Review of the status of foot and mouth disease and approach to control/eradication in Europe and Central Asia


1) European Commission for the Control of Foot and Mouth Disease (EUFMD), Animal Production and Health Division, Food and Agriculture Organization (FAO), Via delle Terme di Caracalla, 00100 Rome, Italy
2) Animal Health Service (AGAH), Food and Agriculture Organization (FAO), Via delle Terme di Caracalla, 00100 Rome, Italy

Summary
The authors describe the situation of foot and mouth disease (FMD) in Europe over the past 70 years and analyse the origin of the disease and methods of control, particularly since preventive vaccination was banned in Europe in the early 1990s. Since then, and until 2001, despite several incursions of the virus, the disease has always been contained and eradicated rapidly. Therefore, the ban on vaccination did not result in an increase of FMD outbreaks. However, the massive outbreak which took place in 2001 in the United Kingdom (UK) with 2,030 outbreaks, raised questions on the policy utilised to date to control the disease in Europe. In future, the utilisation of ring vaccination should be considered as an alternative to mass culling of large numbers of animals. Based on the recent source of introduction of the virus, the authors review the lines of defence which should be reinforced to reduce the risk of further introduction of the disease. The FMD situation in the Commonwealth of Independent States (CIS) is also examined. The situation in the Central Asian Republics and the Caucasian region deteriorated after the collapse of the Soviet Union, despite the continuous effort of Russia to support these countries. International support is needed to prevent FMD from becoming endemic in the region.

Keywords
Asia – Control – Europe – Foot and mouth disease – Prevention – Vaccination.

Introduction
Foot and mouth disease (FMD) is the most important of the Office International des Epizooties (OIE: World organisation for animal health) List A diseases due to the effect the disease has on trade (1, 22). In the past, the disease has ravaged European livestock, but has been gradually brought under control, at great cost, by preventive vaccination programmes, supplemented by destruction of infected herds in most of the countries of continental Europe and, in the United Kingdom (UK) and Nordic countries, by destruction of infected herds alone.

Between 1962 and the late 1980s, cattle populations were vaccinated annually in most countries in continental Europe and the number of outbreaks due to endemic strains of foot and mouth diseases virus (FMDV) diminished gradually (Fig. 1). During this period, the European Commission for the Control of Foot and Mouth Disease (EUFMD Commission) focused efforts on preventing the introduction of the exotic strains of FMDV into Europe by establishing a buffer zone in the Thrace region of Turkey.

At the end of the 1980s, it became apparent that there were no endemic foci of the disease in Europe, nor indeed in the countries bordering Europe to the east. After careful evaluation of the two possible options for preventing the re-occurrence of the disease in Europe – to either continue or discontinue preventive mass vaccination – the European Union (EU) decided to prohibit all vaccination after 1991.

However, FMD remained and is still endemic in the Middle East, including in Asian Turkey (Anatolia) and despite efforts of the Governments of Turkey and of Europe, Anatolia appears to
be a permanent source of sporadic outbreaks in the Balkans and a threat to Europe (Fig. 2). In recent years, FMD was reported mainly in the Balkans: in Turkish Thrace in 1995, in 1996 and 2001, in Greece in 1994, 1996 and 2000 and in Bulgaria in 1993 and 1996.

Despite these occasional incursions of FMD into south-east Europe, in all cases, the control measures were efficient and the disease never spread to such an extent as to become endemic. In Italy in 1993 and in Greece in 1994 and 1996, the disease was controlled by stamping-out (Fig. 3 and Fig. 4). In Albania...
and in the Former Yugoslav Republic (FYR) of Macedonia, in 1996, ring vaccination was carried out in addition to the sanitary measures taken (Fig. 5). The two single outbreaks, which occurred in Bulgaria in 1993 and 1996, were controlled respectively by stamping-out and ring vaccination, and by stamping-out and restriction of animal movements only.

A major outbreak which affected 2,030 farms occurred in the UK between February and September 2001. This was the first major epidemic of FMD in Europe since preventive vaccination had been abandoned in continental Europe in 1991. The disease was eventually controlled by stamping-out of infected herds and flocks and pre-emptive culling on neighbouring and contact farms. This outbreak resulted in major economic losses and massive destruction of infected as well as healthy animals, with a negative impact on public opinion in the UK and in Europe. The disease also spread to Ireland, France and the Netherlands although the number of outbreaks was limited in these countries. This led the EU to re-examine current policies and to look for alternative measures to the massive culling of animals for disease control purposes. An international conference was convened in Brussels on 12-13 December 2001 for this purpose and the policy of Europe is currently under review to ensure that such a dramatic outbreak will not occur again.

This paper is intended to review the history of FMD in Europe and to draw lessons from this history on how to reduce the risk of introduction of the disease into Europe. The paper also includes a review of the situation of FMD in the Commonwealth of Independent States (CIS) in the recent past.

History of foot and mouth disease in Europe

Foot and mouth disease in Europe up to the 1950s

Foot and mouth disease has been known in Europe for centuries. The European Continent has repeatedly been affected by diseases originating in the Middle East, Asia and sometimes Africa. This is particularly true for FMD. The pattern of the disease has been characterised in the past by periodic
epizootics which were often the obvious extension of situations prevailing in neighbouring regions. Disastrous epizootics swept across the continent at intervals of five to ten years and involved large numbers of susceptible animal populations. Between epizootic waves, the disease continued to occur, sporadically or endemically, in those regions with high animal concentrations or animal movements (16).

Eastern Europe was severely exposed, until 1910, to disease outbreaks occurring in Asia, from where epizootics used to sweep westward across Russia.

In the past, infection also originated in North Africa (5), the most dramatic example being the 1937-1939 epizootic which occurred in France and rapidly spread into Europe. This most ravaging panzootic caused some two million outbreaks on the continent where the most severely affected countries were Germany (700,000 outbreaks), France (378,000 outbreaks), the Netherlands (265,000 outbreaks), Czechoslovakia (240,000 outbreaks), Poland (234,000 outbreaks) and Belgium (102,000 outbreaks). During this epizootic, the Waldmann inactivated vaccine was tested in the field in Germany with promising results (2).

After the Second World War, all three European types, i.e. O, A, C, of the disease continued to be endemic in various countries. During this period, the disease was usually contained by ring vaccination.

The last true panzootic occurred in 1951, when a new subtype (A5) of type A virus found ideal conditions for spread in western Europe. A massive spread of outbreaks started in the Rhine region while the causal virus had been isolated one year earlier in south-eastern Europe. In two years, over 900,000 outbreaks were declared, the most affected countries being Italy (430,000 outbreaks), France (330,000 outbreaks), the Netherlands (280,000 outbreaks), the Federal Republic of Germany (204,000 outbreaks), Belgium (59,000 outbreaks), Greece (57,000 outbreaks) and Denmark (28,000 outbreaks). The cost of the 1951-1952 epizootic amounted, according
to the Food and Agriculture Organization (FAO) inquiries, to US$600 million but losses would have been higher had vaccination not succeeded in blocking or slowing down the course of the disease in several countries. After this episode, governments realised that individual action was insufficient to bring FMD under control, and co-ordinated efforts at the European level were needed (6).

The 1950s mark the advent of mass vaccination, systematically applied over large European regions and, as a result, the decline of disease incidence in a steadily increasing number of countries (Fig. 1). From epizootics, the disease pattern changed to regional involvement and later, to sporadic occurrence. As a result of these achievements, the point major vulnerability shifted to the south-east where conditions combine with persisting exposure to infections raging uncontrolled in the Near East. The most vulnerable country is Turkey, with the Anatolian peninsula open to infections along 2,000 km of border. With animal production concentrated in eastern Anatolia and the consumption centres located in western Turkey, the trend has been for epizootics to spread through animals and meat supplies from the east of the country to reach the Bosphorus area.

The indiscriminate introduction into the Near East of slaughter animals originating from infected countries in eastern Africa, Asia and elsewhere also constitutes a significant hazard, keeping Europe under a permanent threat of invasion, especially by exotic types and subtypes of the virus.

From 1962 to 1989, prevention against the introduction of exotic foot and mouth disease virus strains into Europe from the Middle East through Turkey

Since the establishment of the EUFMD Commission in 1954, activities have been focused on Turkey and the Balkans with the following objectives (6):

– immediate objective: establishment of a buffer zone of vaccination in Thrace where favourable physical conditions exist for concentrating efforts in a relatively small and easily defensible area

– middle-term objective: to develop technical infrastructures, including vaccine production units, which would allow a shift of the buffer zone system to eastern Anatolia at a later stage

– long-term objective: strengthening of the surveillance and control of the disease in Turkey.

Between 1962 and 1987, thirty vaccination campaigns were carried out either to establish or to maintain buffer zones in Thrace and in south-eastern Europe.

These campaigns were conducted in response to the threat of exotic virus to Europe (Fig. 2), as follows:

– SAT 1 campaigns (1962-1964)
– A22 campaigns (1965-1966)
– A22 and Asia 1 campaigns (1972-1975)

The campaigns were supervised by a tripartite FAO/European Economic Community (EEC)/OIE Committee.

During this period (1962-1987), 25 million doses of vaccine at a cost of US$12 million were supplied by Europe through the FAO. This sum was calculated to be the equivalent of US$0.12 per head of cattle owned by the 18 contributing countries, spread over a period of 25 years.

Parallel to the FAO-EUFMD campaigns, action was taken by the Soviet Union and Romania to protect their frontier areas against invasion by exotic viruses. The latter action, which also contributed to the defense of Europe, is not dealt with here (7).

1989-1991, moving towards a non-vaccination policy

At the end of the 1980s, the European Commission (EC) decided to implement a single policy for the then twelve EU member countries to facilitate the exchange of animals and animal products within the Union. The agreed policy was to move towards a non-vaccination policy and the then eight EU countries which vaccinated cattle preventively, were asked to ban this preventive vaccination. This decision was preceded by an economic study comparing a stamping-out policy as employed in four Member States with a vaccination and stamping-out policy, employed by the remaining eight States (4). The costs of implementing the two alternative policies were compared. The analysis required a prediction of the number of outbreaks that would occur over a ten-year period under the two alternative policies, based on the experience of Member States already employing the two strategies under comparison. The outcome was a prediction that a non-vaccination policy would result in between 13 and 1,963 (central estimate 273) outbreaks over the ten year period (Table I) compared with an estimate of between 20 and 3,020 – central estimate 420 – outbreaks for a policy based on vaccination (not shown).

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Number of outbreaks</th>
<th>Costs (million Euro)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Best case</td>
<td>13</td>
<td>0.337</td>
</tr>
<tr>
<td>Central case</td>
<td>13</td>
<td>35</td>
</tr>
<tr>
<td>Worst case</td>
<td>13</td>
<td>955</td>
</tr>
</tbody>
</table>

Table I

Predicted outcome of a non-vaccination policy in the European Community (ten-year period)
The non-vaccination policy was officially endorsed by EC Council Decision No 90/423/EC of 24 June 1990 which fixed the deadline of 1 January 1992 to discontinue FMD vaccination in EU countries. The EU trading partners from eastern Europe immediately followed the same measure. This Directive which banned vaccination in Europe, made it obligatory for member countries to set up an FMD contingency plan defining the measures to be taken in case of introduction of FMD. The contingency plans for EU countries needed to be approved by the EC. The Directive also foresaw the possibility of using emergency vaccination to control the disease and the European Vaccine Bank was created. A large stock of antigens for emergency vaccination was stored in antigen banks to immunise susceptible animals in case of need. It is worthwhile mentioning that this possibility of using emergency vaccination has never been employed so far in the EU, mainly because of trade restrictions imposed against countries that vaccinate. Instead, vaccine produced from the antigens stored in the bank has been provided to countries neighbouring the EU (Albania and FYR of Macedonia in 1996) in order to help them to rapidly control the disease and to prevent the risk of introduction into Europe. The European Vaccine Bank also lent appropriate antigens and vaccines to countries under immediate threat (Algeria and Morocco in 1999 and the Republic of Korea and Japan in 2000).

**Foot and mouth disease outbreaks in Europe from 1991 to 2000**

Since 1991, FMD has regularly been introduced into Europe (8, 9, 10, 11, 17, 18). Outbreaks occurred in 1991 in Bulgaria (type O), in 1993 in Italy, Bulgaria and Russia (type O), in 1994 in Greece (type O), in 1995 in Turkish Thrace and in Russia (type O), in 1996 in Albania, FYR of Macedonia (type A), and in Turkish Thrace, Bulgaria and in Greece (type O) and in 2000 in Greece (type Asia 1) (Table II).

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of outbreaks</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1991</td>
<td>Primary: 1 (Bulgaria)</td>
<td>Secondary: 0</td>
</tr>
<tr>
<td>1992</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>1993</td>
<td>Primary: 3 (Italy, Bulgaria, Russia)</td>
<td>Secondary: 56</td>
</tr>
<tr>
<td>1994</td>
<td>Primary: 1 (Greece)</td>
<td>Secondary: 94</td>
</tr>
<tr>
<td>1995</td>
<td>Primary: 2 (Turkish Thrace, Russia)</td>
<td>Secondary: 0</td>
</tr>
<tr>
<td>1997-1999</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2000</td>
<td>Primary: 3 (Greece)</td>
<td>Secondary: 11</td>
</tr>
</tbody>
</table>

**Table II**

**Actual outcome of the non-vaccination policy in Europe over 10 years (1991-2000)**

The history of individual outbreaks and the measures taken for controlling the disease are reviewed below.

**Bulgaria 1991**
The type O outbreak which occurred in Bulgaria in July 1991 at the border with Turkey was brought under control by stamping-out of all animals on infected premises and by ring vaccination.

**Italy 1993**
The epidemic of 53 cases (type O) which occurred in Italy followed the introduction of cattle via Prosecco, near Trieste, from a neighbouring country through the port of Bari. The cattle were destined for slaughterhouses in the Basilicata and Campania Regions but some were sold to farmers, mainly in the south, except for one shipment, which after a short time in the south, went to the Roverchiara district of Verona Province in the north-east. When the cattle entered Italy, they were accompanied by animal health certificates which were later shown to be false. The real origin of the imported cattle and how or where they became infected has not been established but the sequencing by the World Reference Laboratory (WRL) for FMD of a portion of the genome of the virus and comparison with sequences for other contemporary type O viruses indicated a Middle Eastern origin.

**Bulgaria 1993**
The outbreak in Bulgaria occurred in cattle near the village of Simeonovgrad, Haskovo Region, about 60 km from the border with Turkey. The disease was brought under control by stamping-out.

**Russia 1993**
One type A FMD outbreak was reported in cattle in Russia in the vicinity of the All Russian Research Institute for Animal Health (ARRIAH), Vladimir, due to a leakage of virus from the Institute. This was controlled immediately by a combination of stamping-out and ring vaccination.

**Greece 1994**
A major outbreak of type O occurred in Greece in August 1994. The disease was introduced in the sheep population of Lesbos Island in July and remained unnoticed until August when a consignment of infected sheep were transported to the mainland and contaminated cattle which showed clinical signs of the disease. A total of 95 cases were recorded on Lesbos Island and on the mainland as follows: Lesbos Island 23, Xanthi Prefecture 49, Rhodopi Prefecture 15, Chalkidiki Prefecture 2, Evros Prefecture 5, Serres Prefecture 1 (Fig. 4) (19). The disease was most probably introduced to Lesbos through illegal sheep trade from Turkey.

The disease was controlled by stamping-out. The last outbreaks were observed on Lesbos Island on 3 September, in Xanthi Prefecture on 14 September and in Evros on 21 September.
five outbreaks in Evros were considered as having another origin and virus was probably re-introduced.

Russia 1995
One type O FMD outbreak in pigs was reported in Russia in the vicinity of Moscow in June 1995. All pigs on the infected farm, totalling 5,800, had been vaccinated first and were later slaughtered and buried within the infected perimeter. The following additional measures were taken:
– disinfection and sanitation measures were implemented on the infected premises
– all pigs, bovines and small ruminants in the Moscow region were revaccinated.

Restriction measures were lifted at the end of July and the territory of Russia was again declared free of FMD. The likely origin of the outbreak was contaminated imported meat from the Far East.

Turkish Thrace 1995
One type O outbreak was reported on 20 March 1995 in Ulukonak, Karklareli Province, Thrace region. The strain characterised at the WRL was very close to those isolated previously in Turkey and in Greece in 1994. Strict quarantine measures were implemented and a limited number of animals, i.e. 5,020 cattle and 5,585 sheep in the six villages within a 10-km radius were vaccinated twice with a bivalent O and A type vaccine. Sera collected from small ruminants in six villages (i.e. 14 samples per village) around the infected village of Ulunak before vaccination had been tested in the Sap Institute in Ankara. All were found negative for antibodies to FMD types O and A.

Balkans 1996
A type A epidemic started in Albania where FMD was confirmed in May in the District of Korce in south-eastern Albania. Ten villages were infected. Clinically affected animals were destroyed at the time of disease and a programme of slaughter of the remaining susceptible animals in the infected households/villages was completed later. Foot and mouth disease virus type A was isolated and the nucleotide sequencing of the outbreak strain by the WRL showed the virus to be very closely related to a strain circulating in India and Saudi Arabia. Two-round ring vaccination with A22, Iraq strain vaccine was carried out within a radius of approximately 50 km around Korce. A total of 266,048 animals were vaccinated twice at three- to four-week intervals.

Foot and mouth disease was reported in June in the FYR of Macedonia. A total of seventeen outbreaks occurred in the Skopje District and one in Titov-Veles District. The cattle population – total 4,360 – in the 18 infected villages was stamped-out. Two rounds of vaccination of cattle were carried out and approximately 120,000 cattle were vaccinated around the affected villages.

The Veterinary Services of the Federal Republic of Yugoslavia reported FMD in Kosovo, close to the border with Macedonia on 7 July. In total, 101 villages were declared infected and a stamping-out policy was applied. The last report dates to 2 August. However this was not confirmed by the expert mission which visited the country in October and no infected animals were detected by serology.

The EUFMD/FAO and EC supported the countries in the control of the disease and a regional strategy was adopted and implemented under the guidance of European experts. This is a good example of how the disease can be rapidly and efficiently controlled with a combination of stamping-out and ring vaccination. The example also demonstrates that a regional co-ordinated approach to the control of an FMD outbreak involving several countries is essential (Fig. 5) (11).

Turkish Thrace, Bulgaria and Greece 1996
Two outbreaks of type O FMD were reported in Turkish Thrace in May and June 1996, in the Province of Edirne close to the borders of Bulgaria and Greece. Both outbreaks were associated with the illegal movement of cattle from markets on the Asian side of Istanbul to the villages where the outbreaks occurred. The outbreaks were controlled by the destruction of affected animals, disinfection, movement restrictions and ring vaccination with a bivalent O and A vaccine.

The disease was also introduced into Greece and Bulgaria. Between 3 July and 30 September, 39 outbreaks of type O were reported in the Prefecture of Evros in eastern Greece, bordering Turkish Thrace. It was considered likely that the disease had spread across the border. A stamping-out policy was applied and no vaccination was carried out.

On 26 October, a single outbreak of type O was reported in the District of Jambol, Bulgaria, close to the border with Turkish Thrace. Infected and in-contact animals were destroyed. Protection measures were taken and no vaccination was applied.

Bulgaria and Greece regained their OIE status of ‘FMD-free countries without vaccination’ in September 1997 (22). No FMD outbreaks occurred in Europe between October 1996 and June 2000.

Greece 2000
Foot and mouth disease virus Asia 1 strain was last recorded in Greece in 1961, in Evros Prefecture. Foot and mouth disease was suspected on 10 July 2000 and confirmed on 11 July 2000 in the Evros Delta on the border of Greece and Turkey.

Foot and mouth disease virus Asia 1 type was isolated. The nucleotide sequencing data from the WRL demonstrated that the FMDV strain isolated in Greece was very similar to the FMDV type Asia 1 strains isolated in Asian Turkey in 1999 and 2000. In total, 14 outbreaks were reported and approximately
5,400 bovines, 2,300 sheep/goats and 300 pigs were killed and destroyed either within the perimeters of the outbreaks or on in-contact holdings.

According to the Authorities in Greece, there were three primary incursions of FMD along a 60 km front of the Evros River. In all cases, the working hypothesis for transmission was direct or indirect contact with animals across the border. Spreading of FMD to Xanthi was due to the ‘human factor’.

Eradication of FMD was achieved by applying a stamping-out/non-vaccination policy and verified by serological investigation (12).

**Summary of the foot and mouth disease outbreaks in Europe between 1991 and 2000**

The non-vaccination policy has been in operation in Europe for more than ten years and Table II shows the outcome in terms of occurrence of FMD. The number of primary outbreaks amounted to 21, i.e. 2.1 per year, which is approximately double the EC prediction (1.3 primary outbreaks per year as indicated in Table I). However, the EC prediction had been prepared for the then twelve EU member countries and the above calculation refers to 40 countries in Europe and includes EU and non-EU countries. Until the end of 2000, the number of secondary outbreaks following primary outbreaks was equal to 15.3 (322/21), which is less than the estimate of the EC scenario indicated in Table I (20 secondary outbreaks following primary outbreaks).

The number of primary and secondary outbreaks observed is therefore roughly in accordance with EC expert predictions and the change of policy towards non-vaccination did not result in an increase in the incidence of FMD. It must be underlined that the events of 2001 in the UK and in Europe are not related to the modification of the FMD policy in 1991: the UK never practised preventive vaccination of cattle and the spread of the disease within the UK and later to Ireland, France and Netherlands occurred mainly by movements of sheep which were also not previously vaccinated.

The non-vaccination policy adopted by the EC and other countries in Europe was, therefore, considered as appropriate until the major outbreak in the UK in 2001. Between 1991 and 2000, despite the 21 introductions of FMD from infected countries surrounding Europe, the outbreaks were controlled rapidly on each occasion either by stamping-out only or by stamping-out associated with ring vaccination (Table III) and always with limited spread and at low cost (Fig. 1 and Fig. 6) by comparison with the outbreak which occurred in the UK in 2001.

The FMD situation in the world deteriorated in 1999 and 2000 and the risk of introduction of disease into Europe increased. At the end of 1999, and in early 2000, the Executive Committee of the EUFMD Commission warned member countries of the accrued risk of introduction of FMD into Europe and asked them to reinforce their preventive measures (13, 14). It is in this context that FMD occurred in the UK in February 2001 and spread to continental Europe.

**The outbreak of foot and mouth disease in the United Kingdom and in Europe in 2001**

**The United Kingdom**

The last outbreak of FMD on the British mainland was in 1967/1968. The source was attributed to infected sheep meat imported from Argentina. The outbreak was controlled by stamping-out. Control of the outbreak involved the slaughter of some 400,000 animals at a cost, in current terms, of around 1.75 billion pounds sterling. The disease and the virus were eradicated within six months. In recent years, the main threat of the introduction of FMD into the United Kingdom has been perceived to be from incursions overland from the periphery of western Europe.

In February 2001, the pan-Asian Otopotype FMDV spread to the UK. This strain emerged in the Indian sub-continent in the early 1990s and has since spread, causing widespread disease, including outbreaks in countries which had been free of FMD, or of this subtype, for long periods of time. Examples include the spread north to Pakistan, Mongolia and Russia, east to Malaysia, the Republic of Korea, Vietnam and Japan, west to Iran and Turkey, and south to South Africa.

The first outbreak in the United Kingdom was diagnosed on 20 February 2001 in pigs at an abattoir near Brentwood, Essex. This outbreak was linked to a premise feeding swill near Heddon, Northumberland which was probably infected in early February and the source of the epidemic. Airborne virus from there infected a nearby cattle and sheep holding in mid-February, i.e. before the first outbreak was confirmed in Essex.

---

**Table III**

<table>
<thead>
<tr>
<th>Year</th>
<th>Country</th>
<th>Number of outbreaks</th>
<th>Stamping-out only</th>
<th>Stamping-out associated with vaccination</th>
</tr>
</thead>
<tbody>
<tr>
<td>1991</td>
<td>Bulgaria</td>
<td>1</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>1993</td>
<td>Italy</td>
<td>57</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>1994</td>
<td>Greece</td>
<td>95</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>1995</td>
<td>Turkish Thrace</td>
<td>1</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>1996</td>
<td>Bulgaria</td>
<td>1</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Macedonia</td>
<td></td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Federal Republic of Yugoslavia</td>
<td></td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>Turkish Thrace</td>
<td>2</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Greece</td>
<td>39</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>Bulgaria</td>
<td>1</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>2000</td>
<td>Greece</td>
<td>14</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>
The movement of infected sheep from Northumberland through a series of markets resulted in extensive spread in the north-west and south-west of England. Additional movements of sheep resulted in the dissemination of the virus to Scotland, Wales, Northern Ireland, Republic of Ireland and France. Calves that had been in contact with sheep imported into France from the UK spread the virus to the Netherlands (Fig. 7). A summary of the consequences of the episodes in the different countries is provided in Table IV.

The clinical signs were extremely mild in the vast majority of outbreaks involving sheep. The average number of sheep displaying lesions within a single flock was less than 5%. The lesions occurred mainly in the mouths of sheep. A small minority of sheep exhibited foot lesions or lameness. The virus caused severe clinical disease in cattle and pigs (15).

Western Europe
The disease spread through animal movement – mainly sheep – from Great Britain to Northern Ireland (4 foci), the Republic of Ireland (1 focus), France (2 foci) and the Netherlands (26 foci) by early March 2001. Early warning and prompt action, including stamping-out and emergency vaccination (in the Netherlands), controlled the disease in all the countries infected via the UK.

These countries, including the UK, have since regained the OIE status of FMD free without vaccination (22).
Turkish Thrace
The other region in Europe affected during 2001 was Turkish Thrace where, in June, type O virus was confirmed in a flock of goats in the Malkara District, Tekirdag Province. Infected animals brought in from Asian Turkey by dealers were suspected to have caused the outbreak. The outbreak was controlled by ring vaccination.

Analysis of the outbreaks which occurred in Europe in 2001 and future threats
Although the risk of introduction of FMD into Europe was high at this point, the outbreak which occurred in the UK in 2001 and the spread of the disease to continental Europe was totally unexpected. This is illustrated by the result of the analysis of the risk of introduction of FMD into Europe carried out by the EUFMD Commission Research Group in September 2000 (14). The analysis was based on elicitiation of expert opinions. For this exercise, Europe was split into five regions: the Balkans, eastern Europe, southern Europe, western Europe and Islands. The experts estimated that if FMD was likely to be introduced ten times into Europe during the next five years, six introductions would occur in the Balkans region and only 0.2 in the Islands region. For all experts, the risk of introduction of FMD into the UK was considered as very low. The main reason for this perceived low risk of FMD introduction was the relative geographic isolation of the UK and the great distances of the UK from FMD-endemic areas. The UK is also the country which developed the concept of contingency planning and emergency preparedness and up to the occurrence of FMD in 2001, the capacity of the UK Veterinary Services to control FMD, if introduced, was considered good in comparison with other countries in Europe.

Between 1990 and 2000 and until the 2001 outbreak in the UK, Europe was assumed to be free of FMD and threats were thought to be related to the FMD situation in neighbouring countries and in the countries trading with Europe. The long distance spread of a single strain such as the pan-Asian O topotype was not considered an important risk. The risk of entry of FMD virus through illegal import or introduction of infected animal products was also underestimated. One other factor which was not considered was the role of sheep in the spread of the disease.

New evaluation of the threat of introduction of foot and mouth disease into Europe after the outbreak in 2001
 Lessons to be learnt from past outbreaks in Europe
Table V shows the likely origins of the primary outbreaks which occurred in Europe between 1991 and 2001. The origins may be classified as follows:
– illegal introduction of live animals from infected neighbouring countries by smuggling or with forged certificates: Italy 1993, Greece 1994
– legal or illegal importation of meat and animal products: Russia 1995, Balkans 1996, the UK 2001
– escape from laboratories: Russia 1993
– indirect contacts: immigrants in Greece in 1996

Table V
Likely origin of the foot and mouth disease primary outbreaks in Europe (1991-2000)

<table>
<thead>
<tr>
<th>Year</th>
<th>Country</th>
<th>Origin of the primary outbreak</th>
<th>Total number of outbreaks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1991</td>
<td>Bulgaria</td>
<td>Unknown</td>
<td>1</td>
</tr>
<tr>
<td>1993</td>
<td>Italy</td>
<td>Cattle imported with forged certificate</td>
<td>57</td>
</tr>
<tr>
<td>1993</td>
<td>Bulgaria</td>
<td>Unknown</td>
<td>1</td>
</tr>
<tr>
<td>1993</td>
<td>Russia</td>
<td>Laboratory escape</td>
<td>1</td>
</tr>
<tr>
<td>1994</td>
<td>Greece</td>
<td>Illegal import of sheep</td>
<td>95</td>
</tr>
<tr>
<td>1995</td>
<td>Turkish Thrace, Russia</td>
<td>Illegal movement of cattle</td>
<td>1</td>
</tr>
<tr>
<td>1996</td>
<td>Albania, Former Yugoslav Republic of Macedonia, Federal Republic of Yugoslavia, Turkish Thrace, Greece, Bulgaria</td>
<td>Illegal movement of cattle, illegal immigrants, Unknown</td>
<td>130, 39, 1</td>
</tr>
<tr>
<td>2000</td>
<td>Greece</td>
<td>Unknown</td>
<td>14</td>
</tr>
<tr>
<td>2001</td>
<td>United Kingdom, Ireland, France, the Netherlands</td>
<td>Illegal introduction of animal products and swill-feeding</td>
<td>2,060</td>
</tr>
</tbody>
</table>
It is important to underline the difficulties encountered by investigators – Veterinary Services – when trying to determine the exact origin of FMD outbreaks and the source of the virus All European countries – and other countries around the world – have laws and regulations on import and animal movements that, if properly implemented, should prevent the introduction of FMD and other exotic diseases. Therefore, any introduction of FMDV is always the result of illegal action. In this situation, those who are responsible for introduction of the disease will be very reluctant to provide information and when they agree to do so, they rarely tell the full story. This is also the case for the outbreak which occurred in the UK in 2001. The origins mentioned in Table V must therefore be regarded only as being the most likely explanation. However, sometimes the truth is made known later – after several years – when those responsible no longer risk prosecution.

Meat and animal products originating from infected animals imported legally or, more often, illegally, remain a major risk for introduction of the virus. The FMD situation in South America, traditionally an exporter of meat to Europe, had considerably improved between the 1980s and 2000 when FMDV re-occurred in Argentina, Uruguay and Brazil. During the last two decades, imports of beef to Europe from this continent were considered as relatively safe, especially since EUFMD guidelines and EC legislation required maturation and deboning of imported beef (3, 9). As demonstrated in recent years, the major risk for Europe is associated with animals and meat imported or smuggled from Asia or the Middle East and possibly Africa, but not from South America.

If the rules on prohibition of swill-feeding to pigs are not strictly followed, there is a high risk of spread of FMDV through imported meat. It is important to recall that the introduction of the disease to Albania in 1996 and to the UK in 2001 – both resulting in major epidemics – are probably related to swill- or waste-feeding of pigs.

The risk associated with movement of people – tourists and immigrants – originating from FMD-infected countries has often been considered as high for Europe. However this route of introduction of FMDV has never been demonstrated in Europe in the past twenty years. Controls of travellers at points of entry into European countries are weak in comparison with the very strict controls imposed on travellers entering the United States of America and Australia for example. Meat and meat products may be illegally introduced in the luggage of travellers. Fortunately, these products are not systematically infected with FMDV and furthermore, they are usually consumed in urban areas. Under such situations, the probability of FMDV introduction is low and the probability that pigs will be fed the infected product is insignificant. Prohibition of swill-feeding to pigs contributes significantly to eliminating the chain of transmission by this route.

The risk of escape of FMDV from a laboratory is low as long as EUFMD/EC/OIE biosafety measures are followed (21). Only laboratories which fulfil these measures are authorised to manipulate FMDV and virulent material in Europe. Guidelines for biosecurity measures in FMD laboratories were formulated by EUFMD Commission in 1993 (8) and a list of the laboratories and vaccine manufacturers authorised to manipulate FMD virus in the EU is annexed to Directive No. 85/511/EC.

**Geopolitical changes in the last decades and their implications on foot and mouth disease risk to Europe**

The opening of borders and liberalisation of trade have contributed to increasing the risk of introduction and spread of FMDV.

The dismantling of the communist block in the early nineties resulted in large increases in the movement of animals and animal products within the countries of the region and towards western countries in Europe (see ‘Foot and mouth disease in the Community of Independent States and central Asia’ below).

Free movements of commodities, including live animals and animal products, between the EU countries also increases the risk of spreading diseases. This was observed on several occasions for classical swine fever and recently, for FMD introduced into continental Europe by infected sheep transported from the UK. However, the utilisation of an animal movement control system (ANIMO) for notification of movements of live animals within the EU – notification by regional veterinary services of the place of origin of the animals to the place of destination – contributes to better tracing of these movements and to reducing the risk of spread of diseases. The system worked well during the last outbreak in Europe and allowed the tracing of sheep moved in the weeks preceding the outbreak in the UK. This tracing, often followed by pre-emptive culling, contributed to reducing the spread of the disease in continental Europe.

**Effect of the absence of foot and mouth disease in Europe during the last twenty years**

The absence of FMD in most of the European countries for more than twenty years had a negative impact on the level of awareness of the different stakeholders involved in FMD control. When considering surveillance, most farmers, veterinary practitioners and veterinary inspectors have never seen FMD. Within the veterinary services, some countries experienced a substantial reduction of staff devoted to animal health activities while public health and food safety activities were prioritised. In the last ten years, surveillance and control of bovine spongiform encephalopathy (BSE) was given top priority in Europe and limited resources and attention were given to surveillance for exotic diseases including FMD.
Husbandry practices and sociological factors

Three factors are perceived to increase the likelihood of spreading FMD virus if the disease happens to be introduced, as follows:

– long distance animal trading which may introduce disease from outside the region and contribute to its dissemination within the region; the EU rules for protection of animals during transport may increase the risk of spread through contact with other animals during the prescribed rest periods. This was observed for calves transported from Ireland to the Netherlands with a stop-over in France and is, according to the Dutch authorities, the origin of the outbreak in the Netherlands
– dense populations of livestock which facilitates subsequent spread of the virus
– markets which have always played a major role in the dissemination of the virus.

The recent epidemic of FMD in the UK confirms the risk related to the transport of live animals over long distances, often in association with markets. Sheep markets in the UK dramatically amplified the spread of the virus prior to the disease being recognised.

Public opinion pays increasing attention to the livestock industry and the rationale behind decisions taken concerning animal welfare and animal health and such decisions are often challenged. The question on the use of vaccination for controlling the recent epizootic in Europe and reducing the number of animals to be slaughtered, became a matter of public debate in 2001.

Some religious festivities also increase the risk of dissemination of diseases. This is well known in Muslim countries but the episode in Europe in 2001 revealed for the first time the extensive movements of animals, and particularly of sheep, from different origins which take place in the week preceding Hajj. This trade was responsible for the introduction of the virus from the UK to France.

The threat and risk factors identified above can be alleviated using three lines of defence, as indicated below.

First: preventing the entry of the virus
– by increasing security at the borders so as to prevent disease entering the region; reinforcement of control of illegal introduction of animal products is a high priority in Europe
– by promoting an awareness of the threat of disease amongst veterinarians and livestock owners and traders; the last epidemic in Europe revealed that this awareness must concern not only the farming community but also the public in general
– by developing herd and animal identification systems and effective movement certification procedures.

Second: ensuring prompt diagnosis and control should the disease be introduced
– by contingency planning to ensure that the disease is clinically recognised and that resources are available to meet disease emergencies; the delay in recognition and reporting of the first case is critical and determines the size of the outbreak
– by maintaining adequate diagnostic facilities.

Third: being prepared to cope with the worst scenario
– by preparing scenarios for different types of husbandry and especially for highly populated areas/farms
– by validating these scenarios by simulation exercises
– by preparing a contingency vaccination plan, also with different scenarios
– by advance evaluation of economic consequences – particularly relating to trade – of the different scenarios
– by ensuring that a source of vaccine is permanently available (vaccine/antigen bank).

Management of particular risk factors

Control actions that affect normal commercial farming activities can be very costly and disruptive and are therefore difficult to impose and implement. For example, closure of markets at an early stage of the disease is of major importance as demonstrated in the UK in 2001 where a delay of few days had dramatic effect in spreading of the disease.

The sale of sheep for religious festivities should be officially controlled. Sheep must be submitted to inspection and their origin clearly identified.

Swill-feeding should be prohibited.

Foot and mouth disease in the Commonwealth of Independent States and Central Asia

During the existence of the Soviet Union and until the early 1990s, the FMD situation in this region was favourable. This was due to two important factors: the Iron Curtain which had a de facto strong influence on preventing the transboundary movements of animals and the vaccination zone established in the high-risk areas of the southern border of the Soviet Union (Caucasian and Asian borders). The dismantling of the Soviet Union resulted in the opening of the borders and in a progressive reduction in the resources of the National Veterinary Services in the newly independent Republics of the CIS which replaced the Soviet Union.
Considering this dangerous situation, Russia continued to coordinate the activities of surveillance and control of FMD in the region. The ARRIAH, Vladimir, an OIE Reference Laboratory, plays a major role in surveillance and control in the region. However the resources available locally for vaccination campaigns were not sufficient to maintain the buffer zones which existed in the Caucasian region and in the Central Asian Republics at the time of the Soviet Union. Foot and mouth disease was re-introduced to the region as a result of these negative factors. However the global risk of spread from Caucasian region to Russia and Europe is limited (20).

At the request of Russia and of the ARRIAH, an international project for establishing an FMD buffer zone was developed in Trans-Caucasian countries in 1999 and 2000 (Armenia, Azerbaijan, Georgia) by the EUFMD-FAO and financed by the EC. The project was monitored by a Tripartite Group comprising the OIE, the FAO and the EC. During the aforementioned period, efforts were made in Armenia, Georgia and Azerbaijan to eradicate FMD foci and prevent further spread of the disease.

Despite the buffer zone project, FMD persists in the Caucasian region (Fig. 8 and Table VI) as follows:

- type A (similar to A/Iran/96) was identified in Georgia in 1998 (13 outbreaks) and in Armenia (2 outbreaks). The disease due to type A persisted in Georgia in 1999 (6 outbreaks) but the type was not recorded in the region in 2000 and 2001.
- type O (pan-Asian topotype) was identified in spring 2000 in Armenia (4 outbreaks) and in Georgia (4 outbreaks).
- Asia 1 emerged in Georgia and Armenia (21 and 17 outbreaks, respectively) in the middle of 2000 and was also reported in Azerbaijan in 2001. Four outbreaks due to type Asia 1 were diagnosed in cattle in Azerbaijan in July and August 2001. Disease was reported in the Chekinskii District in the

---

**Table VI**

Foot and mouth disease outbreaks in the Commonwealth of Independent States countries and in Central Asia

<table>
<thead>
<tr>
<th>Country</th>
<th>1999</th>
<th>2000</th>
<th>2001</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td>O</td>
<td>Asia 1</td>
</tr>
<tr>
<td>Azerbaijan</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Armenia</td>
<td>–</td>
<td>–</td>
<td>4</td>
</tr>
<tr>
<td>Georgia</td>
<td>6</td>
<td>–</td>
<td>4</td>
</tr>
<tr>
<td>Kazakhstan</td>
<td>–</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Kirghizistan</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Tajikistan</td>
<td>–</td>
<td>–</td>
<td>2</td>
</tr>
<tr>
<td>Russia*</td>
<td>–</td>
<td>–</td>
<td>1</td>
</tr>
</tbody>
</table>

* Foot and mouth disease was diagnosed in the Primorsky Territory
Saki area (northern part of the country), in the Khakassia District, Qax area (northern part of the country) and in the Zaqatala area in the northern part of the country. These were the first cases of FMD reported in Azerbaijan since July 1996.

- Foot and mouth disease attributable to type O and A was recorded in the centre, east and south regions of Kazakhstan in 2000: Karaganda, Zhambyl, Kyzyl-Orda, Almaty, Zhuvalin and Dzhambul Districts, Type O was reported in May 2001 in the Osakarova and Tselinograd Districts.

- Two type O outbreaks of FMD were reported in Ishkashim and in the Shugnan Districts of Tajikistan in June 2000.

- Foot and mouth disease type O occurred in cattle and sheep between February and April 2001 in three districts of Kirghizistan (At-Bashin, Ak-Talin, Ton Districts).

- In Russia, annual FMD-immunisation is carried out in the north Caucasian region (adjacent to Georgia and Azerbaijan). In 2000, one outbreak was diagnosed in Russia on a pig farm in the Primorsky Territory near the Chinese border. The disease was eradicated by destruction of the animals involved, followed by ring vaccination of all susceptible animals.

- Severe outbreaks of FMD type O occurred in Mongolia in 2000. The Kentii, Orkhon and Oulaanbaatar Provinces were infected in March 2000. Twenty-six herds were affected in Ulaanbaatar soum (county) and Dornogovi Province in August 2000. In February 2001, the provinces of Sukhbaatar and Dornod (in the eastern part of the country) were affected by 2 and 3 outbreaks respectively. The FAO provided support to the Government of Mongolia through the supply of expertise and vaccine.

Conclusion

The foot and mouth disease situation in the CIS and particularly in the Caucasian region and Central Asian Republics is cause for concern because of the lack of resources of the countries involved.

In Europe, the FMD situation was satisfactory until 2001 but recent events have revealed that introduction of the disease may have dramatic consequences. Therefore every effort must be made to reduce the threat of FMD by taking appropriate measures sufficiently early within each country – i.e. before any immediate threat occurs – for the benefit of Europe as a whole. All European countries should have a contingency plan based either on the model prepared by the European Commission or that described by the EUFMD Commission. The main element of these plans is to ensure adequate resources to meet disease emergencies. Such plans should be subjected to regular audit to ensure that they are viable in changing circumstances and should be validated by simulation exercises.

The level of awareness of the different stakeholders plays a major role in the early detection of FMD. After little or no FMD in western Europe over the last twenty years, awareness of the disease has decreased dangerously. To improve the level of awareness, training and information are needed. Simulation exercises should be encouraged to verify that the different steps of contingency plans are really in place.

As most of the OIE List A diseases are now exotic to Europe, it is worthwhile considering FMD surveillance in a broader programme which would include the surveillance of all exotic diseases and not only FMD.

Statut de la fièvre aphtueuse et inventaire des méthodes de prophylaxie et d’éradication en Europe et en Asie centrale

Y. Leforban & G. Gerbier

Résumé
n’a donc pas entraîné de multiplication des épizooties de fièvre aphtease. Toutefois, avec ses 2 030 foyers, l’épizootie massive qui a frappé le Royaume-Uni en 2001 a suscité de nombreuses interrogations sur la politique mise en place à ce jour par l’Europe pour combattre la maladie. À l’avenir, le recours à la vaccination en anneau devrait être envisagé comme alternative à l’abattage collectif d’un grand nombre d’animaux. Les auteurs passent en revue les lignes de défense qu’il conviendrait de renforcer pour réduire les risques d’une nouvelle incursion de la maladie, compte tenu des sources récentes d’introduction du virus.

Par ailleurs, ils abordent la situation de la fièvre aphtease dans la Communauté des États indépendants (CEI). L’effondrement de l’Union soviétique s’est soldé par une détérioration de la situation dans les républiques d’Asie centrale et du Caucase, malgré les efforts déployés par la Russie pour leur venir en aide. Faute d’un soutien international, la fièvre aphtease risque de devenir enzootique dans la région.

**Mots-clés**

---

**Repaso de la situación de la fiebre aftosa y métodos de control y erradicación en Europa y Asia Central**

Y. Leforban & G. Gerbier

**Resumen**
Tras describir la evolución que ha seguido la fiebre aftosa en Europa en los últimos 70 años, los autores examinan el origen de la enfermedad y los métodos para luchar contra ella, especialmente desde que a principios de la década de 1990 quedó prohibido en Europa el uso de vacunaciones preventivas. Desde entonces y hasta 2001, y pese a las reiteradas incursiones del virus, siempre se ha logrado contener y erradicar con rapidez la enfermedad. De ahí se deduce que la prohibición que pesa sobre las vacunaciones no ha provocado un aumento del número de brotes de fiebre aftosa. Sin embargo, los tremendos episodios infecciosos que asolaron el Reino Unido en 2001, cifrados en 2.030 brotes, abrieron una serie de interrogantes sobre la política aplicada hasta la fecha en Europa para controlar la enfermedad. En el futuro convendría contemplar el uso de la vacunación perifocal como posible alternativa a la práctica de sacrificios masivos. Basándose en la procedencia del virus que se introdujo recientemente en Europa, los autores repasan las grandes líneas del sistema de defensa y concluyen que sería necesario apuntalarlo para reducir el riesgo de que la enfermedad penetre de nuevo en el continente.

Los autores tratan asimismo la situación de la fiebre aftosa en la Comunidad de Estados Independientes (CEI). Tras el hundimiento de la Unión Soviética, y pese a los incesantes esfuerzos de Rusia por ayudar a las repúblicas centroasiáticas y caucásicas, la situación ha ido empeorando en esos países. Para evitar que la fiebre aftosa adquiera carácter endémico en la región es indispensable el apoyo internacional.

**Palabras clave**
References


