs

– the fight against the spread of epidemics

– inspection of imported animals

– disinfection of wagons and vehicles used to transport animals.

In Article 11 of the Decree, an Epidemic Prevention Unit was created in the Osvaldo Cruz Institute, Manguinhos, Rio de Janeiro, with 'laboratories and installations necessary for its functioning'. This Unit was also responsible for inspection of animals imported through the port of Rio de Janeiro.

The present structure of MAPA, with a few modifications, is a result of the restructuring carried out in 1977 by Decree no. 80.831 of 28 November (8), which approved its basic structure, and introduced a systematic administration system, uniting all animal and agricultural activity in a single secretariat. It also covered hygiene, health and technological inspection of products (meat, milk, grain, vegetables, etc.) and of basic inputs (medication, vaccines, rations, semen, seeds, etc.) used in animal and vegetable production.

Animal health surveillance in MAPA evolved considerably during this period (1909 to 1977). Legislation of the time shows the concern of the government with epidemics, disease research and the preparation of biological and chemotherapy products. The decrees also called attention to the use of prophylactic measures, and control of animal transport and animal products, to prevent exotic illnesses entering the country.

Thus, article 19 of Decree 80.831 specified:

'Art. 19 – The National Secretariat for Agricultural Defence has to manage and execute the activities of health protection, inspection and quality control of products of animal and vegetable origin; control inputs used in agricultural activities; orientate, coordinate, supervise and control the activities of the network of laboratories that support defence, inspection and control activities; develop and promote the implementation of national programmes for control of diseases and plagues which could have economic consequences for the agriculture industry.'

Article 20 of the same Decree made overt reference, for the first time, to specific means of exotic disease eradication:

'Art. 20 – Actions for control and eradication of exotic and emerging diseases in animals and plants, which put the national economy at risk, are defined in specific acts.'

Another innovation was the subordination, from a technical point of view, of federal superintendents to the National Secretariat for Agricultural Defence, in Article 29.

'Art. 29 – Federal agricultural superintendents, administratively subordinate to the General Secretariat, represent the Ministry of Agriculture in the States, in the areas of competence which were delegated to them by the Minister of State, and promote the implementation of projects to protect, inspect and oversee the financing of agriculture, under the orientation of the National Secretariat for Agricultural Defence.'

The National Reference Laboratory for Animals and the National Reference Laboratory for Vegetables were created for technical support, and later joined together to form the National Reference Laboratory for Agriculture (*Laboratorio Nacional Agropecuário*).

The ASF outbreak provided a test for this new structure, and certainly this episode improved the workings of the structure and created, at various levels of government and society, an awareness of the need to eradicate diseases. Brazil today has a structured programme for the eradication of foot and mouth disease and vesicular illnesses, CSF and poultry diseases. To support this, there is a large-scale Programme of Prevention and Containment of Highly Pathogenic Avian Influenza.

Conclusions

The success of the Brazilian programme for the eradication of ASF was due to the Government's speed and efficiency in taking action, in contrast to the situation in Spain and Portugal, where the viral activity lasted four decades. The Brazilian programme was one of the most audacious ever undertaken, and had great participation by civil society, represented by members of the pig-production agribusiness, as well as veterinarians and other professionals from the private and public sectors.

Acknowledgements

Thanks are due to the Brazilian Ministry of Agriculture and the National Science and Technology Institute for Information on the Health and Genetics of Brazilian Livestock (CNPq Instituto Nacional de Ciencia e Tecnologia – Informação Genético-Sanitária da Pecuária Brasileira).

Étude sur le foyer de peste porcine africaine survenu au Brésil en 1978 et sur son éradication

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Résumé

Les auteurs analysent le foyer de peste porcine africaine survenu en 1978 dans la localité de Paracambi, état de Rio de Janeiro, Brésil, ainsi que les mesures mises en œuvre par les autorités brésiliennes pour éradiquer la maladie. La présence de la peste porcine africaine dans le pays a été confirmée par isolement du virus, lequel a été soumis au Laboratoire du Plum Island Disease

Center de New York, États-Unis, pour analyse et caractérisation. Le ministère de l'Agriculture brésilien n'a pas attendu les résultats du laboratoire pour décréter l'état d'urgence zoosanitaire et des mesures de lutte ont été rapidement prises par les Services vétérinaires officiels afin de maîtriser et d'éradiquer la maladie. Ces mesures de lutte ont contribué à réorganiser le secteur de la production porcine dans le pays et favorisé le recours à des pratiques de production à forte technicité ; elles ont également permis de mieux sensibiliser les éleveurs aux problèmes sanitaires au niveau des troupeaux. Tout cela a contribué à faire du Brésil le premier exportateur mondial de viande.

Mots-clés
Brésil – Épidémiologie – Éradication – Maladie exotique – Peste porcine africaine – Porc.

Análisis del brote de peste porcina africana que afectó el Brasil en 1978 y de su erradicación

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Resumen
Los autores hacen balance del brote de peste porcina africana (PPA) que se inició en 1978 en el municipio de Paracambi, estado de Rio de Janeiro (Brasil), y de las medidas adoptadas por las autoridades brasileñas para erradicar la enfermedad. El aislamiento del virus confirmó la presencia de PPA en el país, cuya patogenicidad certificó el laboratorio del Plum Island Disease Center de Nueva York (Estados Unidos). Aun antes de disponer de los resultados del laboratorio, el Ministerio de Agricultura brasileño ya había declarado una emergencia zoosanitaria, a raíz de lo cual los Servicios Veterinarios oficiales adoptaron rápidas medidas de control para contener y erradicar la enfermedad. Dichas medidas contribuyeron a la reorganización de la industria porcina nacional y estimularon el uso de técnicas de producción punteras, junto con una mayor conciencia de todo lo relacionado con la salud de las piaras. Todo ello contribuyó a hacer del Brasil el mayor exportador de carne del mundo.

Palabras clave
Brasil – Cerdo – Enfermedad exótica – Epidemiología – Erradicación – Peste porcina africana.

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